1. Introduction

1.1 Rural Development and Panchayat Raj Department

Rural development is the key to India's economic transformation, as a majority of its population lives in the rural areas. Villages in Tamil Nadu have relatively better facilities and services in terms of electrification, drinking water supply, road connectivity, transportation, education and health infrastructure when compared to most other States. Yet, improving these amenities further so as to bridge the urban- rural divide continuse to drive the policy the focus of the Government of Tamil Nadu.

The Rural Development and Panchayat Raj Department is responsible for the implementation of various centrally sponsored and State funded schemes for poverty alleviation, employment generation, sanitation, capacity building, women's social and economic empowerment, apart from provision of basic amenities and services. The department is also entrusted with the responsibility of enabling the various Panchayat Raj Institutions (PRIs) to function as effective units of Local Self- Government. **There are 12,524 Village Panchayats, 385 Panchayat Unions (co-terminus with Blocks) and 31 District Panchayats under the purview of the department.**

1.2 Panchayat Raj Institutions (PRIs)

Local Self Government in Tamil Nadu has a long history as is evident from the Uthiramerur stone inscriptions in Kancheepuram district. Tamil Nadu, in those days, was a land of village republics, with community groups undertaking many activities for their area development. This tradition reached its peak during the 10^{th}-11^{th} centuries under the reign of Cholas when Village Councils used to levy taxes, improve community life and administer justice in their limited area. These Village Councils had effective links with the Chola rulers. "Kuda Olai Murai" was the name of the secret ballot method exercised to elect members to the Village Councils. With the downfall of Cholas, the State experienced a decline of the Village autonomy and rise of the centralized feudal administrative system. This continued till British rulers introduced local self-governance primarily as an administrative convenience for the imperial Government.

In the post independence era, the first enactment in democratic decentralization in the State was the Madras Village Panchayat Act 1950. Pursuant to the White Paper on the "Reform of Local Administration" in 1957, the Madras Panchayat Act 1958 and Madras District Development Council Act 1958 were enacted with the following salient features:

a) A two tier system of Village Panchayats and Panchayat Unions.

b) Creation of Panchayat Unions co-terminus with the Community Development Blocks.

c) Village Panchayat Presidents to become ex-officio members of the Panchayat Union Councils with the Chairperson of the Panchayat Union Council directly/ indirectly elected.

d) Entrusting the Panchayat Unions and Village Panchayats with a large number of developmental and welfare functions.

e) Abolition of District Boards.

f) Creation of District Development Council as an advisory body.

This two tier system operated very well till 1975 and elections were held regularly. Subsequently, the tenures of the Panchayat Unions and Village Panchayats were extended up to 1.2.1977 and 12.9.1979 respectively. Thereafter, Special Officers (Block Development Officer for all the Village Panchayats in a Block and Divisional Development Officer for all the Panchayat Unions in a Division) managed the rural Local Bodies till the next elections in 1986. The elected rural Local Bodies continued in office till March 1991. Again, no elections were held till October 1996 and the Special Officers managed the rural Local Bodies.

In 1992, the 73rd Amendment to the Constitution was enacted and it brought about a number of fundamental changes in the Panchayat Raj system. Consequently, the Tamil Nadu Panchayats Act 1994 came into force with effect from 22.4.1994. Some of the important changes brought about by the 73rd Amendment to the Constitution and the Tamil Nadu Panchayats Act 1994 are listed below:

a) Introduction of a three tier system – at the Village, Intermediate (Block) and District level.

b) Mandatory conduct of Local Body elections every five years.

c) Introduction of reservation of seats (i.e ward members) and offices (i.e Chairpersons/Presidents) for Scheduled Castes/ Scheduled Tribes in proportion to their population in every Local Body with provision for rotation of the reserved seats and offices.

d) Introduction of reservation of one third of total number of seats and offices for women with provision for rotation.

e) Constitution of a State Election Commission as an independent body to conduct elections to both rural and urban Local Bodies regularly.

f) Establishment of a quinquennial State Finance Commission to recommend devolution of resources from the State Government to the rural and urban Local Bodies.

g) Constitution of a District Planning Committee to consolidate the plans prepared by the rural and urban Local Bodies in the district with a view to preparing a comprehensive development plan for the district.

h) Introduction of the concept of ‘Grama Sabha’ comprising all registered voters in a Village Panchayat.

PANCHAYAT RAJ INSTITUTIONS (PRIs) – Schematic Representation

I-TIER
VILLAGE PANCHAYAT

PRESIDENT (VP)

VICE PRESIDENT

VILLAGE PANCHAYAT WARD MEMBERS

II-TIER
BLOCK PANCHAYAT

CHAIRMAN

VICE CHAIRMAN

BLOCK PANCHAYAT WARD MEMBERS

III-TIER
DISTRICT PANCHAYAT

CHAIRMAN

VICE CHAIRMAN

DISTRICT PANCHAYAT WARD MEMBERS

1.3 Village Panchayat

1.3.1 Functions

Sections 110 & 111 of the Tamil Nadu Panchayats Act, 1994 prescribe the duties and functions of Village Panchayats. Some of the important functions of a Village Panchayat are:

a) Construction, repair and maintenance of all village roads.

b) Extension of village sites and the regulation of buildings.

c) Lighting of public roads and public places in built-up areas.

d) Construction of drains.

e) Cleaning of streets and improvement of the sanitary conditions of the village.

f) Construction and maintenance of public latrines.

g) Sinking and repairing of wells, the excavation, repair and maintenance of ponds or tanks and the construction and maintenance of water-works for the supply of water.

h) Maintenance of burial and burning grounds.

i) Maintenance of parks and reading rooms.

j) Implementation of schemes such as Indira Awaas Yojana (IAY) and Mahathma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) etc.

k) Such other duties as the Government may, by notification, impose.

1.3.2 Administrative powers

The Village Panchayat President himself has been designated as the Executive Authority. Cheques for payment have to be signed jointly by the President and Vice- President. Where the relationship between the two is not cordial, the Collector, in his capacity as Inspector of Panchayats, can designate any other member of the Village Panchayat as joint cheque signing authority along with the President.

The Government have brought out Tamil Nadu Panchayats (Preparation of Plan and Estimates for works and Mode and Conditions of works) Rules, 2007 vide G.O.Ms.No.203 R.D. & P.R. (PR.1) Department, dated 20.12.2007, wherein the

Village Panchayats have been empowered to give administrative sanction and execute individual works up to Rs.2 lakhs from their General Funds. For all works costing more than Rs.2 lakhs but not more than Rs.50 lakhs, the District Collector is the competent authority to give the administrative sanction and for works costing more than Rs.50 lakhs, the Director of Rural Development and Panchayat Raj will be competent to accord administrative sanction. However, the Collector's prior administrative sanction is necessary in respect of all Centrally sponsored and State funded schemes. Village Panchayats have also been given freedom to execute urgent works up to Rs. 2,000 at a time and up to Rs. 5,000 in a year without any technical approval. The President can draw self cheque up to Rs. 500 to meet contingent expenditures.

The Village Panchayats have been given necessary delegation of powers to enable them to attend to repairs and maintenance of hand pumps, power pumps and street lights promptly. They can spend Rs.600 per hand pump per year and up to Rs.7,500 per power pump per year without reference to engineers for preparation of estimates or passing of bills. They can buy street light materials meeting the prescribed quality norms on their own.

1.4 Panchayat Union Council

At the intermediate level, there are 385 Panchayat Unions (Blocks) in the State. The average number of Panchayat Unions per district is 13. The Nilgiris (4) has the lowest number of Panchayat Unions while Villupuram (22) has the highest number.

1.4.1 Functions and Powers

Section 112 of the Tamil Nadu Panchayats Act, 1994 prescribes various powers and functions of Panchayat Union Councils. Some of the important functions of a Panchayat Union Council are:

a) Construction, repair and maintenance of all Panchayat union roads.

b) Construction of water works for the supply of water for drinking, washing and bathing purposes.

c) Construction and maintenance of elementary and middle schools.

d) Control of fairs and festivals under the control of the Panchayat Union.

e) Opening and maintenance of Panchayat Union public markets.

f) Implementing various Centrally sponsored and State funded schemes.

g) Preventive and remedial measures connected with any epidemic or with malaria.

1.5 District Panchayats

There are 31 District Panchayats in the State.

1.5.1 Functions

The functions of the District Panchayats are mainly advisory in nature such as:

a) Preparation of development plan for the district.

b) Compilation of administration reports of Village Panchayats and Panchayat Union Councils of the district and preparation of Annual Report for the District.

c) Planning and review of Agriculture, Land Development, Animal Husbandry, Dairy, Poultry, Fisheries and Rural Industries etc.

d) Planning and review of rural housing programmes particularly housing for SC/STs.

e) Identification of major water supply schemes.

1.6 Administrative Structure

1.6.1 State Level

The Secretary to Government, Rural Development is in charge of Rural Development Department at Government level. The Director of Rural Development & Panchayat Raj (DRD & PR) is the Head of the Department at State Level. Additional Directors assist the Director along with Joint Directors and Assistant Directors. On the Budget, Accounts and Audit matters, a Financial Advisor cum Chief Accounts Officer and three Accounts Officers assist the Director of Rural Development and Panchayat Raj.

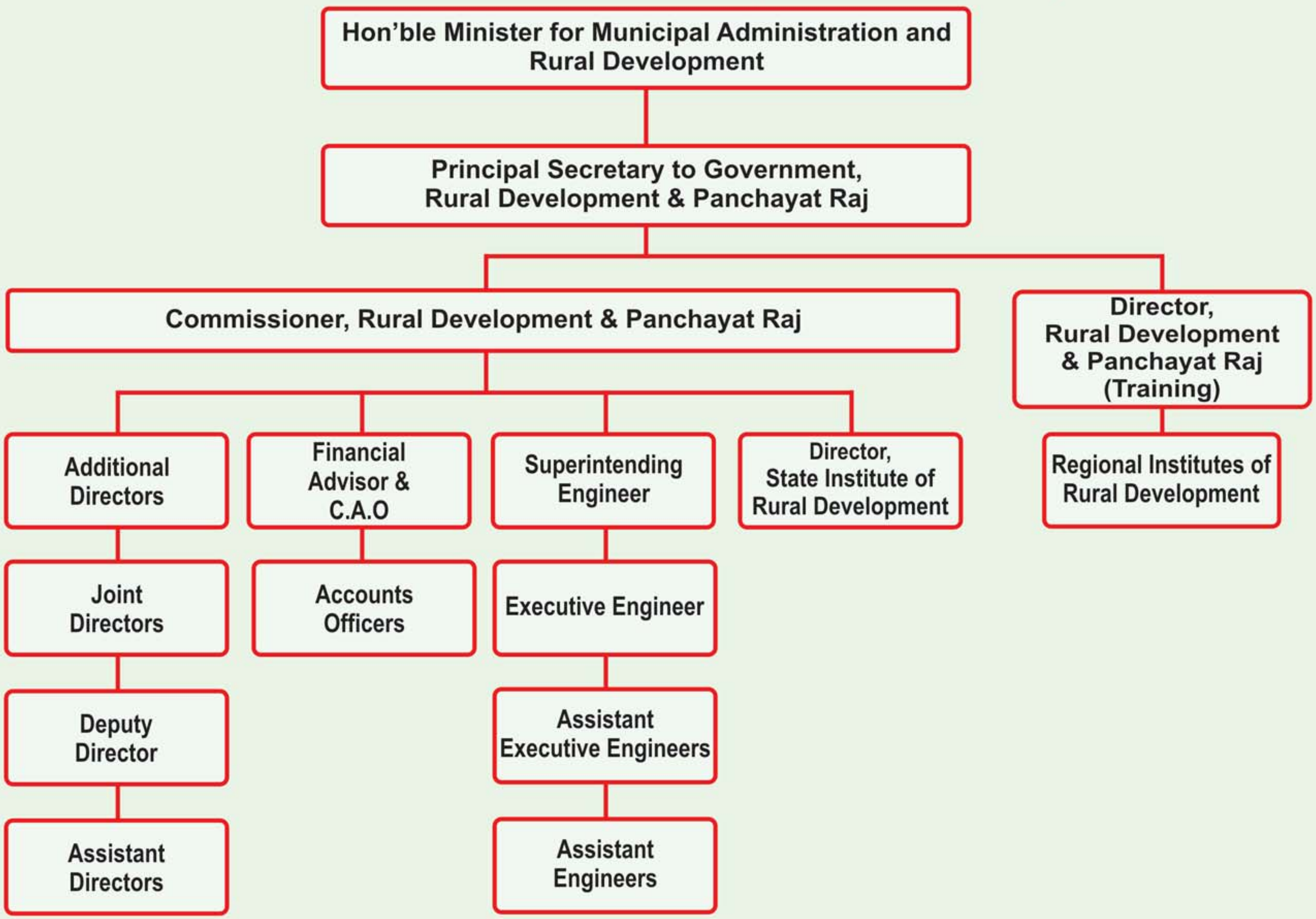
1.6.2 District Level

At the district level, a District Rural Development Agency has been formed for formulating and monitoring the development schemes with District Collector as Chairman. The Project Director is looking after the functions, assisted by an Executive Engineer and a team of Assistant Project Officers.

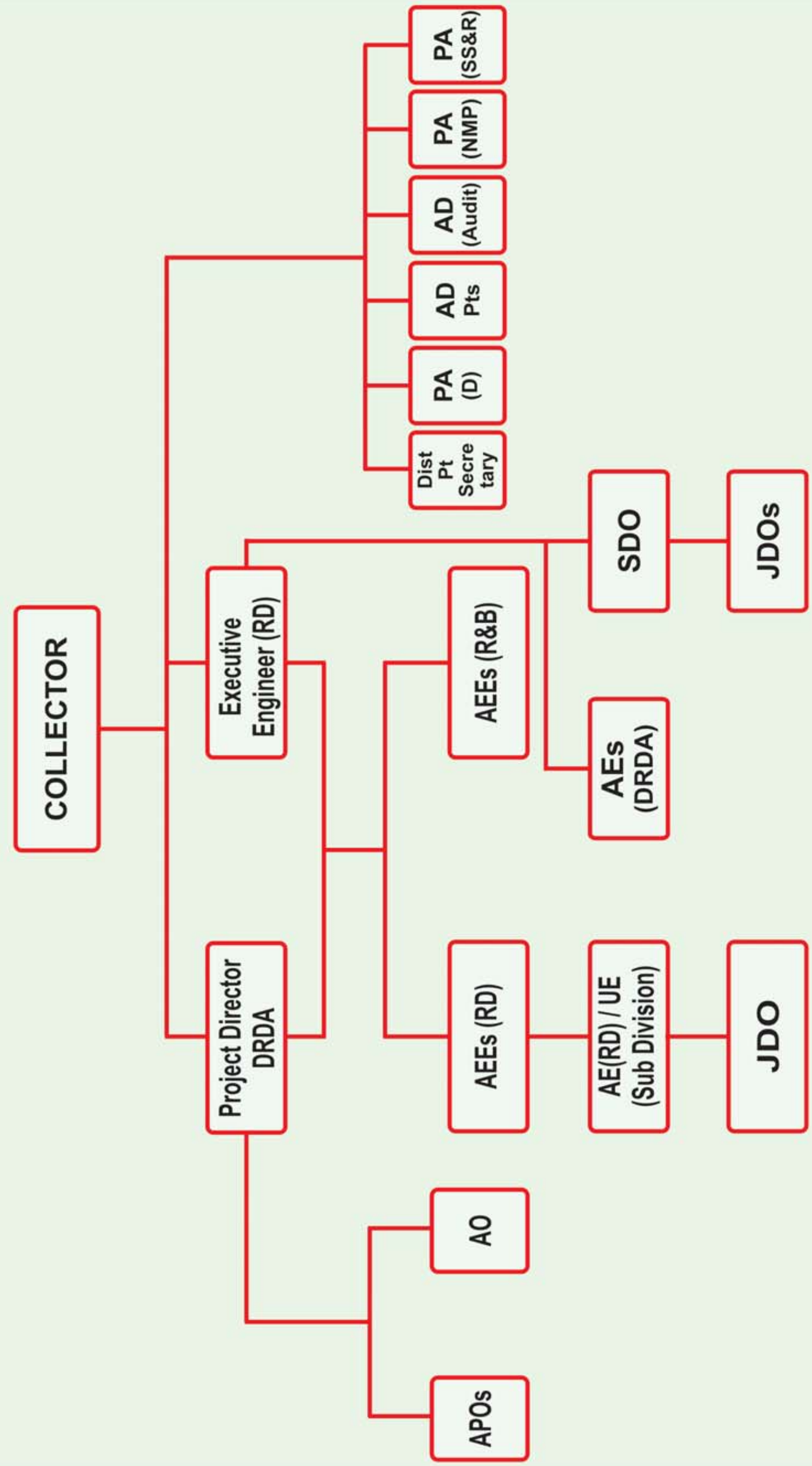
1.6.3 Block Level

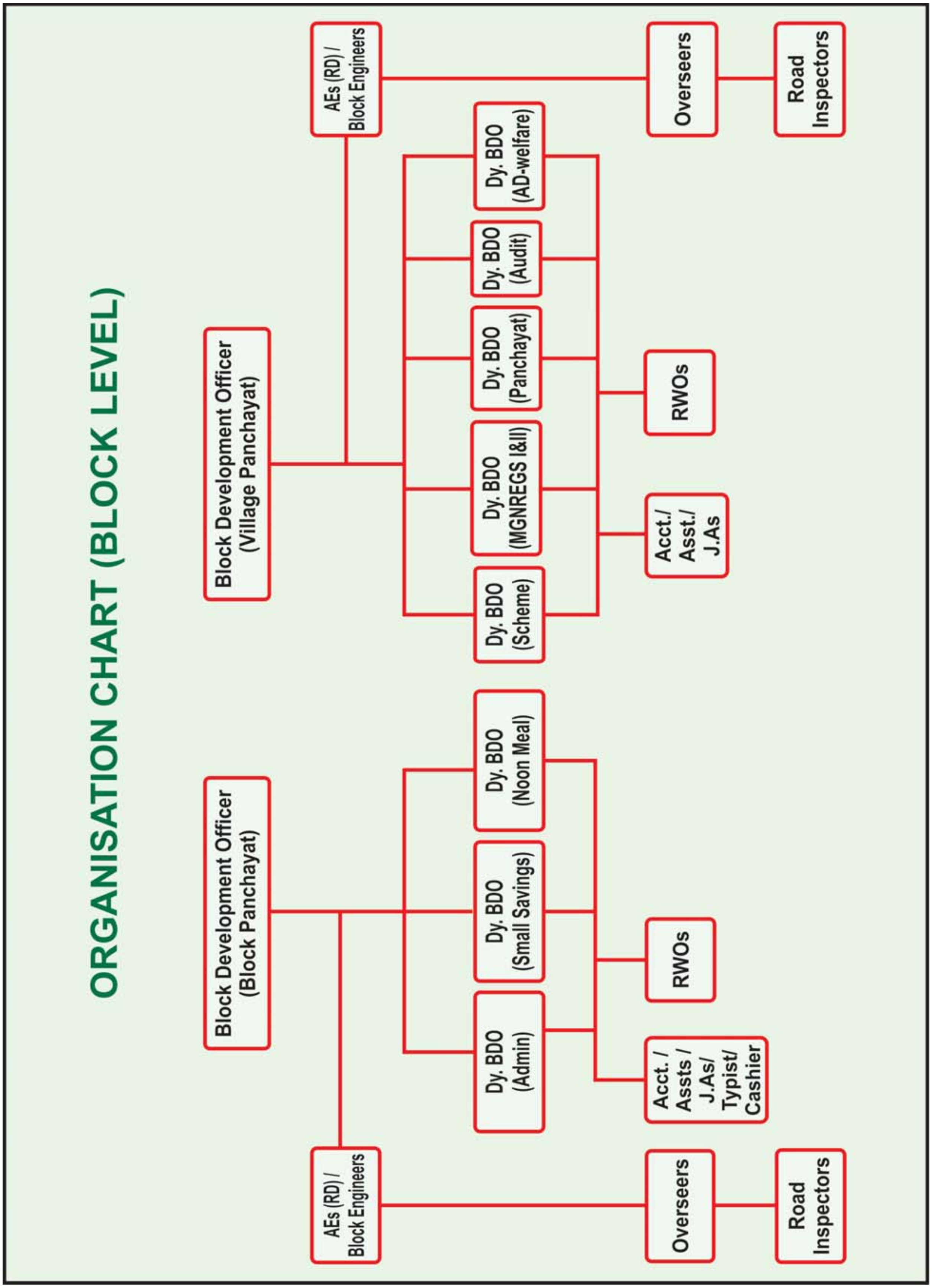
At the Block Level, at present, there are two Block Development Officers designated as Block Development Officer (Block Panchayat) and Block Development Officer (Village Panchayat). All Development works and programmes are executed through Panchayat Union Councils / Village Panchayats. The Block Development officer (BP) is also the Commissioner of Panchayat Union and the Executive Authority of the Panchayat Union council. The Block Development Officer (VP) is in charge of implementing to various centrally sponsored schemes. A team of Deputy Block Development Officers and Administrative Staff assist the Block Development Officer (BP) and the Block Development Officer (VP).

ORGANISATION CHART (STATE LEVEL)

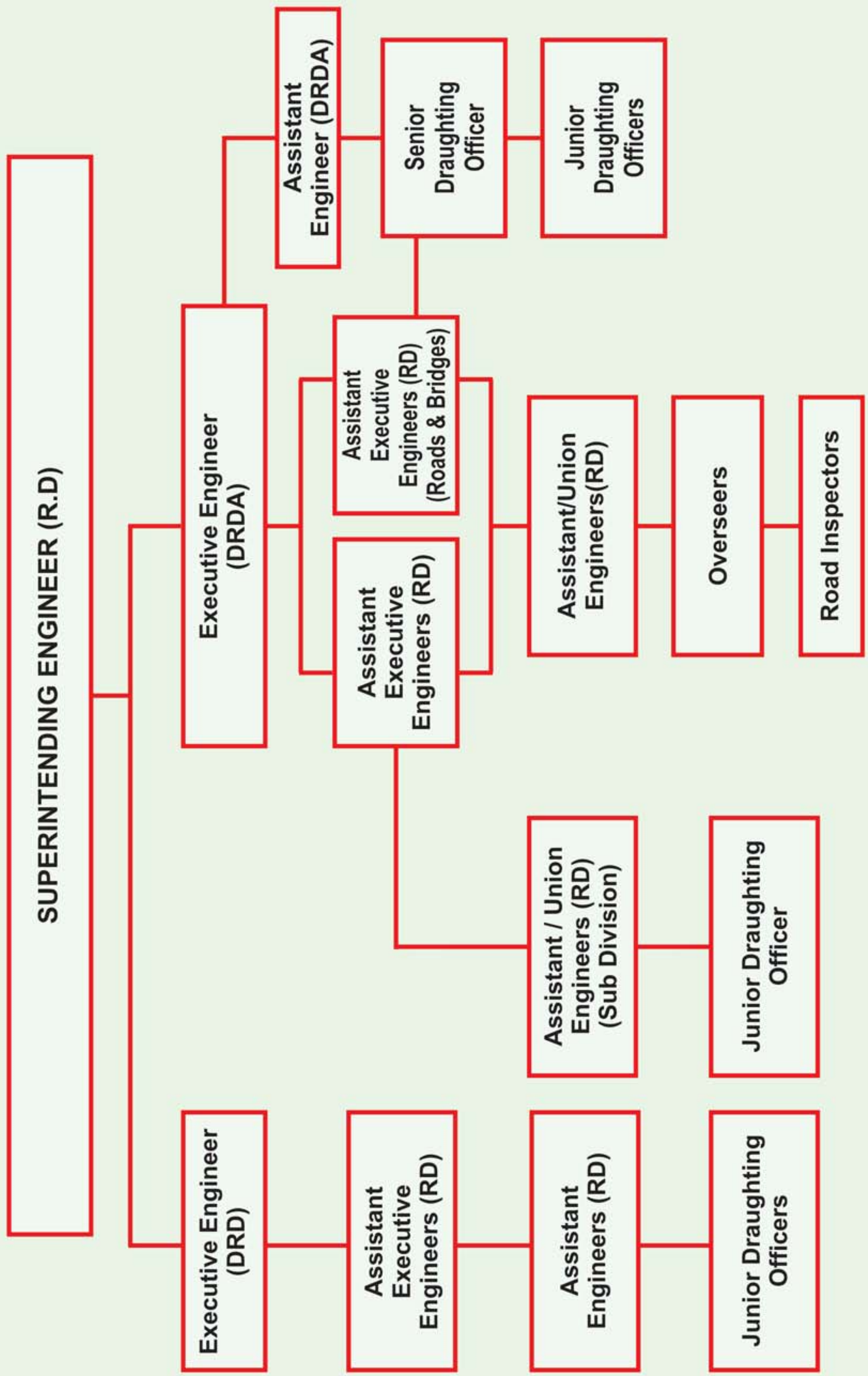


ORGANISATION CHART (DISTRICT LEVEL)




ORGANISATION CHART (BLOCK LEVEL)
Block Development Officer (Block Panchayat)
AEs (RD) / Block Engineers
Overseers
Road Inspectors
Dy. BDO (Admin)
Dy. BDO (Small Savings)
Dy. BDO (Noon Meal)
Acct. / Assts / J.As/ Typist/ Cashier
RWOs
Block Development Officer (Village Panchayat)
Dy. BDO (Scheme)
Dy. BDO (MGNREGS I&II)
Dy. BDO (Panchayat)
Dy. BDO (Audit)
Dy. BDO (AD-welfare)
Acct./ Asst./ J.As
RWOs
AEs (RD) / Block Engineers
Overseers
Road Inspectors

ORGANISATION CHART (TECHNICAL WING)



2. WORKS

2. WORKS

2.1. Introduction

Rural Development and Panchayat Raj (RD&PR) Department is implementing multifarious works such as construction of buildings, roads, bridges, culverts, water harvesting structures, implementation and maintenance of water supply works in rural areas. The following chapters explain the various technical aspects involved in the execution of building works.

2.2. Type design drawings for works

In Rural Development and Panchayat Raj (RD&PR) Department, Standard Type Design Drawings prepared and approved at the Directorate are adopted for some of the standard buildings. For non- standard buildings, the type designs are prepared as per site conditions at the district level.

2.3. Specification of works

Specification describes the nature and the class of the work, materials to be used in the work, workmanship, etc. and is very important for the execution of works. Specifications should be clear and should not be ambiguous. Drawings do not furnish all the details of items of work. For details such as materials, mix proportions, quality, workmanship, etc., specifications are to be referred. The combination of drawings and specifications defines the structure completely.

For Buildings, Standard Specifications as per TNBPSS / MDSSS/NBC and for road works Standard Specifications for Rural Roads published by MoRD are to be followed.

2.4. Standard Data for Preparing Rates

For building works, Standard Data Book published by Public Works Department and for road works, road data prepared by Highways Department are followed. For road works to be executed under PMGSY scheme, Standard Data Book published by MoRD (Ministry of Rural Development) is to be followed.

2.5. Adoption of PWD and Highways Schedule of Rates

The rates of works, materials, labour, etc., vary from place to place. But to have a common method of working out rates, the current Schedule of Rates published by Public Works Department has to be used for arriving rates of items of works in building estimates and estimates of related works such as retaining wall, compound wall, etc.

In case of estimates of road works, for labour and machinery charges, current rates as approved by Highways Department is being adopted. For MGNREGS works (Mahatma Gandhi - National Rural Employment Guarantee Scheme), Rural Schedule of Rates published by RD&PR department is to be followed. For all water supply works, Schedule of Rates prepared by TWAD board should be adopted.

2.6. Survey and Site Inspection for Collecting Particulars for Estimate Preparation

The survey includes reconnaissance, preliminary survey and detailed survey. Reconnaissance means general examination of the ground by walking or riding along the probable routes and collecting all necessary information. Preliminary survey is a relatively large scale instrument survey, conducted for the purpose of collecting all physical information which is required to prepare site plan, longitudinal profile, cross section, contours and to ensure the type of proposal.

Prior to estimate preparation, the site should be inspected first, the preliminary survey to be conducted, the details such as topography, nature of soil and land, ground water table at site during various seasons, presence of water retaining structures and other structures / land marks nearby, etc., are to be collected. The location of culverts, drains, retaining walls etc., are to be decided as per site conditions.

Site selection should be done keeping in mind the following points:

1. Submerged soil, marshy land and made up soil.
2. Areas prone to seismic, land slide etc.
3. Sites involving Land acquisition, patta lands, disputed lands.
4. Site below the crossing of live Electric lines.

   The above sites should not be selected

2.7 Testing of Soil Strata before Preparation of Estimates

The strength of soil is to be tested prior to estimate preparation. In case of major building works such as multistoreyed building or bridges, the plate load test or standard penetration test should be conducted to arrive at the safe bearing capacity (SBC) of the soil. Based on the SBC and nature of soil below foundation level, the foundation type and size are decided. In case of black cotton soil or soil of poor strength, necessary precautions should be taken to decide the type of foundation and to adopt necessary soil stabilization techniques.

2.8. Implementation of Works

The implementation of a work involves the following activities:

a. Preparation of Detailed Project Report.

b. Administrative approval and Technical sanction.

c. Invitation of tenders and Award of contract

d. Execution of works.

e. Payment of Bills

d. Preparation of Completion Report

2.9 Administrative Sanction

Administrative approval of the competent authority is a pre-requisite to take up any work. It is in effect an order to execute a specified work at a stated cost.

Article 38 of Tamil Nadu Financial Code lays down that no Government Servant may incur any item of expenditure from public funds unless,

a. The expenditure must have been sanctioned by a general or special order of the Authority Competent to sanction such expenditure and

b. Sufficient funds must have been provided for the expenditure in the appropriation acts for the current financial year

Before according the Administrative Sanction, the site plan, survey number of land, ownership of the land in which the work has to be carried out are to be verified.

The powers of according administrative sanction for works are detailed below:

(1) In respect of Central Government sponsored and State Government funded scheme works, the authority competent to accord administrative sanction including revised administrative sanction, shall be the District Collector in respect of Village Panchayats, Panchayat Union Councils and District Panchayats.

(2) In respect of original, maintenance and electrical works taken up under the General Funds of Village Panchayats, Panchayat Union Councils and District Panchayats, the authorities competent to accord administrative sanction, including revised administrative sanction shall be as specified in Tables I, II and III below:- G.O. (Ms) No. 203 (PR I) dated: 20.12.2007

TABLE – I

VILLAGE PANCHAYAT

Estimate Value (1)	Competent Authority (2)
(1) Works costing not more than rupees two lakhs.	Village Panchayat.
(2) Works costing more than rupees two lakhs but not more than rupees fifty lakhs.	District Collector.
(3) Works costing more than rupees fifty lakhs.	Director of Rural Development and Panchayat Raj

TABLE - II
PANCHAYAT UNION COUNCIL

Estimate Value (1)	Competent Authority (2)
(1) Works costing not more than rupees ten lakhs.	Panchayat Union Council
(2) Works costing more than rupees ten lakhs but not more than rupees fifty lakhs.	District Collector.
(3) Works costing more than rupees fifty lakhs.	Director of Rural Development and Panchayat Raj

TABLE - III
DISTRICT PANCHAYAT

Estimate Value (1)	Competent Authority (2)
(1) Works costing not more than rupees twenty lakhs.	District Panchayat
(2) Works costing more than rupees twenty lakhs but not more than rupees fifty lakhs.	District Collector
(3) Works costing more than rupees fifty lakhs.	Director of Rural Development and Panchayat Raj

2.10 Technical Sanction

On receipt of Administrative Sanction, detailed investigation is carried out and a detailed project estimate comprising,

i) Soil Investigation Report

ii) Specifications

iii) Detailed plans and drawings

iv) Detailed statement of measurement, quantities and rates

v) An abstract showing the total estimated cost of the work is prepared. (Circular No.78212/ 2011/TU3/dated 22.12.2011)

The Competent Authority i.e Superintending Engineer / Executive Engineer / Assistant Executive Engineer / Assistant Engineer after satisfying himself about the efficacy and economical nature of the design, accords technical sanction to the estimate. Administrative approval and technical sanction are fore runners for invitation of tenders for execution of work.

2.10.1 Delegation of Powers

The powers for according Administrative Sanction and Technical Sanciton, Measurement and Check measurement and Tender Inviting, Accepting and Scrutiny of Tenders for various works taken up under General funds of local bodies and Scheme funds in the Rural Development and Panchayat Raj Department are specified in the G.O. (Ms.) No. 203, Rural Development & Panchayat Raj (P1) Department, dated 20.12.2007, G.O. (Ms.) No. 204, Rural Development & Panchayat Raj (P1) Department, dated 24.12.2007 and G.O. (Ms.) No. 132, Rural Development & Panchayat Raj (PR1) Department, dated 04.08.2008.

Sl. No.	Competent Authority	Original Works	Maintenance Works	Electrical Works
1.	Block Engineer/ Asst. Engineer (Rural Development and Panchayat Raj)	Not more than Rs.1 lakh	Not more than Rs.25,000	Not more than Rs.25,000.
2.	AssistantExecutive Engineer (Rural Development and Panchayat Raj)	More than Rs.1 lakh and not more than Rs.5 lakhs	More than Rs.25,000 and not more than Rs.2 lakhs	More Rs.25,000 and not more than rupees Rs.2 lakhs.
3.	Executive Engineer (Rural Development and Panchayat Raj)	More than Rs.5 lakhs and not more than Rs.30 lakhs.	More than Rs.2 lakhs and not more than Rs.10 lakhs	More than Rs.2 lakhs and not more than Rs.10 lakhs
4.	Superintending Engineer (Rural Development and Panchayat Raj)	More than Rs.30 lakhs.	More than Rs.10 lakhs.	More than Rs.10 lakhs.

2.11 Preparation of estimates

In preparing an estimate, the quantities of different items of work are calculated by the simple mensuration method and from these quantities, the cost is calculated. Knowledge of drawings and interpretation of drawings is essential to prepare detailed estimate of quantities. In preparing an estimate one has to go into details of each item, big or small, and nothing can be left or missed.

Accuracy in estimate is very important. If the original estimate is exceeded, it becomes very difficult for engineers to explain, to account for and arrange for the additional money. Inaccuracy in preparing estimate, omission of items, change in designs, improper rates, etc., are reasons for increase in the estimate.

In preparing a correct estimate, care should be taken to find out the dimensions of all the items correctly and to avoid omission of any kind of work or part thereof. The rates in the estimate should provide for the entire work, which consist of the cost of materials, cost of transport, cost of labour, cost of scaffolding, cost of tools and plants etc.

Before preparing the estimate, the site of work should be verified thoroughly. Detailed survey should be conducted such as topography, site soil exploration etc.. Necessity and need of the work should be studied thoroughly.

For site soil exploration, trial pits at the site of work may be dug to a considerable depth to fix the depth of foundation and to select the type of foundation in case of buildings / bridges and culverts so as to minimize the settlement of foundation incase of black cotton soil or formation of any crack in future due to settlement and for an economical cost leading to stability of the structure. Based on the tests conducted and enquiries made, a comprehensive project report should be prepared.

2.11.1. Detailed Estimate

The estimates should be accompanied with the following:

1. Check Slip
2. Detailed Specification Report
3. Abstract Estimate
4. Detailed Estimate
5. Key Map
6. Lead Statement
7. Data
8. Detailed drawings showing Plan, Elevation and Cross section.

2.11.2 Schedule of Rates

Schedule of Rates is approved every year by the Public Works Department and Highways Department for materials, labour, works, and conveyance of materials. Quarry chart is also approved every year by PWD and Highways departments for HBG metal, sand, gravel etc.

2.11.3 Preparation of Key Map & Lead Statement

Key map is nothing but a map showing the shortest routes for the conveyance of materials from the approved source/quarry to the work site.

Lead statement is the working sheet of the distance required to transport the materials from the source to the work site.

2.11.4 Key Map Details

1. Location of site and quarry(s) of all required materials is to be marked in the Block or District map.
2. Identify the shortest route for transportation of materials from quarry(s) to work site.
3. Calculate the shortest distance in Kms from quarry(s) to work site for all the materials.

2.11.5 Standard Data and Data Preparation

The Standard Data Book for civil works is available for PWD and Highways Department. The required data are prepared for civil works based on the above Standard data with reference to the current Schedule of Rates of PWD and Highways Department.

2.11.6 Preparation of Detailed Estimates

1. The detailed estimates are prepared for the works which are to be implemented for which Administrative Sanction has been given.
2. For each work, the site measurements have to be taken.
3. Trial pits have to be dug at the site for deciding the foundation.
4. For the preparation of detailed estimates for buildings, the type designs already approved can be adopted.

2.11.7 Preparation of Abstract Estimates

1. After preparation of detailed estimate, the abstract estimate is prepared by incorporating the quantities in the detailed estimate and also adopting the data already prepared.
2. The total cost of estimate will be finally arrived.

2.11.8 Specification Report

Every estimate is accompanied with detailed specification report. The details such as name of the work, name of the programme / Scheme, necessity and need of the proposed work, administrative sanction details, estimate cost, location of the proposed work, nature of topography, details of items proposed along with their material specifications, year of schedule of rates followed and other salient features if any are furnished in the specification report.

2.11.9 Check Slip

The model check slip is furnished below.

CHECK SLIP FOR BUILDINGS			
Check slip for scrutiny and Sanction of Estimate			
1	Name of Work	:	
2	Name of Scheme under which taken up	:	
3	Whether Administrative Sanction Obtained	:	
	a.Sanction No. and Date	:	
	b.Amount of Sanction	:	
4	Nomenclature as per A.S.	:	
5	Amount of Estimate now Prepared	:	
6	Whether Detailed Specification Report is attached	:	
7	Whether Lay out Plan is enclosed	:	
8	Whether Soil investigation report is enclosed	:	
9	No. of floors proposed in the estimate	:	
10	Ultimate No. of floors designed for	:	
11	Does the site require filling. If so, whether provision is made in the estimate?	:	
12	If the cost of filling is high whether it is supported by L.S and C.S	:	
13	Whether analysis and design of the structure enclosed	:	

LAY OUT AND SITE PLAN DETAILS			
1	A Site plan for a scale of 1: 500 with the following details.	:	
	a. North point	:	
	b. Survey No. Sub - Division details etc.	:	
	c. Measurement of the Site	:	
	d. Spot levels of the site indicating reference to B.M and its location.	:	
	e. Existing roads, pathways, streams, Railway line and structures with measurement within the site and adjoining land.	:	
	f. Power lines, Telephone lines, Water supply and Drainage lines within the site if any.	:	
2	Classification of the land such as Patta / Poramboke / Wet / Dry.	:	
3	Extent of the land	:	
4	Nature of Site, whether low lying / sloping / level ground.	:	
5	Whether there is rock out crop within the site and if so location may be indicated in the site plan.	:	

SOIL TEST DETAILS

1	Type of soil	:	
2	Safe Bearing Capacity of the soil	:	
3	Standard penetration test or cone penetration test.	:	
4	Percentage of swelling of soil	:	
5	Trial Pit / Bore log Locations	:	
6.	No of Trial Pits / Bore log Locations	:	

DESIGN DETAILS			
1	Whether design details of following structural members enclosed.	:	
	a. Foundation	:	
	b. Column	:	
	c. Beam	:	
	d. Slab	:	
2	If framed structure, whether frame analysis done or not?	:	
	DETAILED DRAWINGS:		
1	Whether the following drawing sheets enclosed.	:	
	a. Plan, Section and Elevation in single sheet.	:	
	b. Structural drawing showing the details of reinforcement for members	:	
2	Whether detailed bar bending schedule enclosed?	:	
	MISCELLANEOUS:		
1	Whether current schedule of rates adopted.	:	
2	Whether key map and lead chart / statement attached duly signed by the Executive Engineer.	:	
3	Whether the following certificates are furnished.	:	
	a. Certified that the particulars furnished above are based on the site inspection and are correct.		
	b. Certified that the provisions made under L.S are adequate and don't warrant revision		

2.12 Unit Cost

The Unit cost for approved type design building and road works is worked out with reference to the schedule of rates and approved by the District Collector every year.

2.13. Tendering

The entire process under which the execution of works are entrusted to eligible and qualified bidders by inviting sealed tenders to execute the work within a given time frame under certain conditions is defined as tendering.

2.14 Registration of Contractors

1. The current solvency certificate should be verified at the time of registration. The minimum solvency should be 30% of the value of the class of the registration sought for.
2. Evidence for Previous certificate should be furnished by the contractor.
3. Income tax and Sales tax clearance certificate should be furnished by the contractor.

2.14.1 Application for Registration

A contractor shall first apply for registration in the prescribed form annexed to rules, to the appropriate authority, as the case may be, with reference to the class and jurisdiction of work for which he is eligible.

2.14.2 Classification of Contractors
(G.O. (Ms.) No. 251, Highways(NH) Dept., dt. 12.10.2007)

As per PWD & Highways Department	
Classification	**Amount Eligible**
Class I	Above Rs.75.00 Lakh
Class II	Up to Rs 75.00 Lakh
Class III	Up to Rs.30.00 Lakh
Class IV	Up to Rs.15.00 Lakh
Class V	Up to Rs. 6.00 Lakh

In Rural Development department, the classification of the contractors as per the PWD and Highways department is followed.

2.15 Tendering of Works

2.15.1. Salient Features of Tamil Nadu Transparency in Tender Act, 1998 and Rules 2000

The Government of Tamil Nadu have framed the rules as Tamil Nadu Transparency in Tender Rules, 2000 in G.O. (Ms.) No. 446 Finance (salaries) Department dated 26.09.2000 based on Tamil Nadu Transparency in Tender Act, 1998 to ensure open and fair procedures while undertaking construction and procurement of goods and services by the Government and Governmental organisations. (See Chapter11)

2.15.2. Preparation of Tender Documents and Tender Schedule

The tender documents and tender schedule are prepared by the office of tender inviting authority after necessary administrative sanction and technical sanction of the work has been awarded. It shall contain the following:

1. Invitation of bids (I.O.B)
2. Instruction to bidders (I.T.B)
3. Forms of bid, qualification information, letter of acceptance, agreement form.

4. Conditions of contract and special conditions to contract
5. Contract data
6. Specifications
7. Drawings
8. Bill of quantities
9. Forms and securities for bid security, performance security, security for advance by way of bank guarantees

2.15.3 Calling of Tender

The notice inviting tenders shall contain the following details:

1. The name and address of the procuring entity and the designation and address of the Tender Inviting Authority
2. The name of the scheme and project
3. The date up to which and places from where the tender documents can be obtained
4. The amount of Earnest Money Deposit payable
5. The last date, time and place for opening of tenders received
6. Any other information the tender inviting authority considers relevant.

2.15.4 Publicity of Tender Notice

2.15.4.1 State Tender Bulletin

The notice inviting tenders and decisions on tenders shall be published in the State Tender Bulletin in cases where,

a. The value of procurement/work exceeds Rupees Twenty Five Lakhs.
b. In any other case where the tender inviting authority deems it fit.

2.15.4.2 District Tender Bulletin

The notice inviting tenders and decisions on tenders in all cases where the value of tender exceeds Rupees Five Lakh and below Rupees Twenty Five Lakh shall be published in the District Tender Bulletin of the district.

If the value of tenders is less than Rs.5 lakhs the tender notice may be displayed in the notice board in the office calling tender

2.15.4.3 Norms for Publication of Notice Inviting Tenders in Newspapers (G.O. (Ms.) No.307, Finance (Salaries) Dept., dt.1.11.2011)

Sl. No.	Number of Dailies and Editions in which advertiesments are to be issued	Estimated value of Construction work	All other categories of procurement inclusive of materials, equipments, food items and consultancies for Construction
(1)	**District level Advertisement:** Advertisements in Two Tamil Dailies. (District-level editions only)	Above Rs. 10.00 Lakhs and upto Rs 25.00 Lakhs	Above Rs. 5.00 Lakhs and upto Rs. 10.00 Lakks
(2)	**State level Advertisement** Advertisements in one English Daily (Tamil Nadu edition) and one Tamil Daily. (All editions in Tamil Nadu)	Above Rs. 25.00 Lakhs and upto Rs. 1.00 Crore	Above Rs. 10.00 Lakhs and upto Rs. 25.00 Lakhs
(3)	Advertisements in One English Daily (South India edition) and One Tamil Daily (All editions in Tamil Nadu)	Above Rs. 1.00 Crore and upto Rs. 5.00 Crores.	Above Rs. 25.00 Lakhs and upto Rs. 1.00 Crore
(4)	Advertisement in one English Daily (All India edition) and One Tamil Daily (All editions in Tamil Nadu)	Above Rs. 5.00 Crores.	Above Rs. 1.00 Crore
(5)	Publication in Indian Trade Journal	Above Rs. 50.00 Crores	Above Rs. 50.00 Crores.

2.15.4.4 Minimum Time Limit for Submission of Tenders

a. Up to Rupees 2 crores in value: 15 days

b. Above Rupees 2 crores in value : 30 days

2.15.5 Cost of Tender Documents

The Government departments which issue tender documents should notify the cost of tender documents inclusive of sales tax and also ensure proper accounting by requiring the cost of tender documents and sales tax to be noted separately in column, head of account in the chalan.

SALE PRICE OF TENDER DOCUMENTS
(G.O. (Ms.) No.253, Revenue (NC.IV-I) Dept, dt.15.5.2007)

Sl. No.	Value of Work	Cost of BidDocument
1	Upto Rs. 2 lakhs	Rs.250 + VAT
2.	Above Rs. 2 lakhs and upto Rs. 50 lakhs	Rs.500 + VAT
3.	Above Rs. 50 lakhs	Rs.1000 + VAT

2.15.6 E-Tendering

The objective of the Tamil Nadu Transparency in Tender Act, enacted in 1998 by the Government of Tamil Nadu is to make the tendering process even more transparent. Tenderers may download the tender documents from the designated website free of cost.

2.15.7 Earnest Money Deposit

While submitting a tender, the tenderer has to deposit with the department an amount ordinarily not exceeding 1% of the value of the contract by means of demand draft, banker’s cheque, specified small savings instruments. The tender documents shall clearly state that any tender submitted without EMD in the approved form shall be summarily rejected except those cases which have been specifically exempted by government orders.

2.15.8 Security Deposit

As soon as the tender has been accepted, the successful bidder has to deposit with the Department an amount not exceeding 5% of the contract value at the time of execution of the agreement. The amount is kept as a security so that the contractor fulfils the terms and conditions of the contract and carries out the work satisfactorily in accordance with the specifications. In case the contractor fails to fulfill the terms of contract, the whole or part of this deposit can be forfeited by the department. The withheld amount for effective performance of the contract, should not exceed 10% of the contract value.

2.15.9 Variation in quantity

The quantity proposed to be procured in the tender shall be indicated in the tender document and the tender accepting authority shall ordinarily be permitted to vary the quantity finally ordered only to the extent of 25% either way of the requirement indicated in the tender document.

In case of procurement in special cases, where it is necessary to have more than one supplier, the authority may place orders on the tenderer quoting the lowest evaluated price for **not less than 60% of the quantity covered in the** and place orders for the remaining quantity on the tenderer(s) quoting the next lowest prices provided they decept the lowest evaluated price. (Section 31, Chapter 7 of Tamilnadu Transparency in Tender Rules 2000)

2.15.10 Exemptions in Tender Act

This act shall not apply to procurement in the following cases.

- During natural calamities and emergencies declared by the Government.
- Available from single source only from a supplier or cases in which a particular supplier or contractor has exclusive rights in respect of the goods or services or construction and no reasonable alternative or substitute exists or where the procuring entity having procuring goods, equipment, technology from a supplier or contractor determines that additional supplies must be procured from that specific supplier or contractor for reasons of standardization and compatibility with the existing goods, equipment or technology.

- From the rate contracts of Director-General of Supplies and Disposals (DGS&D).
- Cement from Tamil Nadu Cement Corporation Limited (TANCEM) and or of paper from the Tamil Nadu Newsprints and Papers Limited.

  - (Section 16 of TTTA 1998)

2.15.11 Applicability of Tender Act / Rules in cases of funded works

The procurement of Tamil Nadu Transparency in Tender Act, 1998, to the extent they are not consistent with the procedure prescribed in the projects funded by International agreements or by International Financial Agencies shall not apply.

2.15.12 Opening of Tenders

1. All the tenders received by the Tender accepting Authority shall be opened at the time specified in the notice inviting Tenders.
2. The tenders shall be opened immediately after the closing time specified for the receipt of tenders allowing a reasonable period, not exceeding one hour, for the transportation of the tenders received to the place they are to be opened in the presence of the tenderers.
3. The tenders will be opened in the presence of the tenderer or one authorised representative of the tenderer who chooses to be present.

2.15.13 Procedure to be followed for Tender Opening

The following procedure shall be followed for the tender opening:

a. All the envelopes received containing tenders shall be opened.

b. Any tender received subsequently shall not be opened and shall be returned unopened to the tenderer.

c. On opening the tender, the members of the tender scrutiny committee shall initial the main bid including the prices and any corrections.

d. A record of the corrections noticed at the time of bid opening shall be maintained.

e. The name of the tenderers and the quoted prices should be read out.

f. The fact whether earnest money deposit has been submitted and other documents produced may be indicated but this shall be merely an examination of the documents and not an evaluation.

g. Minutes of the tender opening shall be recorded. The signatures of the tenderers present shall be obtained unless any of the tenderers or his representative refuses to sign the minutes.

2.15.14 Tender Register

The tender register is a full and complete document from the date of receipt of tender to the date of finalization. The events of tender processing such as opening of tenders, submission to higher authorities if needed, return of tenders accepted or with remarks, acceptance of tender by competent authority etc., should be filled in the tender register by tender accepting authority himself / officer concerned.

This register should be maintained up to date and must give all details such as name of work, estimate amount, Government orders and date, name of office, date of receipt etc.

2.15.15 Evaluation of Tender

2.15.15.1 Pre Qualification Procedures

1. The tender inviting authority shall for reasons to be recorded in writing provide for prequalification of tenders on the basis of:

i. experience and past performance in the execution of similar contracts

ii. Capabilities of the tenderer with respect to personnel, equipment and construction or manufacturing facilities.

iii. Financial status and capacity

2. Only the bids of prequalified bidders shall be considered for evaluation.

2.15.15.2 Two Cover System

A procedure under which the tenderers are required to simultaneously submit two separate sealed covers one containing the earnest money deposit and the details of their capability to undertake the tender which will be opened first and the second cover containing the price quotation which will be opened only if the tenderer is found qualified to execute the tender.

2.15.15.3 Time taken for evaluation and extension of tender validity

The tenders remain valid for a period of not less than 90 days from the last date for receipt of tenders. The validity period can be extended further if a contractor gives his consent in writing, specifying the period of extension.

In case the evaluation of tenders and award of contract is not completed within extended validity period, all the tenders shall be deemed to have become invalid and fresh tenders may be called for.

- (Section 14 (2) and 26 of Tamil Nadu Transparency in Tender Rules 2000)

2.15.15.4 Powers of Acceptance of Tenders

TABLE - I

Sl. No.	Category of Works	Tender inviting Authority	Tender Accepting Authority		
			In case of no tender excess	For tender excess upto 5% in case of works costing not more than rupees five lakhs.	(i). For tender excess more than 5% in case of works costing not more than rupees five lakhs; (or) (ii). For any tender excess in case of works costing more than rupees five lakhs.
(1)	(2)	(3)	(4)	(5)	(6)
1.	General Fund Works of Village Panchayat	President	Village Panchayat	Collector	Director of Rural Development and Panchayat Raj
2.	Schemes works entrusted to Village Panchayat	President	Village Panchayat	Collector	Director of Rural Development and Panchayat Raj
3.	Scheme works entrusted to Block Develop ment Officer (Village Panchayat)	Block Develop ment Officer (Village Panchayat)	Block Develop ment Officer (Village Panchayat)	Collector	Director of Rural Development and Panchayat Raj
4.	General Fund works of Panchayat Union	Block Develop ment Officer (Block Panchayat)	Panchayat Union Council	Collector	Director of Rural Development and Panchayat Raj
5.	Scheme works entrusted to Panchayat Union	Block Develop ment Officer (Block Panchayat)	Panchayat Union Council	Collector	Director of Rural Development and Panchayat Raj
6.	Scheme works entrusted to Block develop ment Officer (Block Panchayat)	Block Develop ment Officer (Block Panchayat)	Block Development Officer(Block Panchayat)	Collector	Director of Rural Development and Panchayat Raj

TABLE - II

Tender Inviting Authority	Tender Accepting Authority	
	If within estimated cost or for tender excess upto 5% in case of individual works costing not more than rupees twenty five lakhs or package of works costing not more than rupees two crores.	i. For tender excess more than 5% in case of individual work costing not more than rupees twenty five lakhs or package of works costing not more than rupees two crores; (or) ii. For any tender excess in case of individual works costing more than rupees twenty five lakhs or package of works costing more than rupees two crores.
1	2	3
Project Officer, District Rural Development Agency	District Collector	Director of Rural Development and Panchayat Raj.

2.15.15.5 Determination of the Lowest Evaluated Price

1. Out of the tenders found to be substantially responsive after the initial examination, the tenderer who has bid the lowest evaluated price in accordance with the evaluation criteria or the tenderer scoring the highest on the evaluation criteria specified, as the case may be, shall be determined.

2. In determining the lowest evaluated price, the following factors shall be considered.

   a) the quoted price shall be corrected for arithmetic errors

   b) in cases of discrepancy between the prices quoted in words and in figures, lower of the two shall be considered.

   c) adjustments to the price quoted shall be made for deviations in the commercial conditions such as the delivery schedules and minor variations in the payment terms which are quantifiable but deemed to be non-material in the context of the particular tender.

d) the evaluation shall include all central duties such as customs duty and central excise duty and sales tax as a part of the price, as detailed below

i) in evaluation of the price of an imported item, the price has to be determined inclusive of the customs duty.

ii) in evaluation of the price of articles which are subject to excise duty, the price has to be determined inclusive of such excise duty.

iii) in a tender where all the tenderers are from within the State of Tamilnadu, or where all the tenderers are from outside the State of Tamilnadu, the sales tax shall be included for the evaluation of the price. and

iv) in a tender where the tenderers are both from the State of Tamilnadu as well as from outside the State of Tamilnadu, the sales tax under the Tamilnadu General Sales Tax Act, 1959 (Tamilnadu Act 1 of 1959) shall be excluded for the evaluation of the price. (Section 29 of Tamil Nadu Transparency in Tender Rules 2000)

e) in the case of purchase of equipment, the operation and maintenance and spare part costs for appropriate periods as may be specified in bid documents may be quantified, wherever practicable and considered.

f) the evaluation and comparison shall include fifteen per cent price preference for domestic small scale industrial units and ten per cent price preference for the Public Sector Undertakings of the Government in respect of products and quantities manufactured by them.

3. In order to secure the best possible procurement price, negotiations with tenderer determined as per clauses (1) and (2) above are permissible subject to provisions in section 10 of the Act.

2.15.16 Work Order

Work order is issued to the contractor whose bid is accepted by the competent authority.

2.15.17 Agreement

The agreement is concluded with the contractors to whom the work orders are issued.

2.15.18 Supplemental Items and Agreement

In course of contract execution any new items of work, which are not covered in the original agreement, may be entrusted with the main contractor himself and rates should be settled with the contractor and supplemental agreements should be entered with the contractor in the prescribed format.

2.15.19 Extension of Time

Competent authority may grant the necessary extension of time for valid reasons if the contractor applies for extension of time. The contractor should apply for extension of time before the due date of completion as provided in the contract agreement.

2.16 Purchase of Materials, Issues, Stock Entry

- Cement is supplied by TANCEM through their own manufaturing units and also Private Suppliers fixed through tender.

Steel rods and steel doors and windows ar supplied by private manufactures fixed by the way of tender at the District level.

- Bitumen and Emulsion are purchased from Public sector Undertakings such as IOC, BPCL and HPCL at the rates prevailing at the time of purchase.

2.16.1 Quality Check

Materials received are to be thoroughly checked for quality and specifications before making entry into stock register and making payment to the supplier.

2.16.2 Stock Entry

Separate registers are to be maintained for the materials received and proper entries should be made then and there, duly acknowledged by the officer responsible for the stocks (AE/JE) and the concerned office head (BDO).

2.16.3 Issue of Materials

Issue of materials to various works is done based on the progress of the works. Materials should be issued only with the written approval of the concerned engineer and BDO (BP) / BDO 4 and after entering in the respective stock register. During preparation of bills for payment, materials issued to the respective work are to be entered in the M-Book and necessary recoveries are to be made from that Bill.

2.16.4 Receipt of Unutilized Material from Contractor

In case where the balance materials are not returned, then double the material cost sanctioned in the estimate / rates specified in the agreement in the case of tendered work have to be recovered from the concerned contractor. For accounting purpose, the stocks should be verified by the BDO/UE at the end of every month.

2.16.5 Maintenance of Stock Register

The entire process of Receipt and Issue of all materials are to be entered in the Stock Register and is a very important document for the purpose of making financial recoveries from the contractor and also contains the details of availability of stocks in hand.

The entries in the stock register are made then there and also have to be submitted for periodie verification by the head of office, other inspecting officers and also for the purpose of auditing. Stock registers are closed for every financial year and whatever closing balance available as on 31st March are to be carried out to the next financial year i.e. 1st of April in a new register. The maintenance of stock register has to be done properly.

2.16.6 Model Format of Stock Register

Sl. No	Date	Name of Work	Opening Balance	Receipts	Total	Issues	Closing Balance	Signature Of Contractor	Signature OfAE	Signature of BDO

2.17 Site Order Book

Every work site should have a site order book in the prescribed format so as to record the comments of the higher officials while inspecting the work.

Name of the work :

Estimate Cost :

Name of the Scheme :

Administrative Sanction details :

Technical Sanction details :

Name of the contractor :

Date of work order :

Date of commencement of the work :

Probable Date of completion :

Sl. No	Date	Description /Stage of work	Comments of Inspecting officer	Signature of Assistant / Union Engineer	Signature of Assistant Executive Engineer	Signature of Inspecting Officer

2.18 Measurement and Check Measurement

2.18.1 Measurement Book

The measurement books are very important records. All measurement books are numbered serially and a register is maintained in the block office showing the serial number of each book, name of office, officer to whom issued, the date of issue, the date of return and remark.

Works are measured and recorded in the Measurement books. Before the measurements are recorded in the M-Book the date of measurement, name of the work, name of the contractor, estimate amount, Agreement No., etc are to be noted on the top of the left and right page.

Measurements should be taken in the presence of contractor and his signature should be taken at the bottom of the measurements for accepting measurements.

All measurements should be recorded directly in the M.Book on the left side only and nowhere else. The entries in the content column should be made after necessary calculations.

There should not be any over writing. Corrections/cancellation should be authenticated.

Entries should be recorded continuously and no blank pages should be left or pages torn out. Any pages left blank by mistake or oversight should be cancelled by diagonal lines and cancellation being initialed and attested and dated.

Loss of M.Book is a serious matter and to be reported to the higher authorities atonce.

Every stage of work after execution is to be recorded and has to be check measured by the competent authority.

2.18.2 Powers of Measurement and Check Measurement (G.O.Ms.No. 203, dated. 20.12.2007 and G.O.Ms. No. 132, dated. 04.08.2008)

For all works except MGNREGS

Name of the work	Measuring officer	Check measuring officer
All works costing up to Rs 1,00,000/-	Union Overseer	Block Engineer/ Assistant Engineer [RD]
All works costing more than Rs 1,00,000/-	Block Engineer/ Assistant Engineer [RD]	Assistant Executive Engineer [RD]

For MGNREGS

Name of the work	Measuring officer	Check measuring officer
Bills of value not more than Rs 1,00,000/	Union Overseer	Block Engineer/ Assistant Engineer[RD]
Bills of value more than Rs 1,00,000/	Block Engineer/ Assistant Engineer[RD]	Assistant Executive Engineer[RD]

Note : In case of MGNREGS if 4 successive bills for a work in a given village panchayat are each less than Rs 1 lakh, the 5th bill shall be passed after being super-checked by the Assistant Executive Engineer, even if the value is less than Rs. 1 lakh.

2.18.3 Super Check Measurement

The Assistant Executive Engineer [RD] shall also super check not less than 5% of works costing below Rs 1, 00,000/- check measured by Block Engineer / Assistant Engineer [RD].

The Executive Engineer [RD] shall also super check at least 10 works check measured by AEE [RD] in each block every year.

2.19 Maintenance of Registers

The following registers are to be maintained :

1. Technical sanction Register
2. Stock register
3. Measurement Book Register
4. Register of Roads
5. Register of Minor Irrigation tanks
6. Check measurement register
7. Bill Pass register

2.20 Preparation of Bills

The Bills are to be prepared for the measurements recorded for the works executed with reference to the agreements concluded by the contractor. When the work is completed in all respects, the Final bill will be prepared. After completion of a portion of the work, a part bill may be prepared. If the material required for the execution of the project is supplied departmentally, necessary recoveries are to be made in the bill while making payment.

2.20.1 Bill Form

Form No. 55-A

Voucher No.

CONTRACT CERTIFICATE

Name of the Work

Amount of Estimate : Rs.

Authority

Name of the Contractor

Agreement No

Last certificate granted for this works if any, Voucher No. Month.

Quantity Executed or Supplied		ITEMS	Rate	Per	Amount		Remarks
Up to Date	Since Last Certificate				Up to Date	Since Last Certificate	
1	2	3	4	5	6	7	8

2.21 Audit paras and necessary precautions

It is the duty of the executing officers to ensure that the funds allotted under various shemes spent properly are strictly as per the guidelines of the scheme. Some of the common queries and objections raised by the auditors are detailed below:

1. Non –recovery of amount for materials issued by the department.
2. Insufficient recovery with respect to quantity of materials issued and cost of materials.
3. Excess issue of materials against the required quantity.
4. Excess issue of materials not returned or not recovered properly
5. Non enclosure of necessary vouchers, hand receipts etc
6. Deviations with respect to provisions of estimate.
7. Using sub standard materials or use of materials purchased from unapproved supplier when there is an approved rate and supplier.
8. Adopting incorrect rates for materials, labour, items of work etc.
9. Incorrect calculation of material adequacy like cement and steel etc.
10. Taking up works that are against the guidelines of the schemes.
11. Non-Production of records i.e. M-Books, Cash book, Estimates Allotment Registers Stock registers, vouchers, Firm bills, Completion Report etc
12. Improper maintenance of registers like stock registers, M-Book registers and Technical sanctions registers etc.
13. Executing items of work not found to be necessary.
14. Executing works without prior administrative sanction or technical sanction.

3. BUILDINGS

3. BUILDINGS

3.1 Planning of Buildings

- A building should be planned to make it comfortable, economical and to meet all the requirements of the users. Area, shape, size, height and type of material will influence the cost.
- A square plan is cheaper than an oblong one. It is therefore desirable to plan or design a building as far as possible in a square shape.
- A double storey building is economical; the upper storey is cheaper by about 15% than the ground storey. The upper storey rooms are airy and better ventilated.
- Ventilation, material selection, joinery position, utilizing of natural lighting, orientation etc., are the prime features in planning a building.

3.2 Orientation of Buildings

- Improper orientation will reduce user comfort and the inmates may find it difficult because of heat and absence of natural breeze.
- As far as possible the lengthy side of building should not face East or West, as maximum area of the outer side of the building is exposed to hot sun.
- In case the lengthy side of building has no other alternative than to face East or West, the design should incorporate necessary sun breakers etc. to minimize heat.
- When the building faces North or South, the orientation may be tilted to get the maximum light and natural breeze and to ward off the sunrays during the severe heat of summer.

3.3 SITE EXPLORATION

Detailed site exploration is needed to provide reliable, specific and detailed information about the soil and ground water conditions.

3.3.1 Methods of Site Exploration (clause 3.20 of NBC 2005)

The common methods of site exploration are given below**:**

a) Open trial pits

This method consists of excavating trial pits and thereby exposing the subsoil surface thoroughly, enabling undisturbed samples to be taken from the sides and bottom of the trial pits. This is suitable for all types of formations, but should be used for small depths (up to 3 m). In the case of cuts which cannot stand below water table, proper bracing should be given.

b) Auger boring

The auger is either power operatedor hand operated with periodic removal of the cuttings.

c) Shell and auger boring

Both manual and mechanized rig can be used for vertical borings. The tool normally consists of augers for soft to stiff clays, shells for very stiff and hard clays, and shells or sand pumps for sandy strata attached to sectional boring rods.

3.4 Soil Testing

Soil inspection or geotechnical inspection is very important in understanding the physical properties of soil and the rocks beneath. This is required to ascertain the type of foundation required for the proposed construction. Various tests are done to explore the sub surface and surface characteristics of soil. Some of these are given below :

1) Water Content
2) Free Swell Index Of Soil
3) Plastic Limit Of Soil
4) Liquid Limit Of Soil
5) Particle Size Distribution Of Soil
6) Specific Gravity Of Soil
7) In-Situ Dry Density Of Soil By Sand Replacement Method
8) In-Situ Dry Density Of Soil By Core Cutter Method
9) Maximum Dry Density And The Optimum Moisture Content Of Soil

Table 1 Mass of Soil Sample Required
(Clause 3.4.2(a))

Sl No.	Purpose of Sample	Type	Mass of Sample Required (in kg)
(1)	(2)	(3)	(4)
i)	Soil identification, natural moisture content tests, mechanical analysis, and index properties, Chemical tests	Cohesive soil Sands and gravels	1 3
ii)	Compaction tests	Cohesive soils and sands Gravelly soils	12.5 25
iii)	Comprehensive examination of construction materials including stabilization	Cohesive soils and sands Gravelly soils	25 to 50 50 to 100

3.5 Ground Improvements (clause 14 of NBC 2005)

In poor and weak subsoil, the design of conventional shallow foundation for structures may present problems with respect to both sizing of foundation as well as control of foundation settlements. A viable alternative, developed over the recent years is to improve the subsoil to an extent such that the subsoil would develop an adequate bearing capacity and foundations constructed after subsoil improvement would have resultant settlements within acceptable limits. Use of suitable geo-synthetics/geo-textiles may be made in an approved manner for ground improvement.

3.6 Methods for Ground Improvement

a) Soil stabilization

b) Vertical drains

c) Stabilization trenches

d) Soil nailing

e) Stone columns

f) Vibro compaction

g) Dynamic compaction

3.6.1 Soil Stabilization

It is the method of Improvement of stability and bearing capacity of soil by use of controlled compaction or by the addition of suitable admixtures or stabilizers. The methods of soil stabilization are :

1. Mechanical Stabilization
2. Soil-cement Stabilization
3. Soil-lime Stabilization

3.6.2 Mechanical Stabilization

Process of improving the properties of soil by changing its gradation. Two or more natural soils are mixed to obtain a composite material.

3.6.3. Soil-Cement Stabilization

This is done by mixing soil and cement with water and compacting the mix to attain a strong material.

3.6.4. Soil-Lime Stabilization

Lime stabilization is done by adding lime (2%-10%) to soil.

3.7 Depth of Foundations (clause 7.10 of NBC 2005)

The maximum depth of scour, wherever relevant, should be considered and the foundation should be located sufficiently below this depth. Other factors such as ground movements and heat transmitted from the building to the supporting ground should also be factored in all foundations shall extend to a depth of at least 500 mm below natural ground level. On rock or such other weather resisting natural ground, removal of the top soil maybe equired. In such cases, the surface shall be cleaned and, if necessary, stepped or otherwise prepared so as to provide a suitable bearing and thus prevent slipping or other unwanted movements.

In cases where there is excavation, in ditch pond, water course, filled up ground condition, adjoining or adjacent to the subsoil on which the structure is to be erected and which is likely to impair the stability of structure, either the foundation of such structure shall be carried down to a depth beyond the detrimental influence of such conditions, or retaining walls or similar works shall be constructed for the purpose of shielding from their effects.

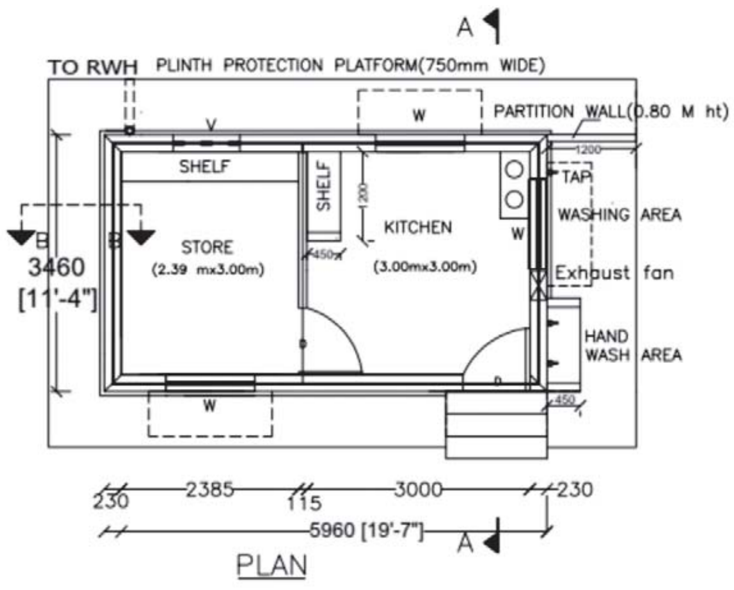
A foundation in any type of soil shall be below the zone significantly weakened by root holes or cavities produced by burrowing animals. The depth shall also be enough to prevent the rainwater scouring below the footings. Clay soils, like black cotton soils, are seasonally affected by drying, shrinkage and cracking in dry and hot weather, and by swelling in the following wet weather to a depth which will vary according to the nature of the clay and the climatic condition of the region. It is necessary in these soils, either to place the foundation bearing at such a depth, where the effects of seasonal changes are not important or to make the foundation capable of eliminating the undesirable effects due to relative movement by providing flexible type of construction or rigid foundations.

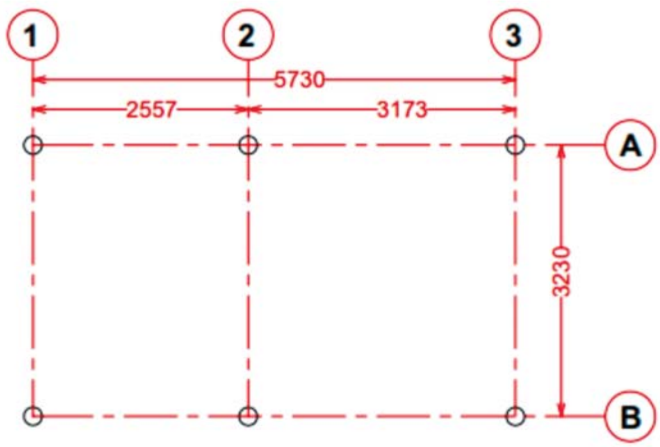
3.8 Termite Proof (clause 19 of NBC 2005)

Termite control measures consist of Isolating or sealing off the building from termites by chemical and non-chemical construction techniques. It is recognized that 95 percent damage is due to internal travel of the termites upwards from the ground. Termites live in soil in large colonies and damage the wooden structure in the buildings by eating up the wood or building nests in the wood. Poisoning the soil under and around the building is a normal recommended practice. It includes Spraying of chemical solution in the trenches of foundations in and around walls, areas under floors before and after filling of earth, etc. In already constructed building the treatment can be given by digging trenches all around the building and then giving a liberal dose of chemicals and then closing the trenches.

3.9 Centre – Line marking (drawing)

- It is the method of transferring the drawings in the paper to the ground.
- The corners and junction of walls are marked with reference to the baseline. After marking, the distances marked are cross verified by measuring the diagonal distances.
- In case of framed structures, the centre to centre of columns, footing sizes, alignment of tie beams / Grade beams to be constructed is to be marked.
- Reference brick pillars are to be constructed to maintain the building centre line up to basement.





CENTER LINE DIAGRAM

3.10 Sand filling and PCC Leveling Course

- In the excavated pit, sand filling or Sand gravel mix1:3 should be done and compacted to a minimum depth of 150 mm to 300 mm as decided by Engineer in charge.
- The cement concrete mix 1:4:8 should be laid to a minimum thickness of 150 mm over which footing is to be rested.

3.11 Foundation

It is the lowest part of a structure which transmits the weight of the structure together with live loads, seismic and wind load to the soil on which the structure rests.

Minimum depth of foundation formula:

$$D_{min} = q/r \{1-\sin\Phi/1+\sin\Phi\}^2$$

q = Intensity of loading (kN/m^2)

r = Unit Weight of soil (kN/m^3)

Φ = Angle of repose for the soil.

Sufficient care shall be taken in areas where withdrawal of ground water is possible resulting in damage to the foundation.

3.11.1 Functions of Foundation

- To transmit and distribute the total load of the structure to a larger area of underlying support
- To prevent differential settlement of the structure.
- To provide stability to the structure.
- To reduce Concentration of load
- To provide levelled and hard surface over which super structure can be constructed.
- It anchors the super structure to the ground thus imparting lateral stability to the super structure.
- Safety against undermining and scouring.
- Protection against soil movements.

3.11.2 Types of Foundations

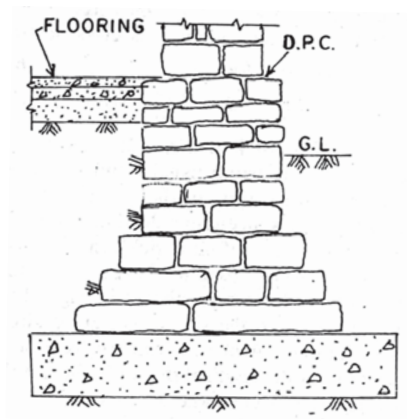
1. Shallow foundation
2. Deep Foundation

3.11.2.1 Shallow Foundation:

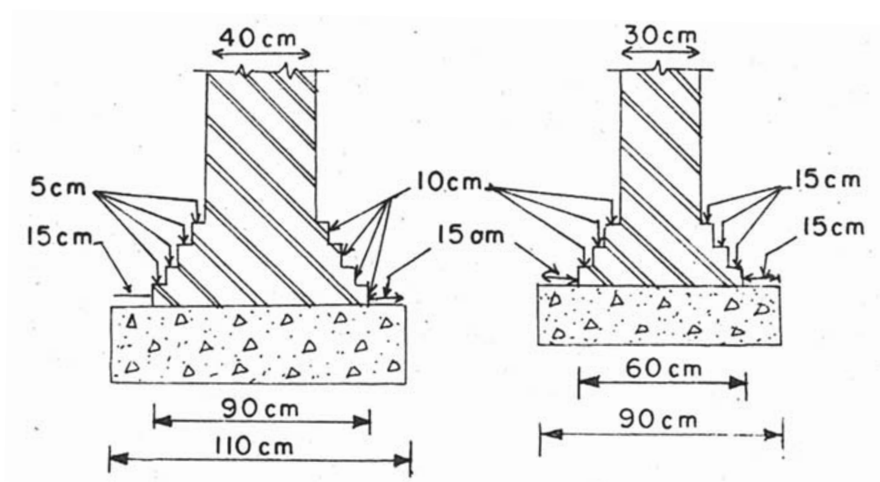
Spread footing	It is the one which spreads the super imposed load of wall (or) column over a large area.
Combined footing	The spread footing which supports two (or) more columns.
Strap footing	The independent footings of two columns are connected by a beam
Mat (or) Raft foundation	The combined footing which covers the entire area beneath a structure and supports all the wall and columns. When the allowable soil pressure is low (or) the building loads are heavy, it may prove more economical.

3.11.2.1(a) Strip foundation

Strip Foundations consist of a continuous strip, made up of brick masonry/ stone masonry/concrete formed centrally under load bearing walls. The continuous strip serves as a level base on which the wall is built and is of such a width as is necessary to spread the load on the foundations to an area of subsoil capable of supporting the load without undue compaction.



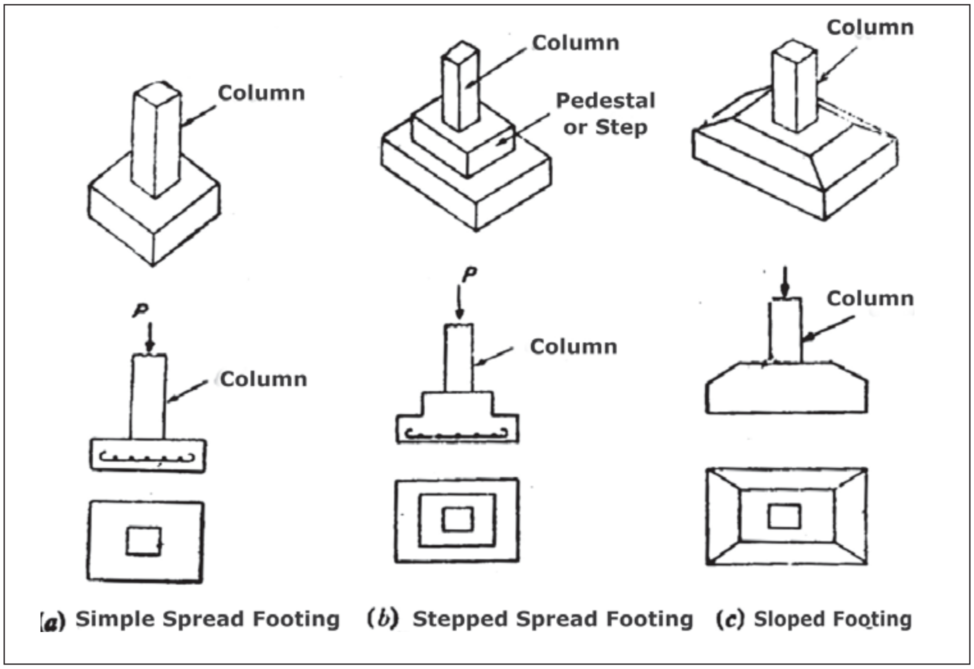
STONE WALL FOOTING



BRICK WALL FOOTING

3.11.2.1(b) Isolated foundation

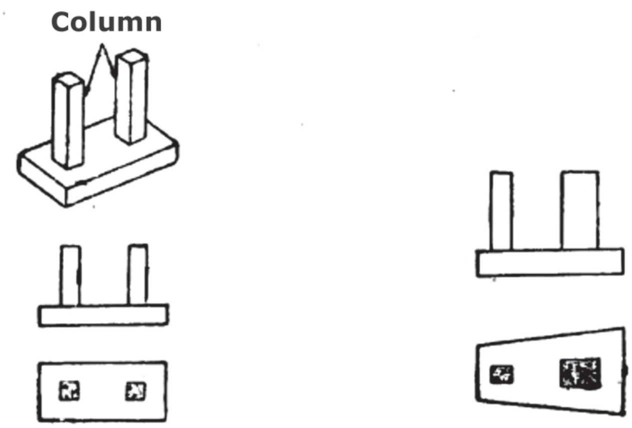
It is sometimes economical to construct a foundation of isolated piers or columns of brick or concrete, supporting reinforced concrete ground beams which in turn support walls, rather than excavating deep trenches and raising walls off strip foundations, at some depth below ground. The isolated foundations are typical rectangular or trapezoidal block made up of reinforced concrete. In some places where burnt clay brick quality is good, these are made with burned bricks also. These are used to support undivided columns. They can be of stepped type or have projections in the concrete base. In case of heavy loaded columns steel reinforcement is provided in both directions in concrete with 15 cm offsets as shown in the figure below.



Types of Isolated Footings

3.11.2.1(c) Combined Footing

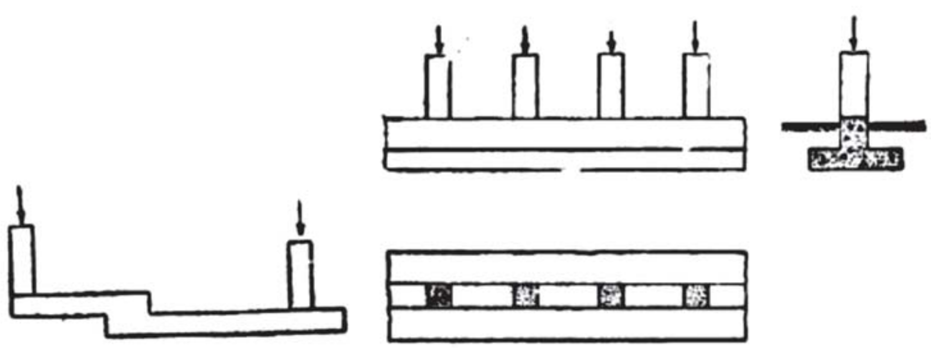
A combined footing supports two or more columns in a row. A Combined footing may be rectangular or trapezoidal constructed with reinforced concrete. The location of centre of gravity of column loads and centroid of the footing should coincide. The combined footing is as shown in the figure below.



(a) Rectangular Combined Footing (b) Trapezoidal Combined Footing

3.11.2.1(d) Continuous Footing

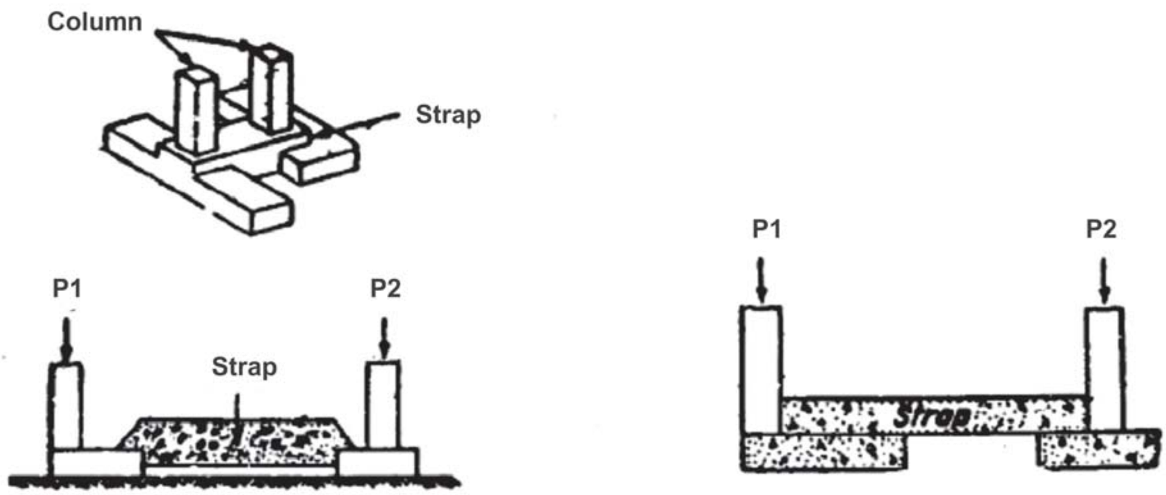
In this type of footing a single continuous R.C slab is produced as foundation for two or three or more columns in a row. This type of footing is suitable at locations liable to earthquake activities. This also prevents differential settlement in the structure. In order to have better stability a deeper beam is constructed in between the columns as shown in the figure.



(a) Stepped footing (b) Strip foundations for closely spaced columns

3.11.2.1(e) Strap or cantilever footing

Strap footing consists of two or more individual footings connected by a beam called strap or cantilever footing or pump handle foundation. This type of foundation may be used where the distance between the columns is so great that combined trapezoidal footing becomes quite narrow with high bending moments. strap or cantilever footing is as shown in figure.

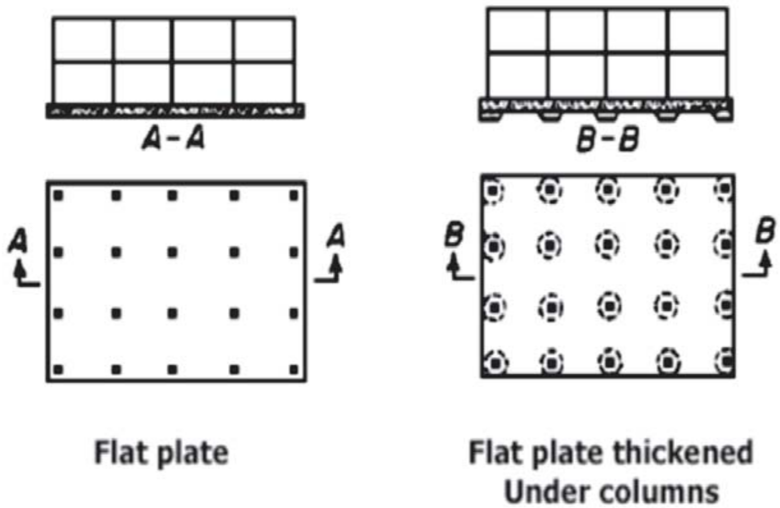


(a) Strap footing with non - uniform Strap.

(b) Cantilever footing with uniform strap.

3.11.2.1(f) Raft Foundation

A raft or mat is a combined footing that covers the entire area beneath a structure and supports all the columns. When the allowable soil pressure is low or the structure loads are heavy the use of spread footings would cover more than one half of the area and it may be more economical to use raft foundation. These are also used where the soil mass contains compressible lenses so that the differential settlement would be difficult to control and when the hard soil is not available within 1.5 to 2.5m, a raft foundation is adopted. The raft is composed of reinforced concrete beams with relatively thin slab underneath, the figure shows different types of raft.



Types of Raft Foundations

3.11.2.2 Deep foundations

These foundations carry loads from a structure through weak compressible soil or fills, on to the stronger and less compressible soils or rocks at depth. These foundations are in general used as buoyancy rafts, Caissons, cylinders, shaft and piles.

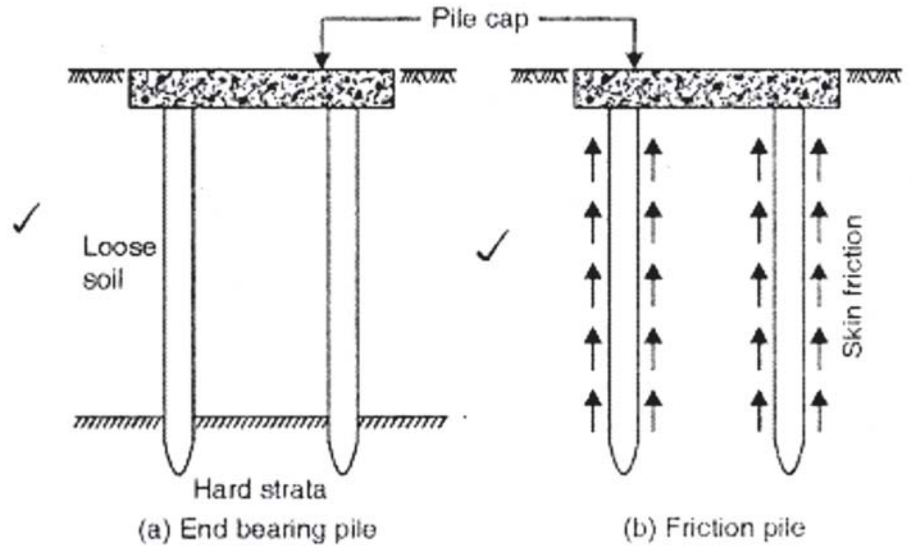
3.11.2.2 (a) Pile foundation

Pile foundation comes under the classification of deep foundation. When the bearing capacity of soil is very low and the structural load is very high, this foundation is suggested. Here the loads are taken to a deep level by means of a vertical member called pile. The pile may be steel, timber or concrete. When a firm bearing strata does not exist at a reasonable depth and the loading is uneven such foundations are suggested.

Depending on the load bearing condition, pile foundation are mainly classified into four types:

1. End bearing pile.
2. Friction pile.
3. Combined end bearing and friction pile.
4. Compaction pile.

Piles are generally used when the SBC of soil is very low and the load is very high. (Construction like bridges, heavy structures etc in waterlogged area, reclaimed soil, marshy land etc)



Classification based on materials and composition

1) Precast.

2) Cast-in-site.

a) Under reamed piles.

b) Bored compaction piles.

Other types of deep foundation

1. **Piers** are foundations for carrying a heavy structural load which is constructed insitu in a deep excavation.
2. **Caissons** are a form of deep foundation which are constructed above ground level, then sunk to the required level by excavating or dredging material from within the caisson.
3. **Compensated foundations** are deep foundations in which the relief of stress due to excavation is approximately balanced by the applied stress due to the

foundation. The net stress applied is therefore very small. A compensated foundation normally comprises a deep basement.

3.11.3 Common Foundation Types

3.11.3.1 Masonry Foundation (clause 7.2.8 of NBC 2005)

Unreinforced foundation may be of concrete or masonry (stone or brick) provided that angular spread of load from the base of column/wall or bed plate to the outer edge of the ground bearing is not more than 1 vertical to 1/2 horizontal for masonry or 1 vertical to 1 horizontal for cement concrete and 1 vertical to 2/3 horizontal for lime concrete. The minimum thickness of the foundation of the edge should not be less than 150 mm. In case the depth to transfer the load to the ground bearing is less than the permissible angle of spread, the foundations should be reinforced.

Main two types of masonry used in buildings are:

1. Stone Masonry.
2. Brick Masonry.

Stone masonry: Masonry units constructed with stones.

(a) Rubble masonry.

(b) Ashlars Masonry / Coursed Rubble masonry.

3.11.3.1 (a) Random Rubble Masonry

- Random Rubble masonry, in CM 1:5 may be adopted in hilly areas as also in plains where cost of Random Rubble masonry is economical compared to 340 mm thick brick masonry.
- For both RR & CR Masonry, bond stone or through stone should be provided at every 1.5 m to 1.8 m, in each course.
- A set of 2 or more bond stone overlapping each other by atleast 15 cm shall be provided in a line from face to back.
- Each bond stone or a set of bond stone shall be provided for every 0.5 sqm of the wall face.

3.11.3.1(b) Brick Masonry

DESIGN EXAMPLE: Foundation for a single storey Building

Maximum width required` = 2 x width of the wall + 0. 3m

(Assuming 23cm thick brick wall) = 2 x 0.23 + 0.3 m. = 0.76m.

Minimum depth required = $\frac{P}{w}\left[\frac{1-sin\emptyset}{1+sin\emptyset}\right]^2$

Assuming

P- Intensity of loading = 125 KN/m^2

W-Unit weight of soil = 18 KN/m^3

Ø-Angle of repose of the soil = 30

Minimum depth of footing = (125/18) x 0.111 = 0.77m.

Assuming bearing capacity of soil = 200 Kn/sqm

Width required = 125/200 = 0.625m

Thus provide a foundation width of 0.76m and depth 0.77m.

The purpose of a masonry foundation is to support the weight of a structure while distributing the weight across subsurface strata, and to act as an anchor to keep the structure in place.

Table 5 Thickness of Footings
(Clause 7.2.12)

Sl No.	Type of Footings	Thickness of Footings (Min)	Remarks
(1)	(2)	(3)	(4)
i)	Masonry	a) 250 mm b) Twice the maximum Projection from the face of the wall	Select the greater of the two values
ii)	Plain concrete For normal structures	a) 200 mm b) Twice the maximum offset in a stepped footing c) 300 mm	For footings resting on top of the pile
	For lightly loaded stuctures	a) 150 mm b) 200 mm	For footings resting on soil Resting on soil Resting on pile
iii)	Reinforced Concrete	a) 150 mm b) 300 mm	Resting on soil Resting on pile

Table from NBC 2005

3.11.3.1(c) RCC Isolated Foundation

Isolated foundations are used to support an individual point load from columns. They may be circular, square or rectangular. They usually consist of a block or slab of uniform thickness, but they may be stepped or haunched, if they are required to spread the load from a heavy column. Isolated foundations are usually shallow, but deep pad foundations can also be used.

3.12 Refilling Basement

- It is a normal practice to use the excavated soils from foundation for filling the basement.
- Excavated expansive clay soils should not be reused for filling in basement, since clayey soils absorb moisture in course of time and creates a side thrust on the walls in addition to heaving and cracking of the floor.
- Sand filling /carted earth may be done in case of clay soil.
- Filling of basement shall be done in layers of 150 mm thick with proper compaction.

3.13 PCC for Flooring

Flooring concrete shall be laid over sand filling for a thickness of 100mm to 300mm.

3.14 Slopes in Floors

The following minimum slopes shall be adopted for the different types of buildings in floors.

1. A slope of 1 in 60 shall be provided for water closets, cattle sheds, and pavements between buildings and storm water drains.
2. A slope of 1 in 100 shall be provided for bathrooms, verandah, kitchen, dairy poultry and paved open-to-sky areas, drying yard for seeds, cement concrete drive ways in bus stations.

3. A slope of 1 in 200 shall be adopted for dining halls, canteen and steam laundry.
4. Rest of the location with mosaic flooring shall be given a slope of 1 in 400.
5. The slope of 1 in 50 given in TNBPSS for weathering course over roof slab of buildings should be strictly adhered to.

3.15 Super Structure

The components of the building above basement level are called as superstructure. Brick and stone masonry are commonly used for superstructure in load bearing structures. For framed structures, columns and beams are used.

3.15.1 Brick Masonry Walls

Brick masonry is the most commonly used masonry for Super structure of buildings.

- Country bricks of size 230 x 110 x 70 mm, well burnt shall be used.
- Cement mortar 1:5 mix is to be used for bonding.
- Bricks are to be well soaked in water before use.
- For partition wall, 110mm thick bricks shall be used.
- For main wall, 230 mm thick bricks shall be used.

3.15.1.1 Provision of Brick Pillars

The minimum size of brick pillars shall be of size by 340 mm x 340 mm. Brick pillar cannot restrain free movement of continuous RCC beams and hence such movement causes cracks at the end walls and also at the mid-height of brick pillars.

Slender brick pillars of size 230 mm x 230 mm should never be constructed as load bearing masonry. Even in the case of larger sections of brick pillars, rich mix mass concrete (with nominal reinforcement) for 150mm height for the full cross sectional dimension of brick pillar should be cast at mid-height of the pillar so as to eliminate shear cracks.

In coastal areas and in the areas where the structures will be subjected to high winds, independent brick pillars for supporting either RCC roof or tiled roof should not be constructed, as the masonry pillars will be subjected to tension. Only RCC columns should be adopted in these locations.

3.15.2 Inspection of Workmanship

Workmanship has considerable effect on strength of masonry and bad workmanship may reduce the strength of brick masonry to as low as half the intended strength. The basic compressive stress values for masonry would hold good for commercially obtainable standards of workmanship with reasonable degree of supervision.

A close supervision while the work is in progress will ensure better quality with the material available for use. The following shall be observed at the time of inspection:

a) All loose materials, dirt and lumps of mortar lying over the surface over which brick work are to be removed with a wire brush.

b) All the bricks shall be thoroughly soaked in clean water immediately before use.

c) The surface over which the brick work is to be started shall be slightly wetted.

d) The first course itself shall be made horizontal by providing enough mortar in the bed joint to fill up any undulations in the bed course.

e) Plastic mortar results in thorough bedding of the brick and more complete filling of the joints which ensure greater strength. Care shall be taken to see that the required quantity of water is added to the mortar at the mixing platform itself and not over the courses.

f) All the joints shall, as far as possible, be thin.

g) Care shall be taken to see that there is no through joints and the lap is not less than half the width of the brick, and that all the vertical joints are properly filled with mortar.

h) The verticality of the walls and horizontality of the courses shall be checked very often with plumb bob and spirit level, respectively.

i) No portion of the work shall be left more than one lower than the other. Where the masonry of one part has to be delayed, it shall be 'raked back' suitably at an angle not exceeding 45^0 according to bond, and not toothed vertically.

j) Where plastering is required to be done, all the vertical as well as horizontal joints shall be raked to a depth of about 1 cm.

k) Care shall be taken to ensure that the brick work is kept wet for seven days commencing from 24 hours after the course is laid.

3.16 Ceiling Heights in Non-Residential and Residential Buildings

- A uniform height of 3.05m clear from the top of floor finish is applicable for all floors.
- In the case of sloping slabs the height of ceiling should be 3.25m at ridge and 2.95m at eaves.
- For special types of buildings, different ceiling heights have to be adopted on functional basis.

3.17 RCC Structures and Steel Fabrication

3.17.1 Columns & Footings

- RCC columns shall be adopted instead of brick pillars, where long row of pillars are to be constructed for verandah with continuous RCC beam over verandah openings.
- Care should be taken while constructing isolated footings to see that the centre of gravity of columns and footings should coincide with each other or else extra reinforcement have to be provided for the eccentric moment developed.

3.17.1(a) COLUMNS - Longitudinal Reinforcement (Clause 26.5.3 of IS 456:2000)

The cross sectional area of longitudinal reinforcement, shall be not less than 0.8% and not more than 6% of the gross cross sectional area of the column.

Note: Where bars from the columns below have to be lapped with those in the column under consideration, the percentage of Steel shall usually not exceed 4% to avoid congestion of rods.

Maximum Spacing of Main Bars: Spacing of longitudinal bars measured along the periphery of the column shall not exceed 300 mm.

Minimum Number of Bars: For circular columns a minimum of six number of rods and for rectangular columns a minimum of four rods are to be provided.

The Minimum Dia of Main Bar: The minimum dia of bar to be used in column for main rods is 12 mm.

Pitch and Diameter of Lateral Ties:

a) Pitch: The pitch of transverse ties shall be not more than the least of the following distances.

1. The least lateral dimension of the compression member.
2. 16 times the smallest diameter of the longitudinal reinforcement bar to be tied.
3. 48 times the diameter of the polygonal links or lateral ties.

b) Diameter: The diameter of lateral ties shall be not less than 1/4 of the diameter of the largest longitudinal bar and in no case less than 5 mm.

3.17.1(b) Footings

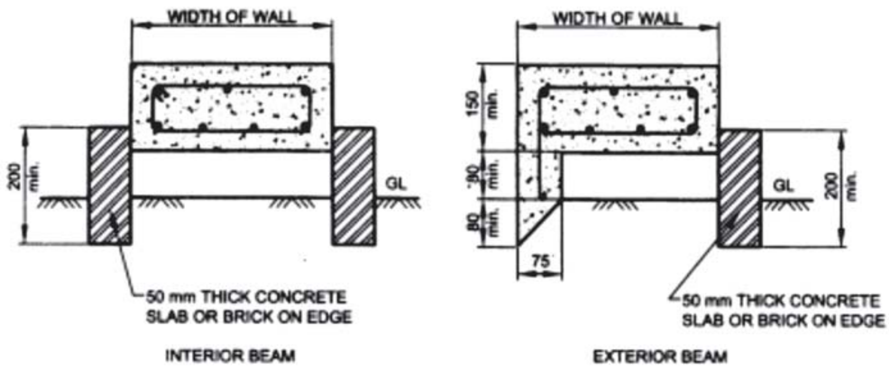
The main reinforcement should be provided along both breadth and length wise. The column bars should be embedded into the footing sufficiently (atleast development lengths).

3.17.2 Beams

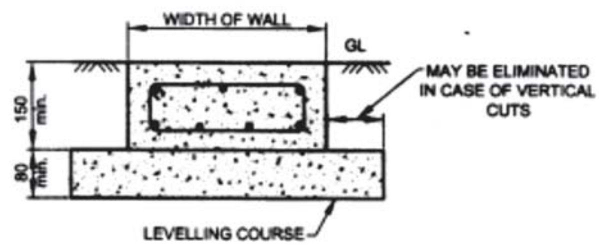
3.17.2 (a) Grade Beams

- As the filling in the basement has to be retained effectively even in case of any erosion or any scooping of earth outside the buildings by burrowing animals, the top of grade beams may be fixed at ground level or above Ground level based on the type of soil at site.
- The grade beams supporting the walls shall be designed taking due account of arching effect due to masonry above the beam. The beam with masonry, due to composite action behaves as a deep beam. The minimum overall depth of grade beams shall be 150 mm. The reinforcement at the bottom should be kept continuous and an equal amount may be provided at top to a distance of a quarter spans both ways from pile centres.
- The longitudinal reinforcement both at top and bottom should not be less than three bars of 10 mm diameter mild steel (or equivalent deformed steel) and stirrups of 6 mm diameter bars should be spaced at a minimum of 300 mm spacing.

In expansive soils, the grade beams shall be kept a minimum of 80 mm clear off the ground. In other soils, beams may rest on ground over a Leveling concrete course of about 80 mm.



6A BEAMS IN EXPANSIVE SOILS



6B BEAMS IN NON - EXPANSIVE SOILS

Ref : fig 6.14 of SP 34 (S&T) 1987

3.17.2(b) Plinth Beam & Continuous Lintel Beams

- The plinth beams and continuous lintels shall be laid continuously for the entire wall length.
- The plinth beam shall be 150 mm thick and it should be laid for the full width of the wall.
- The plinth level may be fixed at a height of 600 – 900 mm above the main road level wherever necessary as per site condition to avoid intrusion of storm water.

3.17.2(c) Roof Beams

Roof beams should be constructed monolithically with roof slab. Torsion reinforcement should be provided at corners in two way slabs as per Annex D - IS code 456 -2000.

3.17.2 (d) Beams - Reinforcement (Clause 26.5.1 of IS 456:2000)

Minimum Reinforcement: (Clause 26.5.1.1(a) of IS 456:2000)

The minimum area of tension reinforcement shall not be less than that given by the following.

$A_s / bd = 0.85 / f_y$

Where A_s = Minimum area of tension reinforcement

b = Breadth of the beam (or) the breadth of the web of T-beam

d = Effective depth and

f_y = Characteristic strength of reinforcement in N/mm^2

Maximum Reinforcement: (Clause 26.5.1.1(b) of IS 456:2000)

The maximum area of tension reinforcement shall not exceed 0.04 bd.

Side Face Reinforcement: (Clause 26.5.1.3 of IS 456:2000)

Where the depth of the web in a beam exceeds 750 mm, side face reinforcement shall be provided along the two faces. The total area of such reinforcement shall be not less than 0.1 percent of the web area and shall be distributed equally on two faces at a spacing not exceeding 300 mm or web thickness whichever is less.

Maximum Spacing of Shear Reinforcement: (Clause 26.5.1.5 of IS 456:2000)

The maximum spacing of shear reinforcement measured along the axis of the member shall not exceed 0.75 d for vertical stirrups and 'd' for inclined stirrups at 45^{o}, where d is the effective depth of the section under consideration. In no case shall the spacing exceed 450 mm.

Minimum Shear Reinforcement: Minimum shear reinforcement in the form of stirrups shall be provided such that:

$A_{sv} / bs_v \geq 0.4 / f_y$

Where, A_{sv} = Total cross sectional area of stirrup legs effective in shear,

S_v = Stirrup spacing along the length of the member

b = Breadth of the beam or breadth of the web of flanged beam and,

f_y = Characteristics strength of the stirrup reinforcement in N/mm^2, which shall not be taken greater than 415 N / mm^2

3.17.3 Slabs

3.17.3 (a) Sunshades

- Sunshade should be provided individually for windows and no continuous sunshade is necessary in normal cases.
- In expansive and black cotton soils, continuous lintel has to be provided and in that case, continuous sunshade can be adopted if found necessary.
- The cantilever reinforcement (Wall stirrups) of sunshades can serve as cross reinforcement for the lintel with required anchorage.
- Sunshades should be provided with a bearing of 230mm on both sides of the opening. Normally a width of 600mm is adopted.

3.17.3 (b) RCC Loft Slabs

- R.C.C loft slabs are generally designed as cantilever slabs with 50mm thickness at the free end and 75mm thickness at the wall end, with the slope given at the Top.
- The spacing of the reinforcement should not exceed twice the effective depth for the cantilever design although IS code provides for three times effective depth.
- The main reinforcement shall be at top of the slab. It should be ensured that every alternate rod is bent in such a way that one third portions of the cantilevered slab near the walls gets the reinforcement at the bottom side as well.

3.17.3 (c) Roof Slabs

- A Reinforced Concrete Slab is one of the most important components in a building. It is a structural element of modern buildings. Slabs are supported on Columns and Beams.
- Thickness of RCC Slabs range from 10 to 50 centimeters. They are most often used for the construction of floors and ceilings.

- Excessive deflections of slabs will cause damage to the ceiling, floor finishes and other architectural details. To avoid this, limits are set on the span-depth ratios.
- These limits are exactly the same as those for beams. Since the slab is usually a slender member the restriction on the span-depth ratio becomes more important and this can often control the depth. The depth of slab required in terms of the span – effective depth ratio is given by,

Minimum effective depth = span/(basic ratio x modification factor)

- The modification factor is based on the area of tension steel in the shorter span when a slab is singly reinforced at midspan.
- When a slab is supported on all four of its sides, it effectively spans in both directions, and it is sometimes more economical to design the slab on this basis. The moment of bending in each direction will depend on the ratio of the two spans and the conditions of restraint at each support.
- If the slab is square and the restraint is similar along the four sides, then the load will span equally in both directions. If the slab is rectangular, then more than one-half of the load will be carried in the shorter direction and lesser load will be imposed on the longer direction ie trapezoidal road transfer pattern.
- If one span is much longer than the other, a large portion of the load will be carried in the shorter direction and the slab may as well be designed as spanning in only one direction. (one way slab)
- Moments in each direction of span are generally calculated using co-efficients which are tabulated in the code.

3.17.3 (d) Slabs –Reinforcement (Clause 26.5.2 of IS 456:2000)

Minimum percentage of Reinforcement: **(Clause 26.5.2.1 of IS 456:2000)**

The reinforcement in either direction in slabs shall not be less than 0.15 percent of the total cross sectional area. However, this value can be reduced to 0.12 percent when high strength deformed bars or welded wire fabric are used.

Maximum Dia : (Clause 26.5.2.2 of IS 456:2000)

Maximum diameter of reinforcing bars shall not exceed one eighth of the total thickness of the slab.

Maximum Spacing of Rods: (Clause 26.3.3 (b) of IS 456:2000)

For main reinforcement, 3d or 300mm which ever is less and for distribution rods, 5d or 450 mm whichever is less.

3.18 Cement Concrete

3.18.1 Concrete Basics

- Concrete is a mixture of paste composed of cement and water coats the surface of the fine and coarse aggregates through a chemical reaction called hydration, the paste hardens and gains strength to form the rock – like mass known as concrete.
- It is plastic and malleable when newly mixed, strong and durable when hardened.

3.18.2 Proportion

- A concrete mixture that does not have enough paste to fill all the voids between the aggregates will be difficult to place and will produce rough, honey combed surfaces and porous concrete.
- A mixture with an excess of cement paste will be easy to place and will produce a smooth surface. However, the resulting concrete is likely to shrink more and be uneconomical.
- In general, cement, water, fine aggregate and coarse aggregate should be so proportioned that the resulting concrete has the following properties.
    1. While fresh, it is workable enough for economical and uniform placement but not excessively fluid.
    2. When hardened, it has sufficient strength and durability for its purpose.
    3. It involves a minimum cost for materials and labour.

3.18.3 Mixes Recommended for various types of Construction

The Mixes recommended for various types of construction are indicated in the table below:

Type of Work	Recom mended mix (by volume)	Maximum size of aggregate (mm)	Water in litres per bag of cement*	Best consis tency
Long span arches	1:1:2	12 to 20	16 to 18	Medium
Heavily Stressed members; small precast works, such as posts and poles for fencing, telegraphs signals, garden, furniture and decorative and other items of work of very thin sections; water tight construction for high heads; long piles.	1:2:2	12 to 20	20 to 23	Medium
Columns and members subjected to medium loads; wall and floors of reservoirs and tanks; cisterns, sewers, well kerbs, platforms and other watertight constructions for moderate heads; non-surfaced roof slabs; concrete deposited under water.	1:2:3 or 1:1 1/2:3	20	25	Medium
General building work subjected to ordinary stresses such as beams, slabs, columns, panel walls, basement and retaining walls, stairs, lintels and sills; roads, pavements, driveways, and sidewalks; floors; steps; bunkers and silos, bridges; dams, piers etc exposed to action of water and frost; machine foundations subjected to vibrations; footings; piles.	1:2:4 as required	12 to 40	27 to 30	Stiff to medium
Mass concrete works in culverts, retaining walls, compound walls and ordinary machine bases; foundation walls which need not be watertight.	1:3:6	25 to 40	34	Stiff to medium
Mass concrete for heavy walls; foundation under column footings and under heavy duty floors.	1:4:8	40 to 75	45 to 48	Medium

** The exact quantity will depend on the method of compaction, i.e. whether the concrete is to be compacted by hand or vibrated and also on the absorption of water by aggregate.*

3.18.4 The Water – Cement Ratio

- In concrete mix design, the ratio of the volume of water to the volume of cement is called the water – cement ratio.
- The strength and workability of concrete depends upon the water cement ratio.
- Some practical values of water cement ratio used are as follows:

S.No	Grade of Concrete	Water cement ratio
1	M 25	0.45
2	M 20	0.50
3	M 15	0.55 to 0.60

3.18.5 Where to Stop Concreting

3.18.5.1 One Way Slabs

In the case of one way slab, concreting can be stopped near the middle of the span, parallel to main reinforcement.

3.18.5.2 Continuous Slabs

In case of slabs continuous over beams or walls, concreting work can be stopped over the centre of the beam or support.

3.18.5.3 Two Way Slabs

In the case of two way slab, concreting can be stopped in either of the centroid axes of the panel

3.18.5.4 "T" Beams and "L" Beams

- The rib of "T" beams and "L" beams should normally be concreted together with the slab. It is preferable to concrete the entire length of the beam at one stretch upon the end of the supports.
- In cases where it is not possible to carry out the concreting upon the support at one stretch work may be stopped near the middle of the span provided, there is no point load in this vicinity.
- Care must be taken to ensure that there is no lapped reinforcement at the place where concreting is proposed to be stopped.
- In the case of 'T' or 'L' beams where entire slab concrete and beam concrete cannot be done simultaneously, the concreting works in ribs can be stopped 5 cm below the bottom of slab level.
- In such cases it should be ensured that the remaining concreting including slab concreting is done within 48 hours of the rib concreting.

3.18.5.5 Beams Carrying Heavy Point Loads

Special attention should be paid for main beams carrying heavy point loads (e.g. secondary beam points). Concreting schedule should be programmed in such a way that the main beam concreting should be covered up to supports avoiding construction joints keeping in mind the location of the construction joint of the subsidiary beam at center.

3.18.5.6 Columns

At the beam and column junctions, the column concreting may be stopped 10 to 15 cm below the bottom level of beams. Two hours should elapse after deposition of concrete in columns before depositing concrete in beams to allow the settlement or shrinkage in column concrete.

3.18.6 Method of Jointing Old and New Concrete

The surface of the concrete already placed should be prepared in such a manner that there is perfect bond by interlocking of granular metal available at the joint and may be prepared in the following manner, confirming to clauses under 12.4 of IS 456-2000.

i. When the work has to be resumed on a surface, which was hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints neat cement slurry shall be applied on the surface before it is dry. For horizontal joints the surface shall be covered with a layer of mortar about 10 to 15 mm, thick composed of cement and sand in the same ratio as the cement and sand in the concrete mix. This layer of cement slurry or mortar shall be freshly mixed and applied immediately before placing the concrete.

ii. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristled brushes, care should be taken to avoid dislodgment of particles of aggregate. The surface shall be thoroughly wetted and all free water should be removed. The surface shall then be coated with neat cement slurry. On this surface, a layer of concrete, not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work. Particular attention being paid to corners and closed spots, work thereafter shall proceed in the normal way.

3.18.7 Treatment of Bearing in Beams and Slabs

- The bearing structure such as brick masonry or stone masonry and the RCC slab or beam coming over it are of different materials.
- If the slab or beam is not allowed to move freely over the bearing surface, cracks will occur in the superstructure, which will then lead to problem of repair and renewal soon.
- Hence much attention should be given for the treatment for bearing surfaces. The slab or beam should be insulated effectively from the support over which they bear.
- The top portion of the bearing surface should be plastered smooth with CM 1:3 and thick craft paper laid over the plaster before the concrete for the slab or beam is laid.
- It should be ensured that the craft paper covers the entire bearing surface and that it is not displaced while laying the concrete.
- The vertical face of the masonry at bearings should also be plastered smooth with CM 1:3, a gap of 12mm width should be left between the vertical face of

the masonry and the RCC beam and the gap should be filled with mastic so that there is no chance of stone chips or other hard materials inadvertently falling into the gap and getting wedged between the RCC and masonry thus, obstructing free movement.

3.19 Stripping Time for Centering Materials (Clause 10.3. of NBC 2005 and Clause 11.3. of IS 456 : 2000)

In normal circumstances and where Ordinary Portland Cement is used, forms may generally be removed after the expiry of the following periods:

	Type of Formwork		Minimum Period before Striking form work
a)	Vertical formwork to columns, walls, beams	:	16-24 hours as may be decided by engineer in charge
b)	Soffit formwork to slabs (Props to be refixed immediately after removal of formwork	:	3 days
c)	Soffit formwork to slabs (Props to be refixed immediately after removal of formwork	:	7 days
d)	Props to slabs:	:	
	i) Spanning upto 4.5 m	:	7 days
	ii) Spanning over 4.5m	:	14 days
e)	props to beam and arches:		
	i) Spanning upto 6m	:	14 days
	ii) Spanning over 6m	:	21 days

3.20 Weathering Course and Roof Finish

After laying the R.C.C. roof slab the following sequence has to be followed for weathering course etc.

1. Brick jelly lime concrete for weathering course must be laid and tamped with wooden beaters for proper consolidation.

2. For finishing the top of RCC roof, only 200 mm x 200mmx20 mm machine pressed tiles with combination mortar 1:1:6 admixed with Water proofing compound @140 ml/bag should be used as per Standard Specification.
3. The ceiling plastering may be done after the brick jelly lime concrete for weathering course is laid and consolidated.

Weathering Course is brick jelly lime concrete using broken brick jelly 20 mm uniform gauge in pure slaked lime (No sand to be used). The proportion of Brick Jelly to lime being 32:12.5 by volume and laid over the RCC roof slab in single layer of required design slope and finished thickness by beating the concrete with wooden beaters of approved pattern. Keeping the surface constantly wet by sprinkling lime jaggery and kadukkawater.

Finishing top of roof with one coarse of machine pressed tiles of suitable size of approved quantity laid in C.M 1:3 to 12 mm thick mixed with water proofing compound confirming to IS at 2% by weight of cement used and pointed neatly to full depth of tiles with the same cement mortar mixed with red oxide as per ISI Standards.

Bell mouth finishing should be done at rain water outlet point. Parapet wall plastering shall be done only after completion of laying of pressed tiles.

3.21 Reinforcement

As per RCC design, steel to be provided in RCC structural members has to be calculated and fabricated as per detailing codes**.** Neccesary Detailing Drawing for various Structural members have been incorporated in the chapter 10 of this hand book.

3.22 Fixing Of Doors, Windows and Ventilators

The fixing of doors and windows requires special attention. Windows facing outside should be fixed inside flush and shutters opening out. In case of window having verandah on the outside, the frames should be fixed outside flush and shutter opening 180 degree so as to be flush with the walls.

It is economical and aesthetically preferable to have single shutters for all doors especially for the doors in bedroom, kitchen, store-room, bath and water closet. If the shutter has to swing 180 degree then in that case it is better to provide double shutters so that no obstruction will be caused when the shutter is opened.

Paneled shutters may be used for bath and water closet rooms and also for doors fixed in outer walls which will be subjected to rain splashing or direct sun light.

3.23 Fixing & Laying Of Sanitary Appliances

Sanitary fittings such as wash basin, water closet etc. should be fixed properly as per standard. It will be discussed in upcoming chapters.

3.24 Plumbing Including Water Supply

Necessary pipe fitting and water tank for water supply should be done as per design and estimate. It will be discussed in upcoming chapters.

3.25 Plastering

The plastering for interior walls and flooring must be finished absolutely smooth with a steel trowel and the plastering for outer side of the walls and flooring exposed to sun must be finished with wooden float and must be left somewhat rough, but uniformly rough without variations. The corners and edges in plastering must be given sharp edge finishing with cement mortar 1:3.

3.25.1 Types of Plaster

1. Lime Plaster.
2. Cement Plaster.
3. Stucco Plaster.
4. Water proof plaster.

3.25.2 Purpose of Plastering

- To provide an even, smooth and durable finished surface.
- To improve the appearance of building.

- To protect the surface from the effects of weathering agents i.e. water, temperature, etc.
- To provide a smooth base for colour washing, painting or distempering.
- To protect the internal surfaces against dust, dirt and vermin nuisance.
- To protect porous materials and faulty joints.

3.25.3 Ceiling Plastering

- Ceiling may be raked so that the bottom of the slab is made rough to receive the ceiling plastering.
- The ceiling plastering must be done after the brick jelly lime concrete for weathering course is laid and consolidated. If the ceiling plastering is done prior to weathering course, the plastering may fall while tamping is done.

3.25.4 Curing for Plasters

- To develop maximum strength and density in the plaster, each coat shall be kept damp continuously till the next coat is applied or for a maximum period of 7 days.
- The water shall be applied by using a fine fog spray. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used.
- Excessive evaporation on the sunny or windward sides of building in hot dry weather may be prevented by hanging matting or gunny bags on the outside of the plaster and keeping them wet.
- After the completion of the finishing coat, the plaster shall be kept wet for seven days and shall be protected during that period from extremes of temperature and weather (16.1 and 16.2 of IS 1661-1972).
- The newly plastered wall surface will have dampness for a period of about two years. If plastic emulsion paint is applied immediately on a new surface the result will not be satisfactory and the desire quality of finish cannot be obtained. In the long run some patches will make the surface unsightly.
- Hence, the newly plastered wall surfaces either in new buildings or re-plastered surfaces in old buildings must be initially given either white or colour washing or cement painting as the case may be. It is only after a lapse of two years

the plastic emulsion paint, synthetic enamel and other oil based paints can be applied.

3.26 White Washing & Colour Washing

Only freshly burnt shell lime white in colour should be used on conforming to IS 712 of 1964. Fevicol type gum/ glue should be added in the preparation of white wash as per IS 6278 of 1971. Adequate quantity of approved blue powder shall also be added to white wash solution for application to the walls.

3.26.1 Preparation of Surfaces

I. New Surfaces:

The surface shall be thoroughly cleaned of all dirt, dust, mortar, drops and other foreign matter before white wash is to be applied.

II. Old surfaces:

a) Surfaces, where the same colour wash is to be repeated – Old surfaces already whitewashed or colour washed shall be broomed to remove all dust and dirt. All loose scales of lime wash and other foreign matter shall also be removed. Where heavy scaling has taken place the entire surface shall be scraped clean. This will also apply where a colour wash has to be given to an already white-washed surface.

b) Surfaces, where different colour wash is to be applied – Old colour wash on surface shall be entirely removed before white-wash or different colour wash is applied. The surface shall be prepared by brushing or by scraping or by other suitable means to produce clean surface and shall be broomed to remove dust, dirt etc.

c) Old surfaces spoiled by smoke – The surfaces shall be scraped with steel wire-brushes or steel scrapers. The surface shall then be broomed to remove all dust and dirt and shall be washed with clean water.

d) Old and grease spots – Old and grease spots shall be removed by a suitable chemical and smooth surfaces shall be rubbed with wire brushes.

e) Any growth of moulds moss shall be removed by scraping with steel scraper and ammonia calcium copper solution consisting of 15 gm of copper carbonate dissolved in 60 ml of liquor ammonia in 500 ml of water shall be applied to the surface and allowed to dry thoroughly before applying white wash or colour wash. An alternative to ammoniacal copper solution treatment may consist of 2 percent sodium pentachlorophenate solutions in water.

f) Local areas affected by efflorescence, shall be initially treated in accordance with the method described in C-3 of I.S. 2395 (Part (I)) 1966 and then applied with whitewash or colour wash.

3.26.2 Cement Painting

- The surface should be properly prepared by applying Plaster of Paris, putty and using sand paper etc. over which the primer coat should be applied and water spray applied.
- Only ISI approved superior quality white cement as base coat should be used and cured with water spray. Over this, good quality two coats of ISI approved cement paint of approved colour should be given.
- Good quality brush and proper mixing of water and cement powder in the ratio 1:1 for first coat, ¾:1 for 2^{nd} Coat should be resorted to. Sprayer should be used for curing the cement painted surface, at least for a week.
- The first coat should be cured for before applying 2^{nd} coat. Use of inferior brand brushes and diluting with much water spoils the quality and strictly should not be permitted.

3.26.3 Painting Wood and Steel

- For all wood works approved quality of white ready mixed primer must be used.
- For iron and steel works approved quality of red oxide primer should be used after finishing the surface with special putty. Over the primer coat, two coats of 1^{st} quality synthetic enamel paint of approved colour should be given as per specification.
- For Old wood work, if the old painted surface is blistered or flaked, it will be necessary to completely remove the old paint, before repainting.

3.27 Electrification to Buildings

Electrification to building should be done as per electrification drawing. The light points, Fan points and other connection points should be decided previously as per requirement.

3.27.1 Wiring

For concealed wiring the provisions should be given prior to roof concreting and verified at the time of checking the steel reinforcement.

3.27.2 Fan Hooks

Fan points should be decided before the concrete for the roof is laid. The location should be decided taking into account the usable area, other than undefined passages in drawing, dining and bedrooms.

4. QUALITY CONTROL IN BUILDINGS

4. QUALITY CONTROL IN BUILDINGS

4.1 Building Materials

4.1.1 Cement

The Cement used shall be any of the following and the type selected should be appropriate for the intended use:

a) 33 Grade ordinary Portland cement conforming to IS 269.

b) 43 Grade ordinary Portland cement conforming to IS 8112.

c) 53 Grade ordinary Portland cement conforming to IS 12269.

d) Rapid hardening Portland cement conforming to IS 8041.

e) Portland slag cement conforming to IS 455.

f) Portland Pozzolana cement (fly ash based) conforming to IS 1489 (Part I) .

g) Portland Pozzolana cement (Calcined clay based) conforming to IS 1489 (Part II).

h) Hydrophobic Cement Conforming to IS 8043.

i) Low heat Portland cement conforming to IS 12600.

j) Sulphate resisting Portland Cement conforming to IS 12330.

Ordinary Portland cement is suited for use in general construction when there is no exposure to sulphate in the soil or in ground water.

4.1.1.1 Storing Portland cement

- Bags should be piled off the floor on wooden planks. If however, the floor is a well constructed dry concrete floor, the bags can be placed directly on it.
- Do not pile bags against the wall. A space of 30cm all round should be kept between the exterior wall and piles.
- Don't pile bags more than about 15 bags high, otherwise it becomes cumbersome to stack or remove them. The maximum width of pile may preferably be not more than about 3m.

- If the pile is to be more then 7 or 8 bags high arrange the bags in header and stretcher fashion, i.e alternatively lengthwise and crosswise so as to tie the piles together and lessen the danger of toppling over.

4.1.2 Aggregate

Aggregates are commonly classified into two sizes, fine and coarse aggregate. Material which is mainly retained on 4.75mm IS sieve is classified as coarse aggregate (stone) whereas the material mainly passing is called fine aggregate (sand).

For Reinforced concrete work, coarse aggregated having a maximum size of 20mm is generally used. All aggregate may be used only where specifically permitted by the engineer –in-charge.

4.1.3 Bulking of sand

Sand contains moisture which causes films of water to form on the surface of particles pulling them apart. This phenomenon is known as bulking.

4.1.4 Water

The disadvantages resulting from the use of too much water in mixing are:

- Water occupies space in concrete and as it evaporates it leaves voids. The more the uncombined water the more voids there will be in the set concrete and the less be its density, strength and durability.
- Excess water brings a mixture of cement and water to the surface of the concrete and this forms a scum or thin layer of chalky material known as 'laitance' which prevents proper bonding of the next layer of concrete and creates a plane of weakness. This is especially harmful when it occurs in tanks or dams where water tight concrete is necessary.
- Excess water leaks out of the shuttering carrying away some of the precious cement and leaving the concrete honey combed in places.

4.1.5 Stones

- It should be hard, strong and durable to resist wear and tear due to atmosphere actions and actions of acids, fumes and smokes.
- It should be close –grained and homogeneous and free from cracks, cavities, flows, soft materials, patches, loose organic matters, iron oxides etc, with proper size and shape.
- Uniform colour and compact texture.
- Water absorption not more than 5%.
- Stones to be used should be dressed properly according to the type of masonry.
- Broken stone should be used to fill the inner side masonry with mortar.
- Bond stone should be used at every 1.5m interval on every course of masonry and used on corner of masonry wall.

4.1.6 Steel

- Steel should conform to standard weights of per meter length.
- The reinforcement shall be any of the following :

  1 Mild steel.

  2 High strength deformed steel bars.

  3 High drawn steel wire fabric.
- RTS is commonly used.
- Steel rod should not have smooth surface.
- Steel shall be stored in such a way as to avoid distortion to prevent deterioration and corrosion.
- To prevent steel from rusting and corrosion the steel should be stacked above the ground, over a support.

4.1.7 Bricks

- Standard size of bricks 19x9x9 cm.
- Bricks should be reddish in color.

S.No	Visual tests	Good
1	Well burnt bricks	Copper colored and are free from cracks
2	Shape	Sharp and square edges
3	When struck with each other	Produce clear metallic ringing sound
4	When Scratched with nails	No impression on their surface
5	Transit and stacking in the course of ordinary handling	Broken less than 3%
6	When immersed in water for 24 hours	Water absorption should not be more than 20%
7	When soaked in water and dried	Do not show white patches or white deposits on their surface
8	When dropped from 1 m height	Do not break

4.1.8 Form Work for Concrete

Form shall be used wherever necessary, to confine the concrete and shaping it to the required lines. If a type of form does not consistently perform in an acceptable manner, as determined by the Engineer-in-Charge, the type of form shall be changed and method of creation shall be modified by the contractor subject to approval of the Engineer-in-Charge.

During concrete placement, the contractor shall continuously monitor plumb and string lines, form positions and immediately correct deficiencies.

Forms shall have sufficient strength to with stand the pressure resulting from placement and vibration of the concrete and shall be maintained rigidly in position where form vibrators are to be used, forms shall be sufficiently rigid to effectively transmit energy from the form vibrators to be concrete, while not damaging or altering the positions of forms.

Forms shall be sufficiently tight to prevent loss of mortar from the concrete.

Suitable struts or stiffeners or ties shall be used for the form work wherever necessary. All supports shall be braced and cross braced into two directions. All splices and braces shall be secured by bolting unless especialy intended otherwise. All struts shall be firmly supported against settlement and slipping by suitable means as directed.

All supports shall be cut square at both ends and firmly supported against settlement and slipping. When the form work is supported on soils, planks, sleepers etc., shall be used to properly disperse the loads.

The joints between the form work and existing concrete shall also be “grant tight”. Forms shall over lap the hardened concrete in the lift previously placed by not more than 75mm and shall be tightened against hardened concrete so that when concrete placement is resumed the forms will not allow loss of mortar at the construction joint.

The form work shall be of well seasoned timber Marine Plywood or steel. When timber forms are used they shall be lined with M.S. Sheet or other suitable smooth faced non-absorbent Materials as specified.

4.1.8.1 Cleaning and Treatment of Formworks:

a. In case of columns, retaining walls or deep vertical component the height of the column shall facilitate placement and compaction of concrete and suitable arrangement may be made for securing the form to the already poured concrete for placing the subsequent lifts. No steel ties or wires used for securing this form work shall be left exposed on the face of the finished work.

b. Suitable insets for block outs for electrical and other service fixtures where necessary shall be provided in the required locations as specified.

c. Cleaning and oiling of forms at the time the concrete is placed in forms. The surfaces of the forms shall be free from encrustations of mortar, grout or other foreign material. Before concrete is placed, the surface of the forms shall be oiled with commercial forms of oil.

4.1.8.2 Removal of Forms

The stripping of form work shall conform to clause 11 of I.S. 456 – 2000. The Contractor shall be liable for damage and injury caused by removing forms before the concrete has gained sufficient strength. Any needed repairs or treatment required on such sloping surfaces shall be performed at once and be followed immediately by the specified curing.

4.1.9 Reinforcement

Steel reinforcement is routinely used in reinforced concrete (RC) structures to augment the relatively low inherent tensile strength of concrete, it is also used:

- To carry shear, compressive and torsional forces in excess of concrete capacity.
- To control cracking of concrete members under working loads or as a result of early thermal effects.
- To minimize or prevent spalling of concrete in fire conditions, as a result of seismic effects, or in the highly stressed regions around anchorages in prestressed concrete construction.

  Reinforcement therefore, plays a vital role in ensuring the safety, integrity and durability of almost all concrete structures. It can only perform that role satisfactorily if it:

- Possesses the required physical and metallurgical properties.
- is of acceptable quality.
- is stored, handled, cut and bent so as to avoid damage and contamination.
- is properly and accurately fixed.

In order to realize the above-referred objectives, it is very necessary that the detailing of reinforcement is meticulously carried out and that necessary detailed working drawings and bar bending schedules is made available to the field engineers. It is also necessary for the field engineers to critically scrutinize the drawings and bar bending schedule received by them for constructability.

4.1.9.1 Grades of reinforcement bars

The BIS Code allows for the use of three grades of reinforcement bars, namely, Fe 415, 500 and 550. Facilities exist in the country for the manufacturers of these grades. However, Fe 415 is the most predominantly used grade in India. The consultants limit specification to only Fe 415 grade due to unproven prejudice against higher grades in terms of ductility; consequently, congestion of reinforcement in many industrial structures is very common leading to deficiencies in the quality of the structure.

On many occasions it is just not practical to satisfactorily place and compact the concrete with heavily congested reinforcement. This is evident from large number of cases where problems have been reported during the construction of thermal power stations, atomic power stations, etc. Grade Fe 415 is already obsolete in the developed world. The minimum grade as per BS: 4449 is Fe 460.

4.1.9.2 Recommended diameters for reinforcement

The IS specification (IS 1786) specifies nominal sizes of 8,10,12, 16,18,20,22,25,28,32,36,49,45 and 50mm bars. It gives an opportunity for the consultants/designers to specify odd sizes such as 18, 22mm etc. and create consequent difficulties during execution both due to non-availability of odd diameters in the market and in terms of quality assurance. It is not possible to distinguish between 20 and 22mm diameters of 18 and 20 mm diameters by visual examination.

4.1.9.3 Weldability

IS 1786 – Clause 0.2 (Foreword) states that "there is also need for these steel bars to be welded and fabricated on the site easily. For this, Strength and ductility had to be achieved at the lowest possible carbon content". The British Standard BS 4449 - 1997 specifies the requirements for weldable steel bars in terms of carbon equivalent value.

4.1.9.4 Chemical composition

The IS code permits carbon content 0.3 percent whereas the internationally accepted maximum value is only 0.25 percent. The increased permissible carbon content has been responsible for corrosion of reinforcement steel in the large number of cases.

4.1.9.5 Tolerances on dimensions and nominal mass

IS 1786 clause 6.2 (Table 2) provides tolerances and nominal mass of + 8 percent for bars and including 10mm 6 percent for bars upto 12 to 16 mm diameter and 4 percent for bars over 16mm diameter.

4.1.9.6 Bending schedules for reinforcement

Shapes and dimensions of bars cannot in general be deduced from the reinforcement drawings in isolation. The main function of the bending schedule is to define exactly the shape of each bar within a group of bars having the same bar mark. A standard layout of the bar bending schedule is given in SP 34. Schedule normally contains information concerning weights of reinforcement. It is the responsibility of the design team to prepare the bar bending schedules. IS 456 also stipulates that bar bending schedules shall be prepared for all reinforcement work.

4.1.9.7 Covers for reinforced concrete: (Clause 12.4 of IS 456:2000)

The inadequate use of covers and chairs has been a major cause of variations in cover to reinforcement and consequently decreased durability of concrete. Unfortunately, there is no comprehensive national standard for the use or the performance of covers and Chairs. IS 456 : 2000 states that "all reinforcement shall be placed and maintained in the position shown in the drawings by providing proper cover blocks, spacers, supporting bars etc." (Clause 12.2) While this is a specification requirement, there are no guidelines in this regard either in the IS codes or in the technical specifications. There are no specific guidelines for the cover blocks. In practice, cover is maintained by a variety of crude contraptions ranging from pieces of broken tiles or broken stones or timber to mortar blocks. None of these are really satisfactory. They do not maintain the cover except perhaps the mortar block, which again is not satisfactory because of the porosity. Porous blocks result in premature corrosion to reinforcement. Occasionally, some specifications do call for cover blocks of concrete of the same grade as that of concrete. While this may be satisfactory, its application is limited to upper end of the cover, say more than 50mm. There is also no guarantee that site-made concrete cover blocks are of the same quality as that of the concrete. Considering the above, the specifications of developed countries do not permit any of the above contraptions including site-made concrete cover blocks.

4.1.9.8 Steel Chairs to support reinforcements

Steel chairs are manufactured from reinforcement bars to provide cover in excess of 75mm. They are commonly used to support top horizontal reinforcement or to support vertical reinforcement in walls. They may be individual or continuous. If placed on formwork or mud mat, the legs of chairs should be provided with protection gaps. Individual chairs are manufactured in standard heights of between 75 and 300mm and are used to support reinforcement at one point. Continuous chairs provide a straight line of support at a uniformed height. Chairs above a height of 300mm are normally scheduled as part of the bar bending schedule.

4.1.9.9 Guidelines for tying reinforcement:

There are six common ways of tying reinforcement bars.

Slabs and Walls

Perimeter bar should be tied at every intersection; for bars up to and including 20mm, alternate intersection should be tied. For bars of 25mm or larger diameter, they may be tied at greater centers.

Cantilevers

Top reinforcement in cantilevers should generally be located by the use of chairs.

Beams

Every intersections of a corner of a link with longitudinal main bar should be tied. Other bars within the links should be tied at 50D centers. Spacers within the beams spacers within the beams should be at centers not exceeding one metre along the beam spacers should be fixed on three sides of the same link.

Columns

Every intersection between vertical bars and links should be tied.

Binding wire

The binding wire is normally a black annealed wire, of 16 gauges. Care should be taken to ensure that the projecting ends of the binding wire do not encroach into the concrete cover.

4.1.9.10 Characteristic Strength of Reinforcement Bars

Types of Reinforcement	characteristic strength (yield stress of 0.2 % proof stress) N / mm2	Ultimate tensile stress, N / mm2	Minimum elongation on gauge length of 5.65 x sq.rt Cross – Sectional area (%)
Mild steel of grades I II	255 236 231 211	412 373	20-23 20-23
Medium tensile steel	353 348 323	538	17-20
Cold worked deformed bars	415	15% more than the actual 0.2% proof stress	14.5
	500	10% more than the actual 0.2% proof stress	12
Hot Rolled	412	15% higher than the yield stress	14.5
SAIL - MA of grades 300 HY 350 HY 410 HY	 300 350 410	 440 - 560 490 - 610 540 - 660	 20 20 19

4.2 CONCRETE:

The manufacture of concrete involves several operations, over each stage of which careful control needs to be exercised.

4.2.1 Proportioning of Materials

In general cement, water, fine aggregate and coarse aggregate should be so proportioned that the resulting concrete has the following properties.

While fresh, it is workable enough for economical and uniform placement but not excessively fluid.

- When hardened, it has sufficient strength and durability for its purpose.
- It involves a minimum cost for materials and labour.

The concrete shall be in grades designated below:

Group	Grade Designation	Compressive strength at No. of days in N / mm²
Ordinary Concrete	M10 M15 M20	10 15 20
Standard Concrete	M 25 M 30 M 35 M 40 M 45 M 50 M 55	25 30 35 40 45 50 55
High Standard Concrete	M 60 to M 80	60 to 80

4.2.2 Sand and Coarse Aggregate:

Sand and coarse aggregate for concrete, and sand for mortar and grout, may be obtained by the Contractor from the approved source shown in the contract documents. Tests performed on samples of sand and coarse aggregate obtained from the approved sources mentioned in the contract documents indicate that they are generally suitable. Well in advance of their usage on the works, the Contractor shall have his own testing of Materials and satisfy himself that they conform to the specification mentioned herein for use in the works.

Samples for pre-construction test and approval, not less than 60 days before sand is required for use. Each, sample shall approximately consist of 100 kg of material. Final acceptance of aggregate will be based on the samples taken from the batch plant or mixing platform.

4.2.3 Batching of concrete .

The quantities of cement, sand and each size of coarse aggregate entering each batch of concrete shall be determined by individual weight measurement. Cement has to be weighed separately from the aggregates.

The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents.

4.2.4 Mixing of concrete

The concrete ingredients shall be thoroughly mixed in mechanical mixer designed to positively ensure uniform distribution of all component Materials throughout the concrete at the end of the mixing period. Mixing shall be done as per clause 9.3 of I.S. 456 – 2000. The mixer should comply with I.S. 1791 – 1985 (I.S. Specifications for batch type concrete mixers).

The concrete as discharged from the mixer shall be uniform in composition and consistent from batch to batch. Workability shall be checked at frequent intervals as per I.S. 1199 – 1959. The mixing shall be continued until there is a uniform distribution of the Materials so that the mass is uniform in colour and consistency and to the satisfaction of the Engineer-in-Charge. If there is segregation after unloading the concrete should be remixed.

The minimum mixing time shall be 2 minutes. Excessive over mixing which require addition of water to maintain the required concrete consistency will not be permitted.

Mixing shall be continued for the minimum period specified, and may be increased and No. of revolutions, speed of the drum may be such that the mix as delivered from the Concrete shall be discharged within half an hour after introducing of the mix water and cement into the mixer. Each batch of concrete, when delivered at the job site from commercial ready mix plants, shall be accompanied by a written certificate of batch weights and time of batching.

4.2.5 Temperature of Concrete

Fresh structural concrete shall be placed at temperature of between 15^{o} C to 32^{o}C. During Hot or cold weather, the concreting should be done as per the procedure set in I.S.7861 (Part I – 1975 or I.S. 7861 (Part – II)).

4.2.6 Concrete mix Proportioning

The determination of the proportions of cement, aggregates and water to attain the required strengths shall be made as follows.

a) by designing the concrete mix, such concrete shall be called " Design mix concrete".

b) by adopting nominal concrete mix, such concrete shall be called "nominal mix concrete".

4.2.7 Placing of concrete

1. Placing and compaction of concrete to be completed before initial setting time.
2. Care should be taken to avoid displacement of reinforcement or movement of form work.
3. The maximum permissible free fall of concrete may be taken as 1.5 m.

4.2.8 Compaction

Concrete should be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into the corner of the form work.

1. Mechanical vibrators complying with IS 2505, IS 2506, IS 2514 and IS 4656 are recommended.
2. Good finishing practices are essential for durable concrete.
3. Over vibration and under vibration of concrete are harmful and should be avoided.
4. Vibration of very wet mixes should also be avoided.

Over working and the addition of water or cement to aid in finishing should be avoided.

4.2.9 Protection

The contractor shall provide protection to prevent erosion to fresh concrete whenever precipitation either periodic or sustaining is imminent or occurring.

When precipitation appears imminent, the contractor shall immediately make ready at the placement site all materials which may be required for protection of fresh concrete. The Engineer-in-Charge may delay placement of concrete until adequate provisions for protection against weather are made.

All fresh concrete surfaces shall be protected from contamination and from foot traffic until the concrete has hardened. Hardened concrete surfaces which have to be finished and shall be protected against damage from foot traffic and other construction activity by covering with protective mats plywood or by other effective means.

4.2.10 Water Curing for concrete: (Clause 13.5. of IS 456 : 2000)

All concrete surfaces shall be treated to prevent loss of moisture from the concrete until the required curing period elapsed or until immediately prior to placement of other concrete or backfill against those surfaces. Only sufficient time to prepare construction joint surfaces and to bring them to a surface dry condition shall be allowed between discontinuance of curing and placement of adjacent concrete. Where required, repair of all minor surface imperfections shall be made prior to curing. Minor surface repair shall be completed with 2 hours after form removal and shall be immediately followed by the initiation of curing by the applicable method specified herein. Concrete surfaces shall be kept continuously moist after form removal until initiation of curing.

4.3 Field Test for Building Materials

4.3.1 Field Tests To Verify Quality of Cement

- Date of manufacture must be checked, as aging reduces the strength.
- Open the bags and ensure that there is no lump (Means no setting)
- Thrust your hand into the cement – and it should be cool inside (means no heat of hydration and no setting)
- Pinch of cement between fingers should give a smooth feeling (means no setting).

- Handful of cement thrown on water should float initially before finally settling.
- Take 100 gm of cement, make stiff paste, and prepare cake with sharp edges, put on a glass plate and Immerse in water.

  a. Shape shouldn't be disturbed.

  b. It should set and attain strength.

4.3.1.1 Loss of Strength Due to Storage

Period of storage	%age of 28-daysStrength
Fresh	100%
3 months	80%
6 months	70%
12 months	60%
24 months	50%

4.3.1.2 Detection of Adulteration:

- Take a small sample of cement on a steel plate and heat it thoroughly for 20 minutes on a stove. Adulterated cement will change its colour on heating. If it is of good quality, there will be no change in colour.

  However this test cannot detect the addition of Pozzolana in cement as it is also produced under high temperatures. (Max. Pozzolana allowed: 35%)

- To detect adulteration with coal ash take a small quantity of doubtful cement in test tube or a glass tumbler and add water till the container is half full. Shake the container thoroughly and allow it to settle for a few minutes. Cement particles will settle down and ash particles will either be found floating on the surface or held in suspension because of their lightness.

Note: If there is a chance to collect the sample of Fly ash used in the cement the fineness and presence of objectionable ash can be checked in the field by mixing the fly ash in a bucket half full of water and passing the resulting slurry through an IS sieve 150 microns. No residue shall be left behind on the sieve in the case of a good sample of fly ash.

4.3.1.3 Setting and Hardening action

1. Prepare three small pats each 75mmx75mmx25mm in size from the sample given with 28 percent water by weight.
2. Prepare similar number of pats with good quality of cement.
3. Cover the pats with moist cloth for 24 hours.
4. Make thumbnail impression or scratch. Good quality cement will resist this impression.
5. If cement doesn’t resist this impression then continue curing it up to 48 hours after which try to break it with pressure of thumb. Bad quality cement will easily break under the pressure.
6. If 48 hours-test show improvement in hardening but does not attain hardness comparable with genuine cement further trail should be made after 72 hours of curing.

4.3.1.4 Ascertaining soundness of cement

1. Make a pat of cement 75 mm in diameter and 15 mm thick and cure it with moist cloth for 24 hours and then boil in water for a period of 6 hours observes the surface of the pat. If the cement is sound the surface will not develop a pattern of cracks.
2. In sound cement cracks are thin and uniformly distributed all over the surface.

4.3.1.5 Precautions

1. In a test for soundness of cement, the cracking of unsound cement should not be confused with the contraction cracks.
2. Contraction cracks develop during boiling where the test pats might have been exposed to heat or drying winds.

Contraction cracks are a few well-defined cracks running from edge to edge and those do not indicate anything wrong with the sample.

4.3.2 Field Tests for Sand

Fine aggregate (Sand) is one which passes through 4.75 mm IS sieve (5-10% oversize permitted by IS : 383-1970)

4.3.2.1 Properties of Good Sand

1. It should be chemically inert.
2. It should be clean and coarse. It should be free from any organic or vegetable matter.
3. It should contain sharp, angular grains.
4. It should not contain salts, which attract moisture from the atmosphere.
5. It should be well graded i.e. should contain particles of various sizes in suitable proportions.
6. It should be free from silt and clay.

4.3.2.2 Test

1. Sand is actually tasted and from its taste, presence of salts is known.
2. Sand is taken from a heap and it is rubbed against fingers. If fingers are stained, it indicates that sand contains silt or clay.
3. A guide to the amount of clay and silt in sand can be obtained from the field settling test. An excessive amount recorded in this test will indicate that other more sensitive tests should be made.

   The test involves placing about 50 ml of a 1% solution of common salt in water in a 250 ml measuring cylinder. Sand as received is then added gradually until the level of the top of the sand is at the 100 ml mark and more solution is added to bring the liquid level to the 150 ml mark. The cylinder is shaken vigorously and the contents allowed to settle for about three hours. The thickness of the silt layer is measured and expressed as a percentage of the height of the sand below the silt layer.

The amount of clay and silt in the sand may be considered acceptable if it does not exceed 10%

If a measuring cylinder is not available, a jam jar filled to a depth of 50 mm with sand and to a depth of 75 mm with the solution, will give a comparable result if the contents are allowed to settle for three hours. The thickness of the silt layout in this case should not be more than 3 mm.

4. For detecting the presence of organic impurities in sand, solution of sodium hydroxide or caustic soda (3% Solution) is added to sand and it is stirred.

   a. **A colourless** liquid shall indicate clean sand free from organic matter.

   b. **A straw** coloured liquid indicates presence of some organic matter but not enough to be objectionable.

   c. **A dark colour** means that the sand contains injurious amount and accordingly it is not to be used unless it is washed and re-test shown that it is satisfactory.

4.3.2.3 Size of Sand for Zone

IS sieve designation	Percentage passing for			
	Grading Zone I	Grading Zone II	GradingZone III	Grading Zone IV
10 mm	100	100	100	100
4.75 MM	90-100	90-100	90-100	95-100
2.36 MM	60-95	75-100	85-100	95-100
1.18 MM	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	05-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

1. Sand falling in Grade I is coarse and that falling in Zone IV is fine.
2. Sand falling in Grade IV shall not be used in reinforced concrete.
3. Ideally, Sand conforming to Zone II or Zone III should be used for concrete wherever possible.
4. Zone I sand tends to give harsh concrete that is sensitive to moisture changes and is prone to segregation.
5. Zone IV sand tends to give concrete too much cohesion and the resultant mix is sticky and difficult to compact.

4.3.2.4 Size of Sand For Works

IS sieve designation	Percentage passing by Weight	
	For Masonry Works (IS : 2116-1980)	For Plastering Works (IS: 1542-1977)
10mm	—	100
4.75 MM	100	95-100
2.36 MM	90-100	95-100
1.18 MM	70-100	90-100
600 micron	40-100	80-100
300 micron	5-70	20-65
150 micron	0-15	0-50

4.3.3 Coarse Aggregates

Coarse Aggregate is one which is retaining on 4.75 mm IS: sieve (5-20% passing the sieve are permitted)

4.3.3.1 Properties of Good Coarse Aggregate

1. Specific Gravity – It should have good crushing strength and Density.
2. Surface Texture – It should be angular and should have sharp edges.
3. Particle Shape – It should not be flaky.
4. Porosity – It should have very low water absorption.
5. Stability – It should be chemically inert.

6. Impurities – It should be free from mineral impurities like mica which decay and also clay and silt.
7. Compactness – It should be graded to achieve maximum compactness.

Angular aggregates are superior to rounded aggregates from the following points of view:-

a. Angular aggregates exhibit a better interlocking effect in concrete, which property makes it superior in concrete.
b. To total surface area of rough textured angular aggregate is more than smooth rounded aggregate for the given volume. By having greater surface area, the angular aggregate may show higher bond strength than rounded aggregates.

4.3.3.2 Gradation requirement of Coarse Aggregates (20 mm) (I.S 383, 1970)

IS sieve designation	Percentage passing by Weight
40 mm	100
20 mm	85-100
16 mm	-
12.5 mm	-
10 mm	0-20
4.75 mm	0-5
2.36 mm	-

4.3.4 Water

The water used in making and curing of concrete, mortar and grout shall be free from objectionable quantities of silt, organic matter, injurious amounts of oils, acids, salts and other impurities etc. as per I.S. Specification No. 456 – 2000.

Potable water (water fit for drinking) is generally considered fit for mixing. Permissible limits for solids when tested in accordance with I.S. 3025 – 1964 shall be as tabulated below.

4.3.4.1 Permissible Limits for Solids in Water (Clause 5.4. of IS 456 : 2000)

Sl. No.	Name of solids	Maximum permissible limit
1.	Organic	200 mg/litre
2.	Inorganic	3000 mg/litre
3.	Sulphate (as SO_4)	400 mg/litre
4.	Chlorides (as Cl)	2000 mg/litre for plain concrete work and 500 mg/litre for RCC work.
5.	Suspended matter	2000 mg/litre

The PH value of water shall generally be not less than 6. Water suitable for mixing is suitable for curing also. But it should not leave objectionable stain or unsightly deposits on the surface. The presence of tannic acid and iron compounds is objectionable.

4.4 Allowable Limits for Building Materials to Quality Standards

Sl. No	Test	Frequency	IS Code	Allowable limits
1.	**CEMENT**			
	a) Chemical	For each consignment		
	i) Alkalies		a) 269 – 1989	OPC < 0.60%
	ii) Minor, Major oxides by Calorimetry		b) 1489 – 1976	PPC < 0.70%
	iii) Chloride		c) 4032-1985	PPC/OPC < 0.05%

Sl. No	Test	Frequency	IS Code	Allowable limits
	b) Physical	For each Consignment		
	i) Fineness		a) 269-1989 b) 1489-1976 c) 4031-1988	Not < 2250 cm2/gm
	ii) Soundness (Lechatelier)			Not > 10mm
	iii) Consistency			Penetration upto 5 to 7 mm from base
	iv) Setting time (Initial & final)			IT-Not < 30 min FT-Not < 600 min for 33 Grade
	v) Compressive Strength			3 days - 160 kg/cm2 7 days - 220 kg/cm2 28 days - 330 kg/cm2
	vi) Heat of Hydration			PPC 7 days - 65 Cal/gm OPC 28 days - 75 Cal/gm
	vii) Drying Shrinkage			< 0.15%

Sl. No	Test	Frequency	IS Code	Allowable limits
1.	**GRAVEL** i) Size of Gravel ii) Liquid limit iii) Plasticity Index	For each stack	IRC 19-1977	 Not larger than ¾" <20% <6%
2.	**WATER** PH value Organic In-Organic Sulphate	Two samples for each source	 IS 3025 Part II Part XXIV	 6 to 8 Not greater than 200mg/lit Not greater than

Sl. No	Test	Frequency	IS Code	Allowable limits
	Chloride Suspended Solids		Part XXXII Part XVII	300mg/lit Not greater than 500mg/lit Plain Concrete: Not greater than 2000mg/lit. RCC Work : Not greater than 1000mg/lit Not greater than 2000mg/lit
3.	**RR STONE** i) Abrasion Value ii) Crushing strength iii) Specific Gravity iv) Water Absorption	For each Quarry	1124 – 1974 1121 – 1974 1124 – 1974 1126 - 1974	Not to exceed 6% Granite – 1000 kg/cm^2 Basalt – 400 kg/cm^2 2.60 (min) Not to exceed 5%
4.	**REINFORCEMENT** Weight Diameter Ultimate Test Strength Yield Stress Elongation	For each consignment	1786 - 1985 432 - 1966	Dia 8mm 4% Dia 8mm 2.5% Dia 25mm 0.5% Dia 25mm 0.5% Refer the table below for allowable limits.

4.5 Frequency of testing Cement Mortar / Masonry and Concrete

Sl. No	Test	Frequency	IS Code	Allowable limits
1.	Cube Test for concrete	3 tests specimens per $50m^3$ of concrete subject to a minimum of three samples per day for each grade of concrete.	456-2000	
2.	Cube test for cement mortar in masonry	3 tests per each grade of mortar per day.	2250 – 1981 Appendix A	
3.	Permeability test on cement mortar	Once in a week	3085 – 1965	Not greater than $2.5x10^{-8}$ mm per sec. for rich mortar & 4.8 x 10^{-8} for lean mortar.
4.	Permeability test on masonry (applicable for masonry dams)	At least two holes in every block for every lift, one in upstream and one in downstream in staggered fashion.	11216-1985	Not greater than 2.5 Lug eons in masonry in CM: 1:3 and 5 Lug eons in masonry in CM 1:4 for dams.
5.	Slump test	One test in each shift on at frequent intervals to checked workability	IS 1199	As per Mix design.

The actual frequencies shall be determined by the Engineer-in-charge to suit the nature and variability of material placed and the rate of fill placement with the objective of ensuring best quality control and quality construction.

	COARSE AGGREGATE				
i)	Sieve Analysis every 150 m3 or less	One test for gradation and percentage of various size	To know Part I 1963	IS 2386	
ii)	Specific Gravity, Bulk Density, Moisture content, Absorption & Slit Continent	- do -	To utilise data for mix design computation	IS 2386 Part III 1963	Not > 2.6 Not more than 5% by weight Not > 3%
iii)	Soundness test (Sodium Sulphate method)	- do -	To assess the quality of course aggregate	IS 2386 Part V 1963	Loss Not > 12% after 5 cycles of immersion in $Na_2\ So_4$.
iv)	Abrasion, Impact & Crushing Value	- do -	- do -	IS 2386 Part IV 1963	Wearing Surfaces: Loss Not > 30% Non Wearing Surface Not > 45%.
v)	Organic Impurities (Mica content)	- do -	- do -	IS 2386 Part II 1963	Less than 1%
vi)	Alkali reactivity (Alkali-Aggregate reactivity)	Twice in one working season nature of aggregate	To know the 'innocuous' or 'deleterious'	IS 2386 Part VII 1963	•Falling in left side of Sc/Re curve. 'Innocuous'. • Falling in right side of Sc/Re curve. 'Deleterious'
vii)	Petrographic Examination	Twice in one working season constituents and silt in aggregate	To know the deleterious	IS 2386 Part VIII 1963	Deleterious constituent plus silt shall not exceeds 5%

4.6 DOs and DONTs

4.6.1 For Foundation (Concrete Work)

Sl. No.	DOs
1.	Verify dimensions and foundation levels as per drawing.
2.	Wet the foundation surface to a depth of 150 mm or to impermeable material.
3.	Compact with suitable bedding materials in case of over excavations and with M-5 grade concrete in case of rock.
4.	Ensure the rock surface free from oil, objectionable coating unsound fragments.
5.	Check-up correct batching of ingredients.
6.	Check the batch of cements and its make.
7.	Check-up water cement ratio and slump test.
8.	Ensure uniform mixing in a mixer for at least 2 ½ minutes.
9.	Ensure proper compaction with vibrators and keep stand – by vibrator and needles.
10.	Operate immersion type vibrators nearly in vertical position to vertical drain.
11.	Cure with water for 28 days.

Sl. No.	DONTs
1.	Do not forget to compare bearing capacity of actual soils met with design strength.
2.	Don't lay the foundation concrete without wetting the surface.
3.	Don't allow admixtures, which will harm the strength of concrete.
4.	Do not lay the concrete under water and over slush.
5.	The minimum mixing time should not be less than 2 min.
6.	Do not forget to keep stand by vibrator and needles.
7.	Do not forget to cast the cubes.
8.	Do not allow segregation of concrete.
9.	Do not use unsatisfactory mix.

4.6.2 For Super Structure

Sl. No.	DOs
1.	Check the form work
2.	Apply cement slurry after cleaning the surface at vertical joints.
3.	Clean and cover with a layer of 10 to 15 mm thick mortar of the same proportion of concrete mix for horizontal joints.
4.	Place the concrete, preferably at temperature not exceeding about 90^{o}F.
5.	The concrete shall be discharged within half an hour after introduction of the mix water and cement.

Sl. No.	DONTs
1.	Avoid abrupt surface irregularities.
2.	Do not deviate from specified dimensions of cross section from - 6mm to +12 mm
3.	Do not allow concreting until all form work installation of items to be embedded and preparation of surface involved are approved.
4.	Concrete Should be poured on to the form work casing not bounded between brick work.

4.6.3 Reinforced Cement Concrete Slabs (I.S. CODES 2502, 1786)

Sl. No.	DOs
1.	Check the reinforcement as per drawing and I.S. Code with particular reference to concrete cover.
2.	Provide asphaltic pad and water stopper as per drawing.
3.	Ensure lighting arrangement if the work is to be carried out during night.
4.	Ensure stand by vibrator & mixer in working condition at site before start of work.
5.	Fill up the cubes of concrete samples for testing.

Sl. No.	DONTs
1.	Do not pass without specified cover.
2.	Do not Permit rods of shorter length in over laps.

4.6.4 Masonry

I.S. CODES 1597, 1812, 1200, 383, 269, 2116

Sl. No.	DOs
1.	The stone shall be of uniform colour, texture, strong, hard durable.
2.	Dress C.R. stone to a depth of 75 mm on all four sides.
3.	Wet the stones before placing in position. Clean and cover with fresh mortar.
4.	Place stones in layers to the line and plumb.
5.	Provide weep holes at 2 metre interval staggered as per drawing.
6.	Chisel & dress the corner stones.
7.	Face stones shall be laid alternately in headers and stretchers.
8.	Provide bond stones at 1.5 meters. Interval in each layer and mark.
9.	Place the hearting stones on its broadest face.
10.	Ensure perfect hearting to make the masonry water tight.
11.	Mortar shall be used within 30 min. after discharge from mixer.
12.	Sieve analysis for sand shall be done periodically.
13.	For flush pointing the mortar shall be finished off flush and level with edges of the stones.
14.	Joint shall be raked out to minimum depth of 12 mm when the mortar is green.
15.	Cure the masonry with water for 14 days.
16.	Cure the plastered surface with water for 14 days.
17.	Cure the pointing surface with water for 7 days.

Sl. No.	DONTs
1.	Do not use soft stones of crushing strength less than the specified strength
2.	Do not allow projections more than 40 mm on the face.
3.	Do not allow stones of length more than 3 times the height.
4.	Do not allow stone of breadth less than height of ¾ of thickness of wall.
5.	Do not allow breaking of vertical joints less than 75 mm.
6.	Header shall not project not less than 10 cm beyond stretcher.
7.	Do not place in position without cleaning and wetting.
8.	Do not allow skin stones, weathered stones.
9.	Do not place stone in position without wetting.

10.	Joints thickness should not be more than 12 mm.
11.	Do not allow mixing less than 2 minutes for thorough mix.
12.	Do not add more water than required to have a consistency of 90 to 130 mm.
13.	Avoid spreading of mortar over the surface of the masonry. Mortar should be spreader over the stone just before laying the next layer.
14.	No pointing to be commenced without washing and wetting the joints thoroughly.

4.7 Check List for Ensuring Quality of Work

4.7.1 Checklist for Reinforcements

The following queries can be used as a checklist for initial scrutiny of drawings and schedules.

- Does the detailing permit sensible location of construction joints?
- Is the reinforcement congested?
- Would alternative detailing provide greater flexibility or ease of fixing?
- Is there scope for prefabrication?
- What is the best sequence?
- Is the reinforcement detailed provide sufficient rigidity and stability of cages during fixing?
- Are set-up bars, bracing bars, chairs, spacers etc required?
- Do schedule agree with drawings?
- Does reinforcement in one member clash with that in an adjacent member?
- Are scheduled bending dimensions compatible with member dimensions and specified concrete cover?
- Are starter bars detailed?

4.7.2 Delivery checklist

For the delivery checklist, one has to:

- Ensure adequate offloading space
- Check weights given on delivery ticket (by calculation and bar count)

- Ensure correct handling during unloading
- Check reinforcement is of correct type
- Check bundles are correctly labeled
- Check reinforcement is of correct grade
- Check bar size (for example, by gauge or tape)
- Check extend of scale and pitting

4.7.3 Storage checklist

For the storage checklist, one has to:

- Ensure storage area is spacious and well organized
- Ensure reinforcement is stored clear of the ground
- Keep reinforcement free of mud, oil, grease
- Provide a lose protective cover over the reinforcement
- Ensure good air circulation around the steel
- Store materials according to construction program
- Avoid long term storage of reinforcement on site

4.7.4 Bending checklist

For the bending checklist, one has to:

- Use a steel tape when marking bars for bending
- A site bending yard must be properly planned and set up
- Reinforcement should be bent cold on a proper powered bending machine
- Do not permit high yield steel to be heated on site before bending
- Check the bent shape for dimensional accuracy, (for example, against a full size template) bend ratio and for signs of fracture.

4.7.5 Pre-concreting checklist

For the pre-concreting checklist, one has to:

- Ensure correct number of bars have been fixed, check that all laps are of the correct length
- Ensure correct use of cover blocks, spacers etc
- Check cover for reinforcement is correct at all locations
- Ensure that all twisted ends of ties are bent inwards away from concrete faces
- Ensure adequate access for concrete compaction.

4.7.6 R.C.C Work

1. Quality and size of coarse aggregate-whether the metal is over sized, under sized or improperly graded, whether it contains disintegrated, soft or foreign material, whether mixed or coated with dust/earth.
2. Quality of sand, -its grading, silt content and bulkage to be seen.
3. Water for mixing and curing-whether tested for suitability.
4. Cube test - whether cubes taken, numbered and tested and whether proper arrangements for curing the cubes is made.
5. Cover blocks - adequacy of thickness and evenness and appropriateness of cover provided with reference to the exposure conditions and types of RCC member.
6. Whether any reinforcement exposed on removal of forms.
7. Honeycombing-extent and quality of repairs.
8. Testing of steel reinforcement for suitability.
9. Spacing of hooks and overlaps, whether suitably staggered and of required length.
10. Rigidity, evenness, lines and levels of the centering and shuttering- whether thickness of finishing of R.C.C surface like rendering and plastering is excessive for making up deficiencies.
11. Final finish of the work.
12. In case of thin sections whether particular attention is given to maintain quality and finish.

13. Whether curing done properly and for specified no.of days.
14. Whether proper expansion joints and contraction joints provided.
15. Whether hacking of green R.C.C. work done on surface requiring plastering.
16. Whether construction joints left at appropriate and predetermined locations and proper keys left for joining old and new concrete.

4.7.7 Check List for Points before allowing Concrete Pouring

1. Formwork and staging checked for line, levels and their strength.
2. Reinforcement checked.
3. Cover to reinforcement and adequacy of cover blocks checked.
4. Adequacy of chairs for reinforcement and their numbers noted.
5. Whether proper planks or plates provided for walking over reinforcement so that reinforcement is not disturbed by walking directly over it.
6. Adequacy of quantity and quality of materials checked (cement, sand and aggregate, etc.)
7. Embedded parts in slab checked (e.g. Fan box, insert plates, etc.)
8. Gaps in shuttering to be properly sealed by jute bags/mortar/rubber beading (for superior work)
9. Whether shuttering plates properly oiled or not.
10. Whether proper access of man and material to location of slab casting checked.
11. Whether construction joints planned in advance (for break-in concrete pouring operation during lunch or after the day.)
12. Curing arrangements to be checked in advance for Proper curing of slab after casting (e.g. condition of water pump, water tank, adequacy of water, etc.)
13. Whether precautionary arrangement taken in case rain comes e.g. arrangement of tarpaulin, etc

14. Whether adequate arrangements made for avoiding drying of the slab after casting due to low humidity, heat or wind, by taking any of the following measures:

    (a) Placing wet gunny bags over slab; (b) Application of curing compound (which doesn't allow water to evaporate); (c) Application of some water absorbent material like CaCl which absorbs moisture from atmosphere and keeps concrete wet.

15. In case of load bearing wall, whether bearing plaster provided over wall along with white-wash/bitumen/Kraft paper/ polythene over it.

4.7.8 Check List for Quality of Brick Work

1. The thickness of joint in brick masonry should not exceed 1 cm.
2. The face joints should be raked to a depth of 15 mm by raking tool when the mortar is still green so as to provide proper key for plaster or pointing.
3. Brick work should be taken up in layers not exceeding one metre height at a time.
4. Check that the brick work is in plumb.
5. Check that the brick courses are in level.
6. Check the quality of bricks with specific reference to:
    a) Strength.
    b) Efflorescence.
    c) Dimensional accuracy
    d) Water absorption
    e) Evenness of baking.
7. Check that no brick bats are used as queen closer.
8. Check strength of mortar by scratching with sharp instrument like screw driver.
9. Check quality of sand in mortar (test for fineness modulus and silt content)
10. Check mixing of mortar whether done by hand or by machine, whether mixing is done on a proper platform,

11. Check arrangements for curing.
12. Whether raking of green joints done or not.
13. Whether soaking of bricks done or not.
14. Check general quality of works with reference to lines, levels, thickness and trueness of the joints.
15. Whether brick corners are provided properly by a proper brick closer and not by putting brick bats.
16. Whether top courses in plinth, in window sill and below R.C.C slab and parapet are provided with brick on edge.
17. Whether joints of brick work are filled with mortar fully, check specially vertical joints.
18. Check type of scaffolding and whether tied and braced properly.
19. Check reinforcement in brick partition wall, whether provided.
20. Check bonding of cross wall with long walls.
21. Whether holes left in the brick work while execution for supporting scaffolding are filled with concrete and not with dry bricks.

4.7.8.1 Common Defects Noticed in Brickwork

1. The bricks used were of substandard quality compared to the quality specified in the contract.
2. No tests were carried out to find out the efflorescence level and water absorption in the bricks.
3. The bricks were not soaked in water properly. Water was only lightly sprinkled on the stack of bricks. The bricks were dry inside.
4. Joints in the brick masonry were thicker than specified in the contract specification
5. Joints in brick work below ground level were not finished properly as the contractor assumed that these joints would not be seen once earth is filled back.
6. Vertical joints in brick work were hollow.

7. The mortar had not gained strength. On scratching by a screw drive, the mortar could be raked out completely with ease.
8. Raking of joints was not done when mortar was green.
9. Brick bats were used as fillers and closers.
10. Mortar was not mixed properly on a platform or in a machine
11. The brick layers were uneven and not truly horizontal
12. The brick work was not in plumb.
13. The brick work was done in weaker mortar and not as per structural requirement.
14. The brick courses on edge were not done where needed.
15. Gaps existed between door frames/window frames and masonry.
16. Heavy efflorescence was observed in the brickwork.
17. The brick masonry in long partition walls was done without reinforcement.
18. The holes in the brick work which were left for supporting scaffolding were filled with dry bricks without proper mortar around it and superficially plastered which later became the source/of dampness in the building.

4.7.9 Checklist for Stone Masonry Work

The following check list may be utilized while inspecting stone work:-

1. Quality of stone
2. Strength of mortar.
3. Mix of mortar
4. Quality of sand-record of fineness modulus and silt content.
5. Mixing of mortar whether done in a machine or by hand-whether in hand mixing, proper platform is made for mixing.
6. Whether joints fully filled with mortar.
7. Whether required number of bond stones provided (Marking of bond stones during construction is needed for easy identification)
8. Extent of spalls in jointing.

9. Extent of spalls in hearting.
10. Curing arrangements.
11. Brushing in stones.
12. Quality of dressing.
13. Height of individual stones as compared to the width on the face and/or depth inwards.
14. General quality of work-line, levels, thickness and trueness of the joint. Whether thickness of joint is excessive.
15. Whether dressing of various types of stone work is as per specifications, especially at jambs, corners, sills etc.
16. Brushing of stone surfaces to remove excess cement which is stuck.

4.7.9.1 Defects usually noticed in Stone Masonry

The following defects are usually noticed:

1. Joints in the stone masonry below ground level were not properly filled, many joints were hollow.
2. Width of joints on the face of the wall was very much more than the maximum width of the joints specified.
3. In case of face joints chips were utilized for leveling instead of dressing the stone.
4. Percentage of chips utilized in the hearting was much more than the limit specified in the specifications.
5. The thickness of wall was so specified that it was neither possible to obtain stone of full width nor each stone could be more than 15cm.
6. The joints of quoins and jambs neither were nor dressed as specified.
7. Quoins were not provided at corners.
8. The bushings were very much in excess of the allowable limit.
9. In case of tooled and chisel dressed masonry the undulations were much more beyond the permissible limit.

4.7.10 Some Useful notes on flooring work

1. Flooring should be done after plastering work on the walls are over.
2. If building is multistoried, it is preferable to start flooring work from top storey so that movement of the persons on the newly cast flooring is minimized.
3. Polishing on the floor wherever required (e.g. Mosaic flooring) should be done after completion of painting on the wall.
4. For flooring on roof, terrace, balconies, glass strips shouldn't be provided between panels. In these cases, the joints between two panels should be filled by a flexible sealant. If glass strips are provided at such location, they invariably become the source of leakage for the lower floor.
5. Persons should be discouraged to walk on freshly laid floor since the marks left on such flooring become a permanent eyesore later.
6. Border panel of the flooring should preferably be cast along with skirting.
7. Flooring should be done after first marking 'Thias' with the help of water level and string('suta') to ensure proper level and slopes.
8. Flooring in ground floor should always be done over base of lean concrete (min. 2"thk) and shouldn't be done directly over soling.

5. MAINTENANCE OF BUILDING

5. MAINTENANCE OF BUILDING

Any building constructed with meticulous care and excellent finish is to be kept up well and maintained properly to serve the purpose for which it was put up .However, just like any living being, the environment does have profound effect on buildings. Problems arising out of this and other operation & maintenance problems, need to be taken care to prevent decay and deterioration of the building.

Generally, these aspects are adequately taken care of at the design and Construction stages, with appropriate factor of safety. Nevertheless, due to bad workmanship, and poor supervision, maintenance problems do crop up. The maintenance problems which are common in buildings are discussed below:

5.1 Common Problems in Concrete and their Maintenance

Sl. No.	Defect	Causes	Suggested solution
1.	Segregation & Bleeding	Mix is lean, Over vibration	Use richer mix. Avoid over vibration
2.	Permeability & shrinkage.	High water content in the mix, Lack of compaction. Improper grading of aggregates	Reduce water cement ratio to proper specification. Ensure sufficient compaction. Use proper graded aggregate
3.	Blow holes on exposed faces	Improper mix design. Inadequate cover between reinforcement and mould face which restrains local flow of concrete between mould face and reinforcement	Use correct water -cement ratio. Use agent to improve workability if water cement ratio is to be kept low. Use adequate cover for reinforcement. Resort to adequate mechanical vibration using vibrator head of larger circumference (it is to be noted that vibrator needle has no effect on the concrete below the tip of the needle) Resort to knifing at the contact face of mould

Sl. No.	Defect	Causes	Suggested solution
		Lack of sufficient vibration	Resort to vigorous tamping with a wooden mallet on all sides of form work during the concerting process
4.	Plastic cracks (small - near horizontal crack at faces)	During compaction higher particles tend to settle down and water rises up and collects below certain points of concrete, rising higher due to arching or interlocking. This causes cracks below such points.	Use cohesive mix Place and compact concrete in layer avoiding any local point of arching.
5.	Crazing(map or starry fine cracks on the surfaces upto 3 cm long)	Shrinkage of surface due to surface carbonation (caused due to free lime released during hydration reacting with CO_2 which reduces resistance of the surface to drying shrinkage.)	Reduce water -cement ratio. Use pozzolona cement. Resort to member curing to keep the surface covered.
6.	Efflorescence (white patches on surface).	High water -cement ratio in mix High quantity of free lime released during hydration.	Reduce water cement ratio Use pozzolona cement
7.	Spalling	Usage of concrete of low strength. Form lining is not absorbent. Cement used slow setting.	Use the concrete of sufficient strength Use Absorbent form lining. Use cement of appropriate setting time or use accelerators.

Sl. No.	Defect	Causes	Suggested solution
		Cement used is adulterated Evaporation of moisture in concrete which is required for hydration due to severe temperature conditions coupled with wind. Improper grading or insufficient cement sand mortar in the mix.	In case of suspected adulteration, carryout necessary field tests to ascertain whether the cement is adulterated or not, prior to incorporating in the work. In case the initial setting time has not lapsed, the concrete may be tempered by adding a little quantity of water and then mixing before use. Use richer mix with sufficient fine aggregate.

5.2 Reasons for Building failures in foundation and their remedies

Foundation failures do occur, mainly so because foundation anchored in any soil undergoes settlement, degree of settlement being variable depending upon the soil characteristics, subsoil water table, the nature of superstructure, load, climate condition etc.,

5.2.1 Differential Settlement in Foundation

Where the settlement in soil below foundation is uniform, it may not cause any damage, but otherwise, differential settlement occurs, resulting in cracks and unrelieved stresses and strains in the superstructure. The type and size of cracks in the superstructure give out enough clues as to what the failure reasons are. If there is a settlement at ends of wall, with outer parts trying to push out in-between portion remaining intact, the crack width will be significantly wider at top compared to bottom. If the Middle –Portion is setting down, the crack width will be wider at bottom compared to top the cracks may be complex if window /door opening intervene in the wall under stress due to settlement.

Buildings with additions/alterations are likely to suffer more damages from differential settlement than simple structures if load on added part is substantially different from the original construction. It is also possible that the foundation of the main building may have been damaged during the addition/alteration. Before undertaking detailed investigation to pin point the cause of failure and subsequent restoration work, as a first step, it should be checked whether there is immediate danger of collapse, if there is, building should be vacated. It is also necessary to wait until the settlement is complete. If completion drawing of the structure are not available, a series of trials pits may be dug examine the strata for the following characteristics.

- Type of soil
- Whether the strata is uniform
- Whether any plants or organic matter are present
- Depth of ground water
- Colour and smell

From visual observations of the position of the crack in the superstructure and also the soil charactertics, it should be possible to determine the cause of failure accurately.

5.2.2 Over–Loading in Foundation

- This could happen, if building is put to use for a differential purpose than originally designed for. Over loading could occur due to additions of door and windows opening which leads to transfer more load to adjoining wall. The remedy are

  (i) Relieve the excess load

  (ii) Underpinning – propping up the affected portion and then digging done below the foundation in short section to provide a more solid foundation replacing the existing endangered portion.

5.2.3 Consolidation of Soil Foundation

This occurs when foundation is anchored on made up(poorly consolidated)or poor soil such as soil with high slit content or soil with large amount of organic matter present in it. Where the damages affects most of the building, remedy possibly lies in constructing a ground beam running under all walls to even out the load, this calls for temporary propping up of the building for providing the beam. However, if the damage occurs only at localized points or corners it may be sufficient to dig out that portion and replace the affected portion by a masonry or concrete pier.

5.2.4 Undermining Foundation

Flooding, subterranean streams or even leaky drains can cause undermining of foundations. Excavation and pumping of ground water in adjoining plot for new construction can also lead to this problem. In such situations damage occurs due to loss of support which can lead to the wall above bulging out on the side which is unsupported. Water flowing from under the existing foundation into a deeper area can also lead to finer particles being carried away by the water flow. This in turn results in compaction of the soil under the operating load and consequent loss or support for the structure. Remedy lies in locating the source of water and stopping its entry and flow from under the foundations and then dealing with the foundation settlement as suggested in previous paras.

5.2.5 Soil Movement under Foundation

This is a common phenomenon in clayey and other expansive soil such as black cotton soil. Such soils expand during rainy season and dries up in dry season causing the movement and consequent damage to foundations/superstructure. drying effect can also happen, if roots of nearby trees pass below the foundation considerable drawl of moisture from the soil.

Remedy lies in keeping the moisture level in soil within suitable range to avoid soil movement or it the drying occurs on account of trees. Remedy lies in cutting them off. However it is better to take precautions during initial construction by anchoring foundation below the crack depth using straight or under reamed bored compactor piles depending upon the type of structure, such that the soil movement does not affect.

5.2.6 Other Reasons

Beside the above, foundation cracks can occur, when rodents burrow holes below the foundation and also when roots of trees in the vicinity pass immediately below foundation and grow in size, leading to unrelieved stresses and eventual cracks in walls.

5.3 Methodology for Rehabilitation

5.3.1 Guniting

The popular terminology for the pneumatic application of mortar or concrete on to any surface is gunite or shotcrete. Although it is in vogue for the past 50 years, it is only in the last decade, it has found increasing and Varity of application. Gunite or shotcrete can be either dry mix method or wet mix method, the former being more versatile in the field of restoration of structures, it has been a powerful tool to the engineers. Comprehensive tests have demonstrated that is the quite efficient enough. A few details of the above are summarized in what follows.

5.3.2 Specification

1. Recommended Cement aggregate Ratio - 1:3 to 1:4.5 by weight
2. Recommended water Cement Ratio - 0.35 to 0.50 by weight
3. Operating pressure - 0.3 to 0.6 N/Sq.mm at nozzle
4. Recommended gradation of fine aggregate – Gradation corresponding to Zone –II and Zone -III of IS: 383
5. Recommended maximum size of coarse aggregate (If needed) –12 mm
6. Recommended additives- Chloride free acceleration water proofing guniting and any standard manufactures.
7. Reinforcement – Electrically welded fibre mesh or high strength steel with 8 to 12 SWG Recommended.
8. Minimum expected strength – 25 N/Sq.mm at 28 days.

5.3.3 Admixtures for Guniting

1. Conplast Sparayerset Mfd. by M/s Fosroc Chemicals (India) Ltd., Bangalore.
2. Sigunit Powder and Sigunit Ln 6/11 Mfd by Sika Qualcrete Pvt .Ltd., Calcutta.

5.4 Schedule for Maintenance Period

Sl. No	Details	Internal			External		
		White wash	Superior painting like distem pering / emul sion / epoxy paints, etc.,	Colour / white washing	Superior painting like cement based paint.	Painting Varni shing to wood work	Painting steel / casement / grills / gates.
1.	Residential buildings	Annual	Biennial	Biennial	Biennial	Once in 3 year	Once in 3 year
2.	Non Residential /Facility buildings (All bldgs.except hospital)	Annual	Once in 3 year	Biennial	Once in 3 year	Once in 3 year	Once in 3 year
4.	Cleaning Electrical installations, fans etc,in all buildings	Annually					

NOTE :

1. Walls in public toilets can be painted twice in a year up to lintel level and fully annually.
2. Painting hospitals and clinics may be done as & when required to maintain good hygienic condition
3. Maintenance of other special structure shall be attended as and when required.
4. Existing type of other finishing has to be retained unless otherwise specially ordered/approved by competent authority.

5.5 Defects Commonly Observed in Plastering

1. Blistering of plastered surface

Small patches swell out beyond the plane of the plastered surface and this defect is particularly seen in case of plastered surfaces inside the building.

2. Cracks

These are formed on the plastered surface and may be hair cracks or cracks which may be easily seen. The development of fine cracks is known as crazing.

3. Efflorescence

Soluble salts are present in plaster-making materials as well as building materials such as bricks, sand, cement, etc. Even water used in the construction work dries out, the soluble salts are brought to the surface and they appear in the form of a whitish crystalline substance. Such a growth is referred to as efflorescence and it seriously affects the adhesion of paint with wall surface.

4. Flaking

The formation of a very small loose mass on the plastered surface is known as flaking and it is mainly due to bond failure between successive coats of plaster.

5. Peeling

The plaster from some portion of the surface comes off and patch is formed. Such formation is termed as peeling and it is also mainly due to bond failure between successive coats of plaster.

6. Popping

Sometimes the plaster mix contains particles which expand on being set. A conical hole in plastered surface is formed in front of the particle. This conical hole is known as blow or pop.

7. Rust-stains

These are sometimes seen on the plastered surface, especially when plaster is applied on metal lath.

8. Softness

The excessive dampness at certain points on the plastered surface makes that portion soft. The main reasons for such softness are undue thinness of the finishing coats, presence of deliquescent salts, excessive suction of the undercoats etc.

9. Uneven surface

This defect becomes prominent only due to poor workmanship of the work.

6. EARTHQUAKE ENGINEERING

6. EARTHQUAKE ENGINEERING

6. Effect of Earthquake on Structures

6.1 Introduction

- Earthquake throughout the world cause a considerable amount of death and destruction.
- Historically however most earthquakes have occurred in the western and north – eastern parts of India.
- Tamil nadu is not classified either under high damage risk zone like Delhi (Zone IV) or like Guwahati or Bhuj (Zone V).
- The actual rupture of the ground due to fault movement could damage a structure. Secondary effects such as the liquefaction of loose granular soil, slope movement or failure and inundation from a tsunami could also cause structural damage.
- Earthquake damage can be classified as being structural or non – structural. Structural damage means the building's structural support has been impaired.
- Structural support includes any vertical and lateral force resisting systems such as the building frames, walls and columns.
- Non structural damage does not affect the integrity of the structural support system. Examples of non – structural damage include broken windows, collapsed or rotated chimneys and fallen ceilings.
- During an earthquake, buildings get thrown from side to side and up and down. Heavier buildings are subjected to higher forces than lightweight buildings given the same acceleration.
- Damage occurs when structural members are overloaded or differential movements between different parts of the structure strain the structural components. Larger earthquakes and longer shaking durations tend to damage structures more.

6.1.1 Seismic Zones in India

Basic Geography and Tectonic Features

- India lies at the northwestern end of the Indo-Australian Plate, which encompasses India, Australia, a major portion of the Indian Ocean and other smaller countries. This plate is colliding against the huge Eurasian Plate (Figure 1) and going under the Eurasian Plate; this process of one tectonic plate getting under another is called subduction. A sea, Tethys, separated these plates before they collided. Part of the lithosphere, the Earth's Crust, is covered by oceans and the rest by the continents. The former can undergo subduction at great depths when it converges against another plate, but the latter is buoyant and so tends to remain close to the surface. When continents converge, large amounts of shortening and thickening takes place, like at the Himalayas and the Tibet.

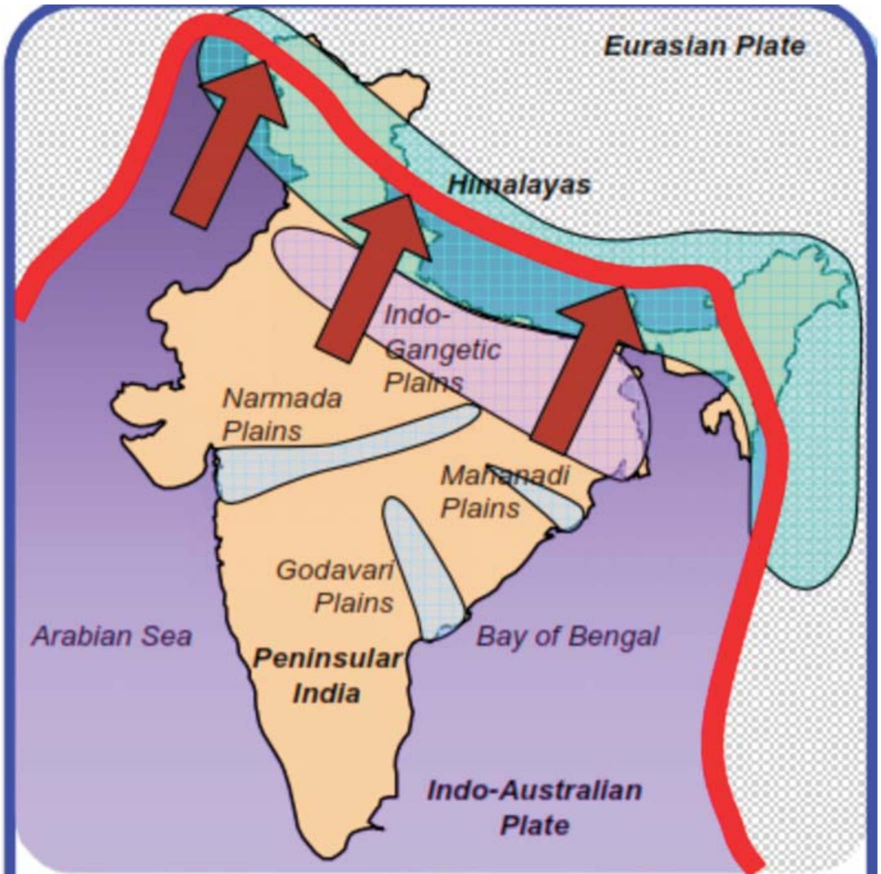


Figure 1: Geographical Layout and Tectonic Plate Boundaries at India

The varying geology at different locations in the country implies that the likelihood of damaging earthquakes taking place at different locations is different. Thus, a seismic zone map is required to identify these regions. Based on the levels of intensities sustained during damaging past earthquakes, the 2002 version of the zone map subdivided India into four zones – II, III, IV and V.

The maximum Modified Mercalli (MM) intensity of seismic shaking expected in these zones were *V or less*, *VI*, *VII*, *VIII*, and *IX and higher*, respectively. Parts of Himalayan boundary in the north and northeast, and the Kutch area in the west were classified as zone V. The seismic zone maps are revised from time to time as more understanding is gained on the geology, the seismotectonics and the seismic activity in the country.

6.1.2 Past earthquakes in India

Date	Event	Time	Magnitude	Max. Intensity	Deaths
16 June 1819	Cutch	11:00	8.3	VIII	1,500
12 June 1897	Assam	17:11	8.7	XII	1,500
8 Feb. 1900	Coimbatore	03:11	6.0	X	Nil
4 Aprl. 1905	Kangra	06:20	8.6	X	19,000
15 Jan. 1934	Bihar-Nepal	14:13	8.4	X	11,000
31 May 1935	Quetta	03:03	7.6	X	30,000
15 Aug. 1950	Assam	19:31	8.5	X	1,530
21 Jul.1956	Anjar	21:02	7.0	IX	115
10 Dec. 1967	Koyna	04:30	6.5	VIII	200
23 Mar. 1970	Bharuch	20:56	5.4	VII	30
21 Aug. 1988	Bihar-Nepal	04:39	6.6	IX	1,004
20 Oct.1991	Uttarkashi	02:53	6.6	IX	768
30 Sep. 1993	Killari (Latur)	03:53	6.4	IX	7,928
22 May 1997	Jabalpur	04:22	6.0	VIII	38
29 Mar. 1999	Chamoli	12:35	6.6	VIII	63
26 Jan. 2001	Bhuj	08:46	7.7	X	13,805
26 Dec, 2004	Sumatra	06:28	9.3	VII	10,749

6.2 Earthquake Induced Settlement

Those buildings founded on solid rock are least likely to experience earthquake – induced differential settlement. However, buildings on soil could be subjected to many different types of earthquake-induced settlement.

6.2.1 Tsunami Surface Effects

- Surface fault rupture which can cause a structure that straddles the fault to be displaced vertically and laterally.
- Regional uplifting or subsidence associated with the tectonic movement.
- Liquefaction induced ground loss below the structure such as the loss of soil through the development of ground sand boils.

6.2.2 Torsion

Torsion problems develop when the centre of mass of the structure is not located at the centre of its lateral resistance, which is also known as the centre of rigidity.

6.2.3 Pounding Damage

- Pounding damage can occur when two buildings are constructed close to each other and as they rock back and forth during earthquake, they collide into each other.
- Similar to pounding damage, the collapse of a building can affect adjacent structures.

6.2.4 Behaviour of Brick Masonry Walls

Masonry buildings are brittle structures and one of the most vulnerable of the entire building stock under strong earthquake shaking. The large number of human fatalities in such constructions during the past earthquakes in India corroborates this. Thus, it is very important to improve the seismic behaviour of masonry buildings. A number of earthquake-resistant features can be introduced to achieve this objective.

Ground vibrations during earthquakes cause inertia forces at locations of mass in the building. These forces travel through the roof and walls to the foundation. The main emphasis is on ensuring that these forces reach the ground without causing major damage or collapse. Of the three components of a masonry building (*roof*, wall *and* foundation) (Figure 1a),

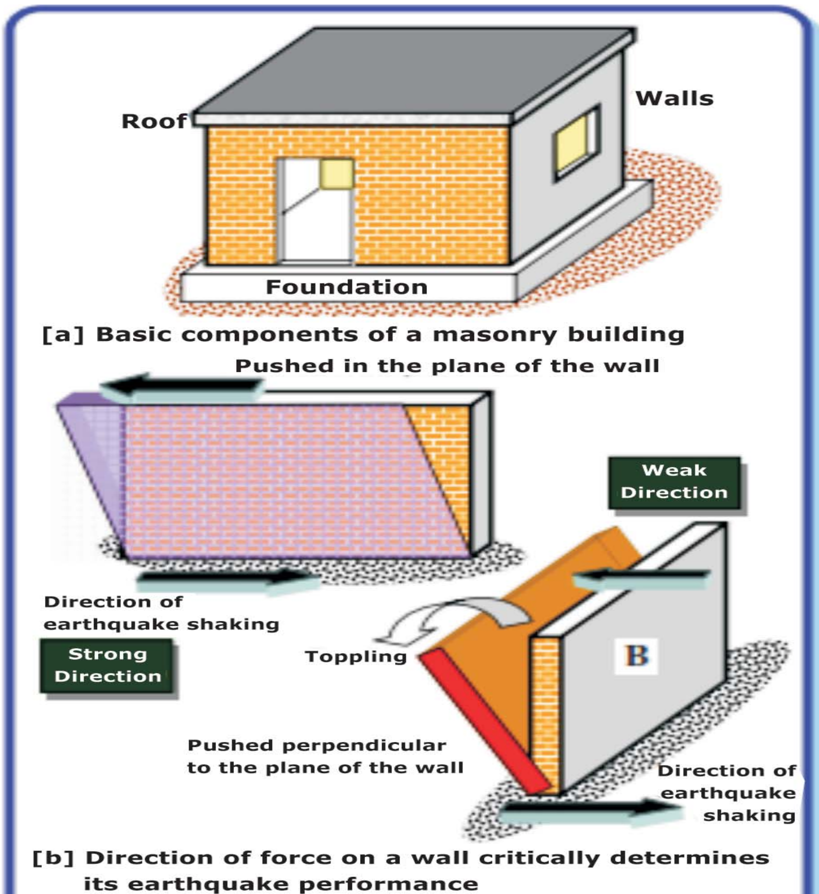
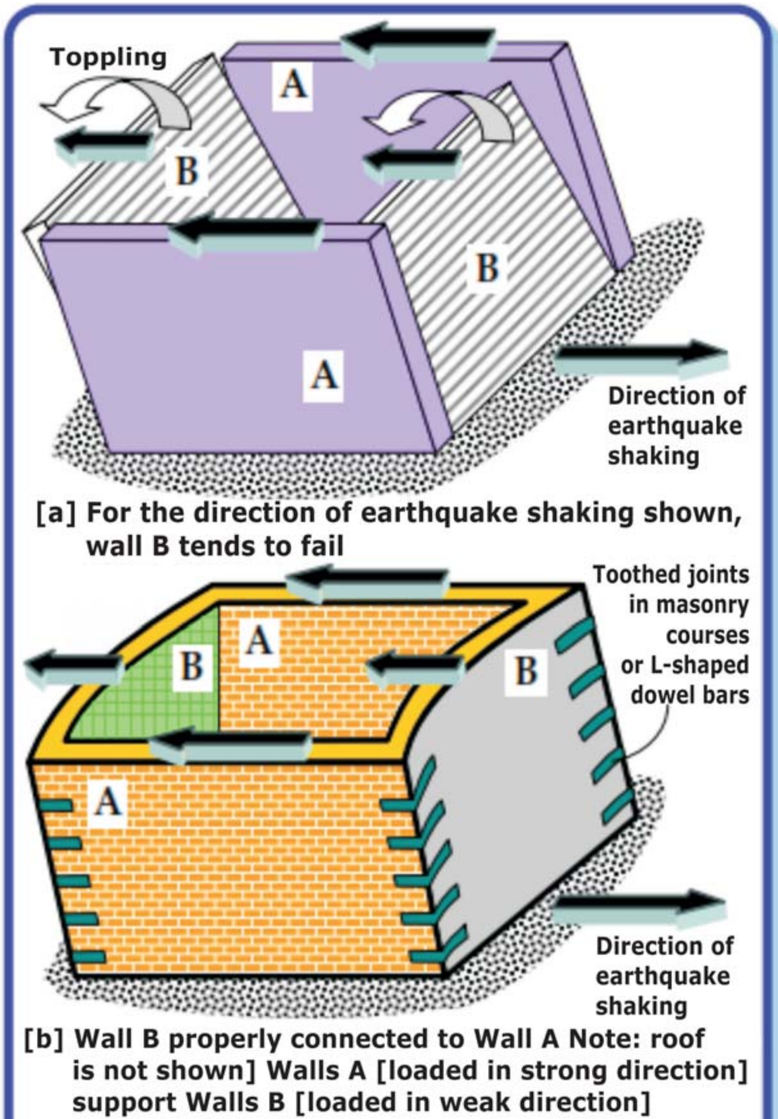


Figure 1: Basic components of a masonry building - walls are sensitive to direction of earthquake forces.

The walls are most vulnerable to damage caused by horizontal forces due to earthquake. A wall topples down easily if pushed horizontally at the top in a direction perpendicular to its plane (termed weak direction), but offers much greater resistance if pushed along its length (termed strong direction) (Figure 1b).

The ground shakes simultaneously in the vertical and two horizontal directions during earthquakes. However, the horizontal vibrations are the most damaging to normal masonry buildings. Horizontal inertia force developed at the roof transfers to the walls acting either in the weak or in the strong direction. If all the walls are not tied together like a box, the walls loaded in their weak direction tend to topple (Figure 2a).

To ensure good seismic performance, all walls must be joined properly to the adjacent walls. In this way, walls loaded in their weak direction can take advantage of the good lateral resistance offered by walls loaded in their strong direction (Figure 2b). Further, walls also need to be tied to the roof and foundation to preserve their overall integrity.



[a] For the direction of earthquake shaking shown, wall B tends to fail

[b] Wall B properly connected to Wall A Note: roof is not shown] Walls A [loaded in strong direction] support Walls B [loaded in weak direction]

Figure 2: Advantage sharing between walls - only possible if walls are well connected.

6.3 Vertical Resisting Systems for Earthquakes

- Shear walls
- Braced frames
- Moment resisting frames

6.3.1 Desirable Features of Structural Materials for Earthquake Resistance

- High Ductility
- High strength- to – weight ratio
- Homogeneity
- Ease in making full – strength connections

6.4 Earthquake Resistant Techniques

Among the most important advanced techniques of earthquake resistant design and construction are:

6.4.1 Base Isolation

A base isolated structure is supported by a series of bearing pads which are placed between the building and the buildings foundation.

6.4.2 Energy Dissipation Devices

- A certain amount of vibrational energy is transferred to the building by earthquake ground motion. By equipping a building with additional devices which have high damping capacity, we can greatly decrease the seismic energy entering the building and thus decrease building damage.

- Accordingly a wide range of energy dissipation devices have been developed and are now being installed in real buildings. Energy dissipation devices are also often called damping devices.

6.5 Seismic Forces in Masonry

The major forces experienced by masonry structures due to earthquake can be listed as below.

1. Compressive force due to vertical motion
2. Out–of-plane bending due to forces perpendicular to the axis of masonry wall
3. In – Plane bending due to loading in the same plane of wall because of shear.
   - When the ground vibrations reach a building, they are converted in to structural vibrations, causing excessive deformations in every structural component.
   - The creation of tensile and shearing forces in walls of masonry buildings cause all types of damages in such buildings.

6.6 Reasons for damages in Masonry

1. The tensile strength of masonry is very low especially with low strength mortar.
2. Masonry structural components have high self weight which will attract large seismic inertia forces.
3. The poor shear strength of brick masonry contributes the diagonal shear failure during earthquakes.
4. Brick masonry structures are brittle in nature undergoing sudden collapse.
5. If the joint between the wall and roof is weak, then there is a chance for separation of walls from the roof leading to failure.
6. A weak connection between walls is of great significance. Proper bonding between walls at corners with adequate brick dowels is mostly neglected.
7. The corners of masonry openings attract stress concentration and initiate distress in case of structural vibrations.
8. Asymmetry in plan and elevation is also a major problem resulting in severe damages during earthquakes.

9. Non uniform distribution of live and dead loads is also a contributing factor for the distress.

10. The % of openings of the wall area is another contributing factor about the seismic resistance in masonry buildings.

11. Defects due to adopting sub standard materials, delayed use of mortar, improper curing, and using dry blocks without soaking in water, improper construction of masonry bonds and adopting poor quality control in the construction of masonry are also vital reasons for the damages due to earthquake.

6.7 Enhancement of Seismic Resistance in Masonry Buildings

The main handicap in brick masonry is the rigidity of brick masonry as structural components and lack of ductile behavior. If we can introduce material ductility and improve the tensile strength of masonry along the longitudinal and lateral contours, we can certainly rely upon masonry Structure which is otherwise durable, cost effective and can be built with semi skilled labour.

1. B.I.S suggests to have run through reinforced concrete band for the entire length of external and internal walls at plinth level and at lintel level.

2. Provision of vertical and horizontal external strengthening bands using fibrocement jacketing next to door and window openings is suggested by B.I.S to enhance the seismic resistance. This strengthening procedure is termed as “Splint and bandage method”

3. B.I.S also describes method to adopt vertical and horizontal bands which is termed as “confinement reinforcement”.

4. Apart from the strengthening methods suggested we can also use epoxy mortars in slender masonry structural components to have additional strength.

5. Usage of glass fiber reinforced polymer laminations at required places can definitely result in excellent structural ductility and save the lives of the occupants in the event of an earthquake exhibiting large scale with undergoing total collapse.

6. Application of "Polymer grid" laminations using high density poly ethylene grids can also be a suitable alternative to usage of welded fabric which is corrosive in nature.

7. Usage of fibers in mortars in cement mortar and application of special mortars blending with polymer compound will enhance the ductile behavior of the masonry structure.

6.8 Role of Horizontal Bands

Horizontal bands are the most important earthquake-resistant feature in masonry buildings. The bands are provided to hold a masonry building as a single unit by tying all the walls together, and are similar to a closed belt provided around cardboard boxes. There are four types of bands in a typical masonry building, namely *gable band*, *roof band*, *lintel band* and *plinth band* (Figure 3), named after their location in the building. The lintel band is the most important of all, and needs to be provided in almost all buildings.

The gable band is employed only in buildings with pitched or sloped roofs. In buildings with flat *reinforced concrete* or *reinforced brick* roofs, the roof band is not required, because the roof slab also plays the role of a band. However, in buildings with flat timber or CGI sheet roof, roof band needs to be provided. In buildings with pitched or sloped roof, the roof band is very important. Plinth bands are primarily used when there is concern about uneven settlement of foundation soil.

The lintel band ties the walls together and creates a support for walls loaded along weak direction from walls loaded in strong direction. This band also reduces the unsupported height of the walls and thereby improves their stability in the weak direction.

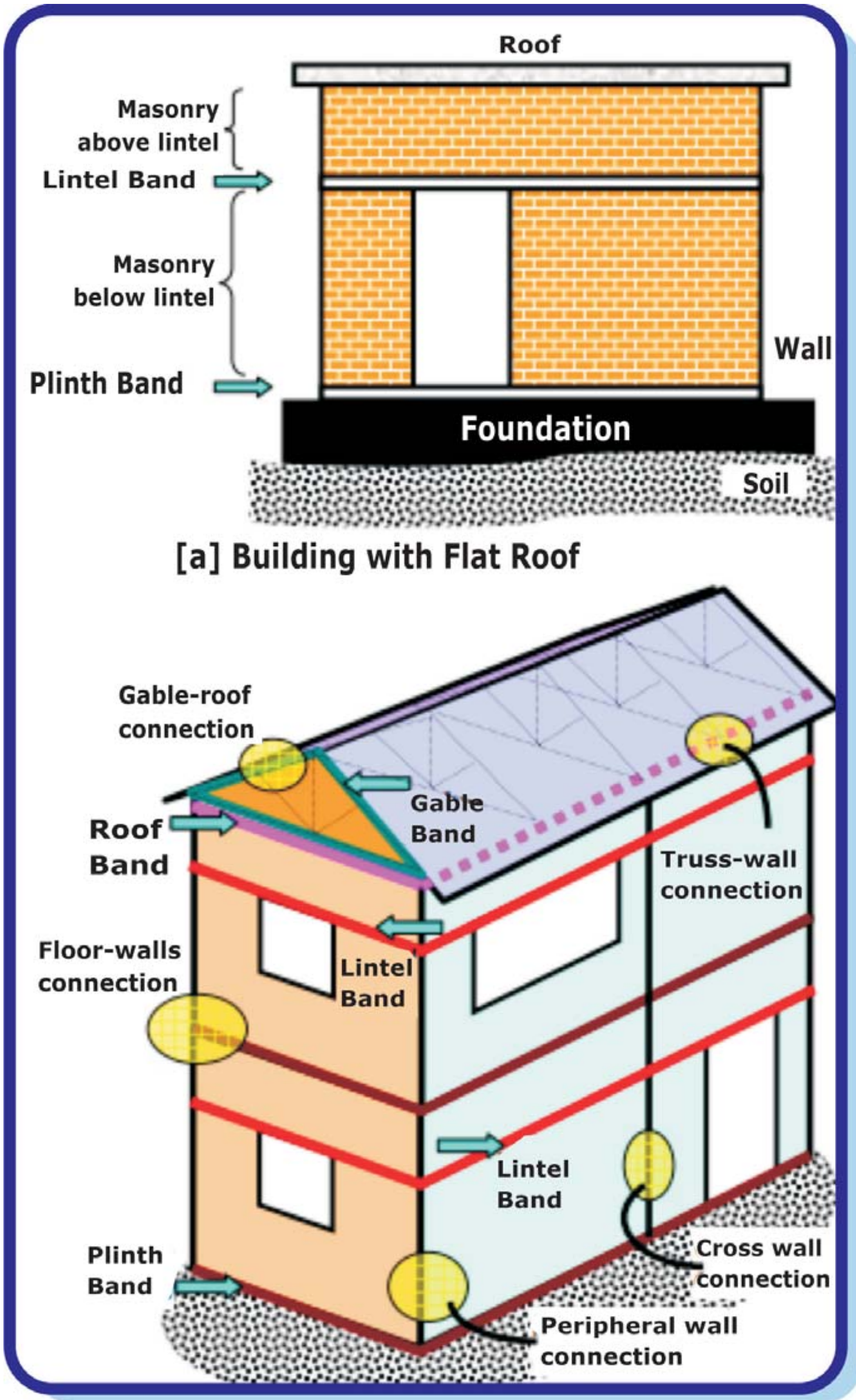

Roof
Masonry above lintel
Lintel Band
Masonry below lintel
Plinth Band
Wall
Foundation
Soil
[a] Building with Flat Roof
Gable-roof connection
Roof Band
Gable Band
Truss-wall connection
Floor-walls connection
Lintel Band
Lintel Band
Plinth Band
Cross wall connection
Peripheral wall connection

Figure 3

7. CRACKS IN BUILDINGS

7. CRACKS IN BUILDINGS

The Sight of a crack in concrete, causes panic to all concerned. Most of the cracks occur as a result of shrinkage of concrete. Shrinkage is simply a reduction in the volume of concrete as it hardens. If this reduction in volume is controlled or prevented, then a crack would not occur. However, in reality, ground friction and a number of things such as structural connections lead to shrinkage and thus cause cracks.

A 100-foot-long regular-weight concrete slab normally would shrink by about 3/4 inch. In other words, one should expect cracks totaling in widths up to 3/4 inch in every 100 feet of concrete. Lightweight concrete shrinks more. **It is important to note that concrete does crack and that this is not abnormal.**

7.1 Non-structural Cracks

Not every crack threatens the structural safety of a building. In fact, in many instances, cracks are merely cosmetic in nature. These cracks are typically seen in flat work such as driveways, patio, walkways and curbs. Typical reasons for these cracks are :

1. Poor workmanship
2. Inappropriate joint detailing
3. Tree roots and impact from passing vehicles.
4. Moisture changes
5. Thermal movement
6. Elastic deformation
7. Creep
8. Chemical reaction
9. Foundation movement and settlement of soil
10. Vegetative growth

7.2 Structural Cracks

A majority of the structural cracks occur as a result of the following conditions:

1. Design deficiency
2. Construction deficiency
3. Settlement or heaving of soil
4. Corrosion in reinforcement

7.3 Differences between structural and non-structural cracks

1. Structural crack refers to crack that developed at the core or frame that form the foundation of the building itself. Normally, any type of crack occurred in this case is very dangerous and must be attended to immediately.

2. Non-structural crack, as the name itself implies, refers to crack in any part of the building that doesn't belong to the core or frame of the building. For example, craked wall (except load bearing wall), driveway, patio, and walkway.

7.4 Horizontal crack

It is typically caused by lateral pressures on the structure which exceed the flexural capacity of the Structure.

7.5 Plastic shrinkage crack

When water evaporates from the surface of freshly placed concrete faster than it is replaced by bleed water, the surface concrete shrinks. Due to the restraint provided by the concrete below the drying surface layer, tensile stresses develop in the weak, stiffening plastic concrete, resulting in shallow cracks of varying depth. These cracks are often fairly wide at the surface.

7.6 Thermal crack

Temperature rise (especially significant in mass concrete) results from the Heat of hydration of cementitious materials. As the interior concrete increases in temperature and expands, the surface concrete may be cooling and contracting. This causes tensile stresses that may result in thermal cracks at the surface if the temperature differential between the surface and center is too great. The width and depth of cracks depend upon the temperature differential, physical properties of the concrete, and the reinforcing steel.

7.7 PREVENTION

7.7.1 Optimum water ratio

Shrinkage is a primary cause of cracking. As concrete hardens and dries it shrinks. This is due to the loss, through evaporation, of excess water. The wetter the concrete mix, the greater will be the shrinkage. Concrete slabs can shrink as much as 3/4 inch per 100 feet. The actual amount is 1/16th of an inch for every ten feet of horizontal distance. This shrinkage causes forces in the concrete which literally pull the slab apart. Cracks are the end result of these forces. Concrete does not require much water to achieve maximum strength. In fact, a wide majority of concrete used in residential work, in many cases, has too much water. This water is added to make the concrete easier to install. It is a labour saving practice. This excess water not only causes cracking, but also weaken the concrete.

7.7.2 Curing method

Rapid drying of the slab will significantly increase the possibility of cracking. The chemical reaction which causes concrete to go from the liquid or plastic state to a solid state requires water. This chemical reaction, or hydration, continues to occur for days and weeks after concrete is poured. Engineers must make sure that necessary water is available for this reaction by adequately curing the slab. The use of liquid curing compounds, covering the slab with plastic, wet burlap, and other methods can be used to cure concrete.

7.7.3 Proper usage of material

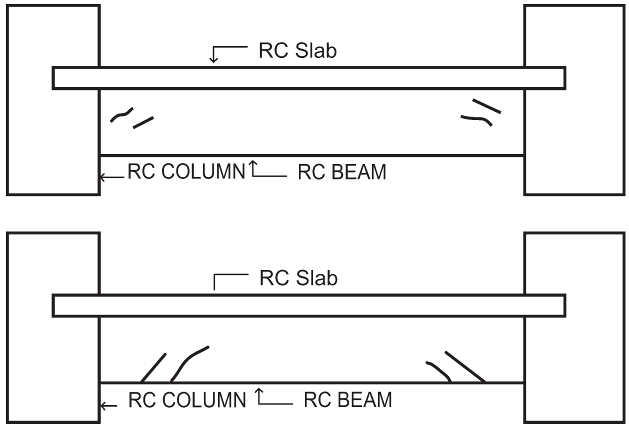
Many people had wondered why ancient structures are so strong and still standing tall till now. Engineers had found that these buildings were over-designed or in other words, maximum usage of construction material. Let's take an example of a driveway concrete slab. A 5-inch thick slab is definitely better in sustaining heavy vehicles than a 4-inch thick slab which is more likely to crack under loading. Some contractors might suggest that 4-inch is just enough when cost comes into consideration but a 5-inch thick is even safer in reality. Thicker concrete is a good idea for better load bearing structure

Shrinkage in plastering can be reduced by ensuring proper adhesion. The plastered surface should not be stronger than the back ground.

Shrinkage cracks in masonry can be minimized by avoiding use of rich cement mortar and by delaying plastering till masonry has dried after proper curing and has undergone most of its initial shrinkage.

In concrete basement walls, some cracking is normal. Most builders or third-party providers offer limited warranties for basements. A typical warranty will require repair only when cracks or leak exceed the following:

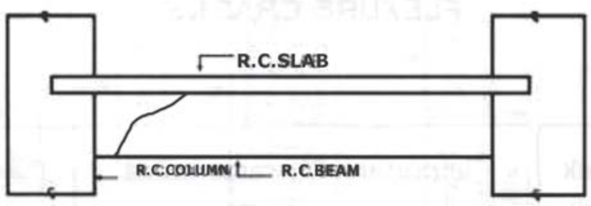
	Crack Width	Vertical Displacement
Basement Walls	$^1/_8$" (3mm)	N/A
Basement Floors	$^3/_{16}$" (12mm)	$^1/_8$" (12mm)
Garage Slabs	¼" (12mm)	¼" (12mm)



SHEAR CRACKS

Member	Crack Type	Important Characteristics	Possible Reasons
R C Beam	Shear	Originates nearer to supports. May be single or in groups. Maximum width at neutral axis region or at bottom of beam.	Shear capacity of the beam is inadequate. Cross-section or torsional reinforcement insufficient.

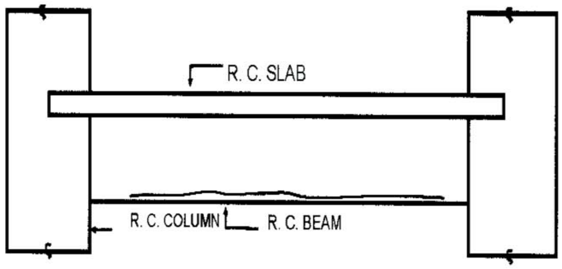
Figure 7.1 a Shear Cracks (Ref : SP25 (S&T) 1984)



TORSION CRACKS

Member	Crack Type	Important Characteristics	Possible Reasons
R C Beam	Torsion	Originates nearer to maximum torsion region. Single. Generally uniform width. Appears over the whole peripbery in helical form.	Torsional strength of the beam is inadequate. Cross-section or torsional reinforcement insufficient.

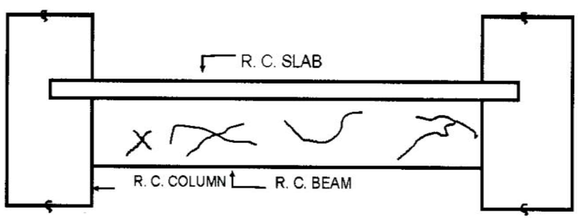
Figure 7.1 b Torsion Cracks (Ref : SP25 (S&T) 1984)



BOND CRACK

Member	Crack Type	Important Characteristics	Possible Reasons
R C Beam	Bond (corrosion)	Runs above the line of reinforcement. Uniform width in general.	Bond between reinforcing bars and concrete not satisfactory, may be due to corrosion of bars or fire damage.

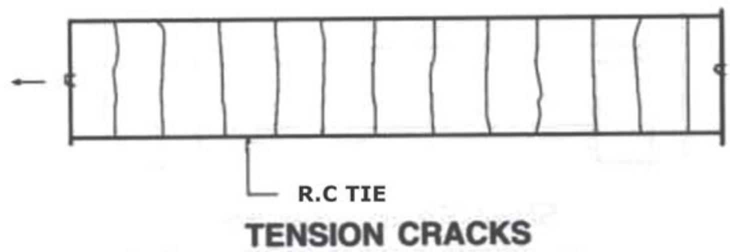
Figure 7.2 a Bond cracks (Ref : SP25 (S&T) 1984)



SHRINKAGE CRACKS

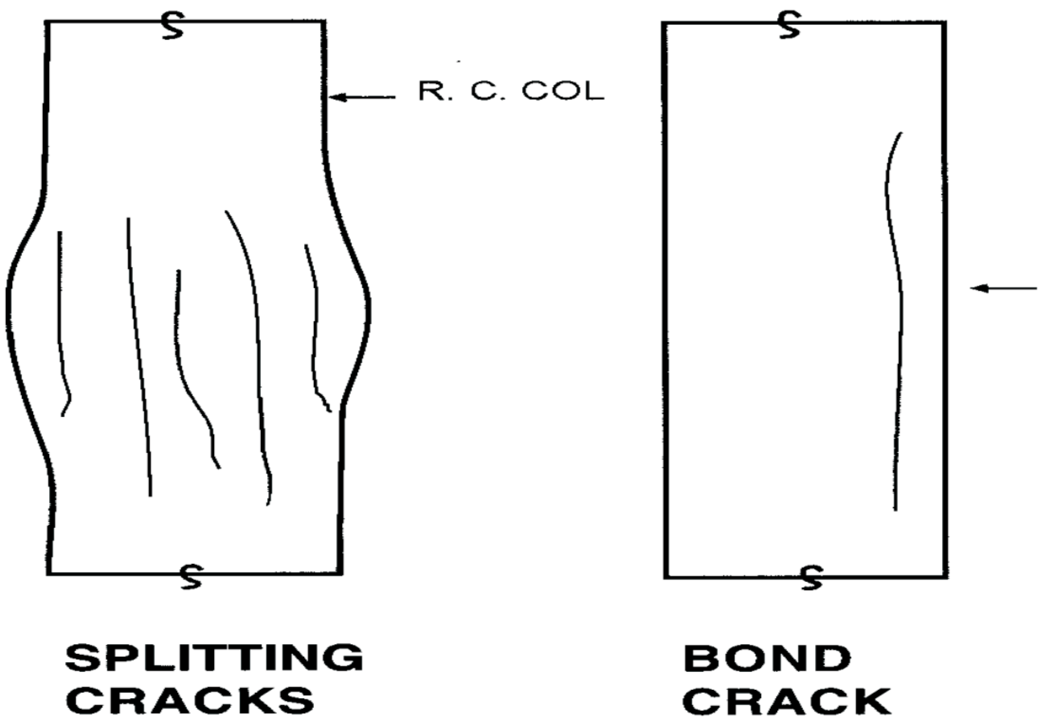
Member	Crack Type	Important Characteristics	Possible Reasons
R C Beam	Shrinkage	No regular pattern or thickness and in general. Superficial.	Curing is inadequate or no control over water-cement ratio. Usage of excessively rich mix . Shrinkage reinforcement, if any, insufficient.

Figure 7.2 b Shrinkage Cracks (Ref : SP25 (S&T) 1984)



Member	Crack Type	Important Characteristics	Possible Reasons
R C Tie	Tension	Appear Over Whole Periphery. Generally over the whole length of the member. Parallel to each other. Uniformly observed.	Capacity of the member in tension is inadequate. Tensile reinforcement is insufficient.

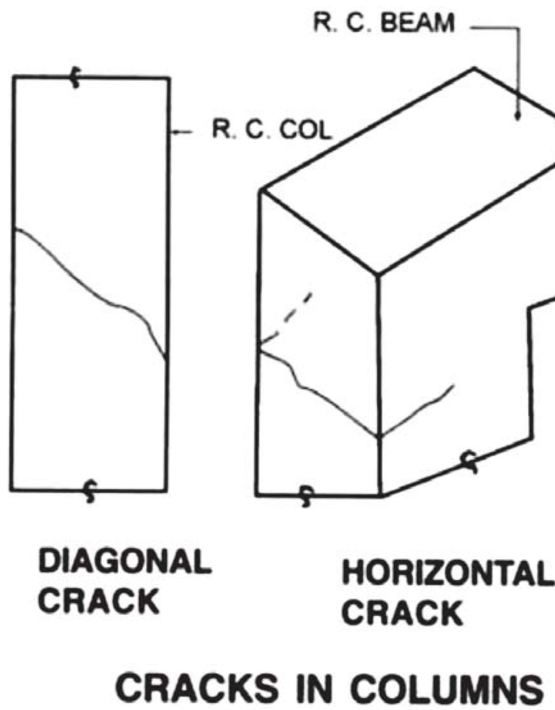
Figure 7.3 Sliding cracks (Ref : SP25 (S&T) 1984)



CRACKS IN COLUMNS

Member	Crack Type	Important Characteristics	Possible Reasons
R C Column	Splitting	Building in that region. Short parallel vertical cracks. Varying widths.	Inferior quality concrete. Load carrying capacity of the column inadequate. Cross-section or reinforcement insufficient.
R C Column	Bond (corrosion)	Runs above the line of reinforcement. Uniform width in general.	Bond between reinforcing bars and concrete not satisfactory. may be due to corrosion of bars or fire damage.

Figure 7.4 Cracking in columns (Ref : SP25 (S&T) 1984)



Member	Crack Type	Important Characteristics	Possible Reasons
R C Column	Diagonal	Runs diagonally across the section. Can occur anywhere in the height. Uniform thickness.	Load carrying capacity of the column is inadequate Cross-section or main reinforcement insufficient.
R C Column	Horizontal	Occurs near beam - column junction.	Moment resistance capacity of column inadequate in the corresponding region Inadequate quantum of reinforcement or disposition of reinforcement not satisfactory.

Figure 7.5 Cracks in columns (Ref : SP25 (S&T) 1984)

7.8.4 Some Measures for controlling shrinkage

7.8.4.1 Initial Expansion

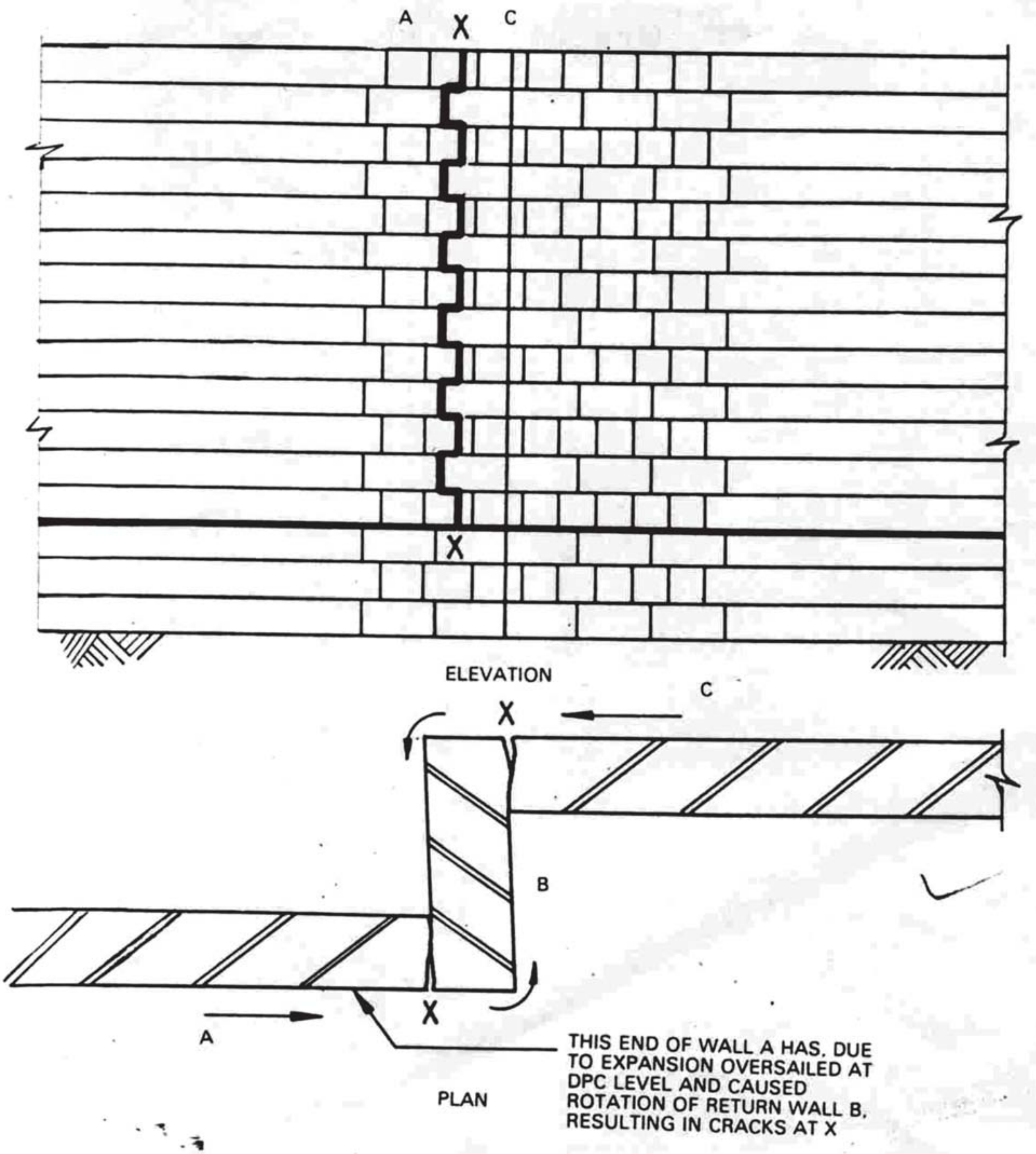


Figure 7.6 Cracking due to Expansion of Brickwork (Ref : SP25 (S&T) 1984)

7.8.4.2 Thermal Movement

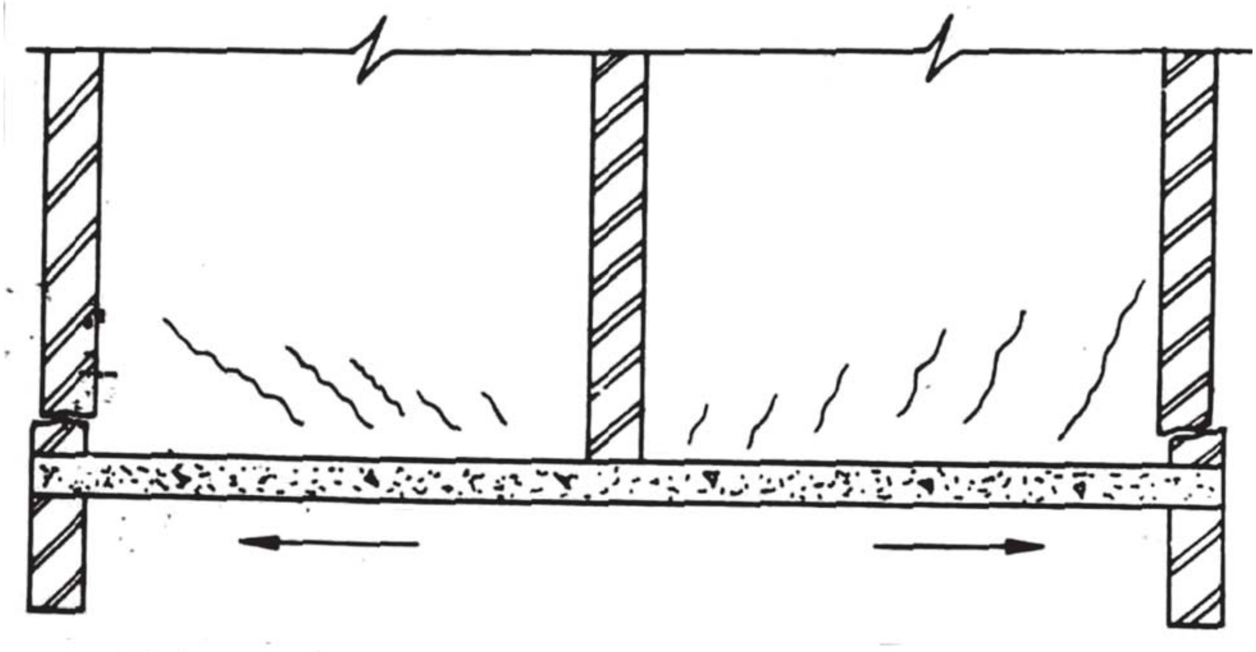


Figure 7.7 Cracking in Top Most storey of a Load Bearing Structure (Ref : SP25 (S&T) 1984)

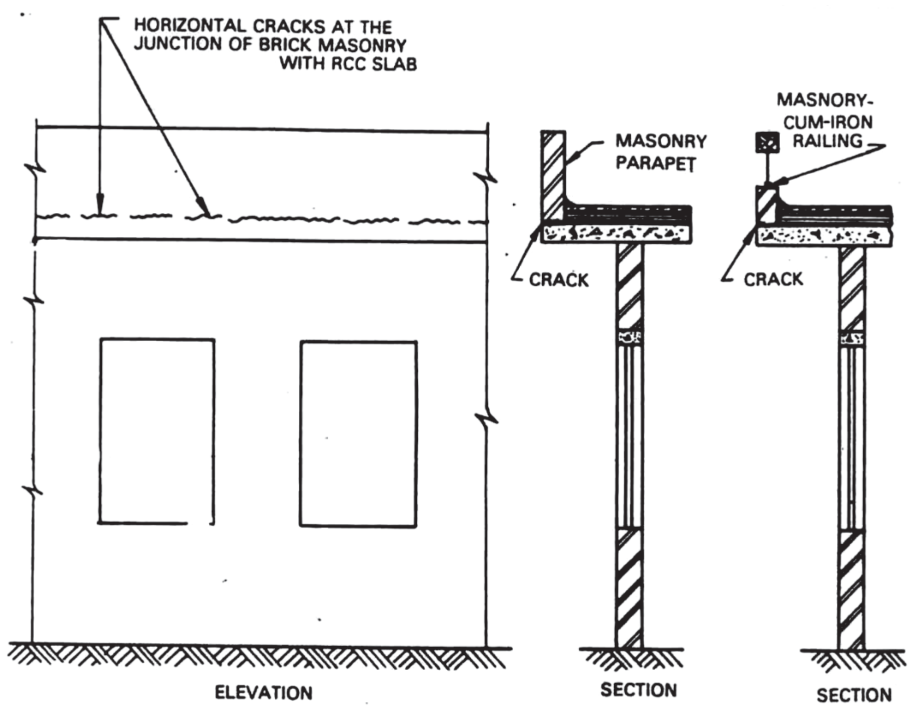


Figure 7.8 Horizontal crack at the base of brick masonry parapet (or Masonry-cum-Iron Railing) supported on a Projecting RCC slab (Ref : SP25 (S&T) 1984)

7.9.4.3 Elastic Deformation

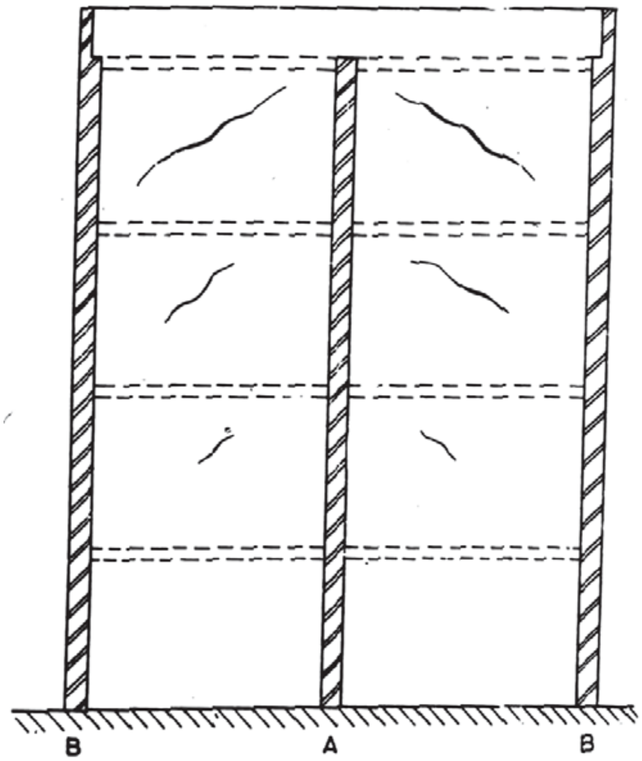


Figure 7.9 Diagonal Cracks in Cross Walls of Multi-Storied Load Bearing Structures (Ref : SP25 (S&T) 1984)

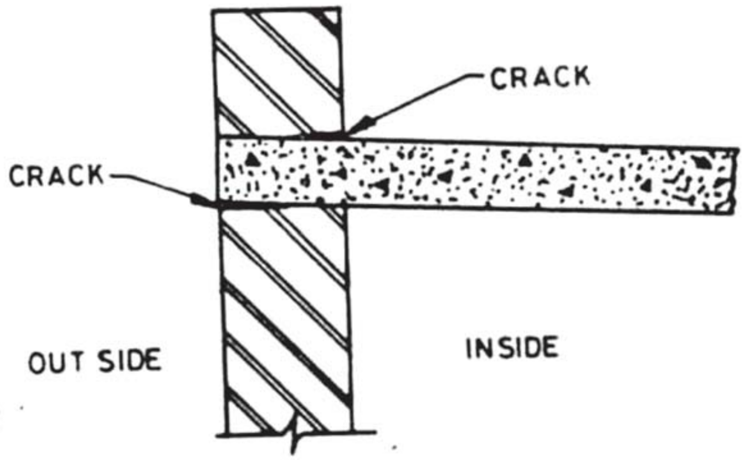


Figure 7.10 Horizontal Cracks in a Wall at Supports due to Excessive Deflection of a Slab of Large Span (Ref : SP25 (S&T) 1984)

7.8.5 General measures for prevention / reduction of cracks due to elastic strain, creep and shrinkage

- Water cement ratio is to be controlled.
- Reasonable pace of construction should be adopted.
- Brick work over load bearing RCC members should be done after removal of shutting giving a time gap.
- Brick walls between columns should be deferred as much as possible.
- Plastering of areas having RCC and brick members should be done after sufficient time gap say one month or suitable groves provided in junction.
- Shuttering/Struts should be allowed to stay for a larger period say 30 days or so for cantilevers which are bound to defect appreciably.

7.8.5.1 Movement due to chemical reaction

- Certain chemical reaction in building materials result is appreciable change in volume of resulting products and internal stresses are set up which may result in outward thrust and formation of cracks.
- Soluble sulphate reacts with tricalcuium aluminate in cement and hydraulic lime and form products which occupy larger volume and ends in developing cracks. An example of cracking of a floor due to coming in contact of the sub base made of brick with heavy sulphate content and water is seen in fig 7.12

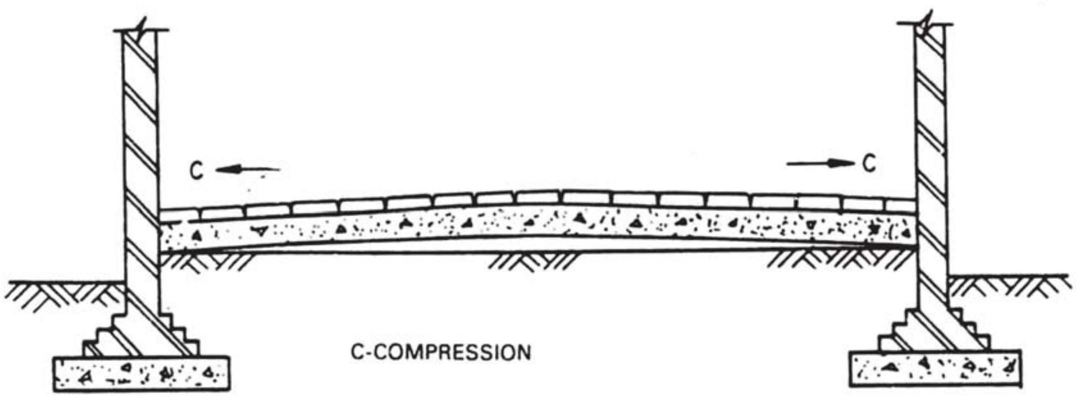


Figure 7.11 Cracking and Upheaving of a Tile Floor due to Sulphur Action in Base Concrete (Ref : SP25 (S&T) 1984)

7.8.5.2 Prevention

- If sulphate content in soil is more that 0.2 % or in ground water more than 300 ppm, rich mix of concrete and mortar has to be adopted.
- Avoid bricks containing too much soluble sulphates (more than 5 %) and use rich mortar in such cases.
- Use expansion and control joint at close intervals.

7.8.5.3 Corrosion of Reinforcement

Corroded reinforcement expands and cracks the concrete cover. To avoid this phenomenon rich mix of concrete using proper quality water and adequate cover should be provided.

7.8.5.4 Foundation movement and settlement of soil

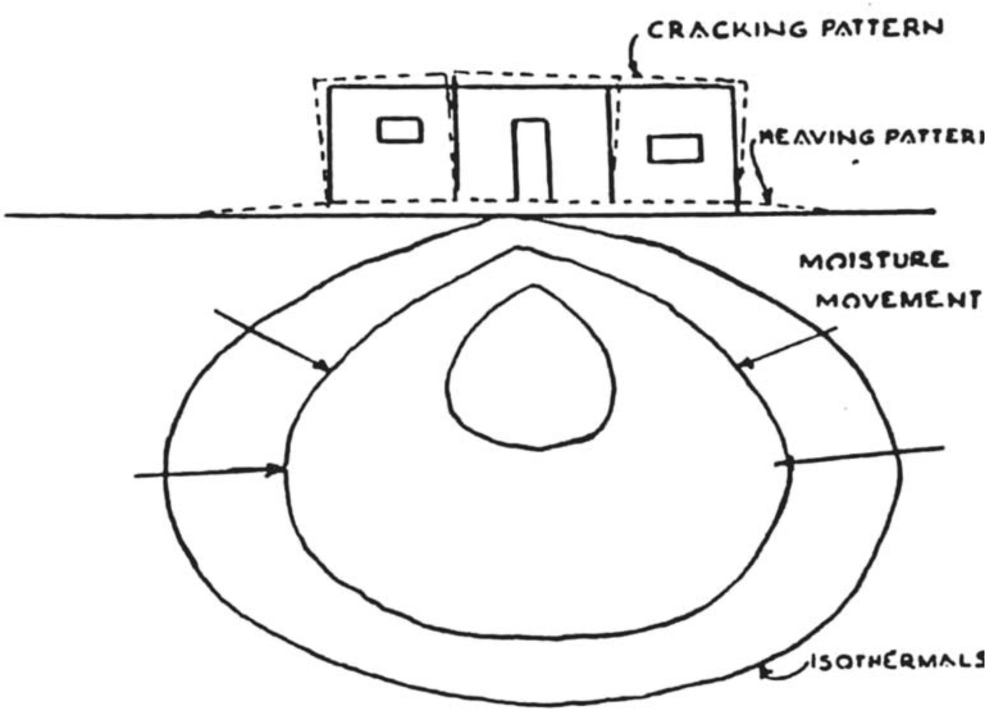


Figure 7.12 Diagramatic Sketch of Thermo-Osmotic Heaving of Buildings on Desiccated Clay Soils

7.8.5.5 Cracking due to vegetation

Large trees growing in the vicinity of buildings cause damage in all type of soil conditions. If the soil is shrinkable clay, cracking is severe

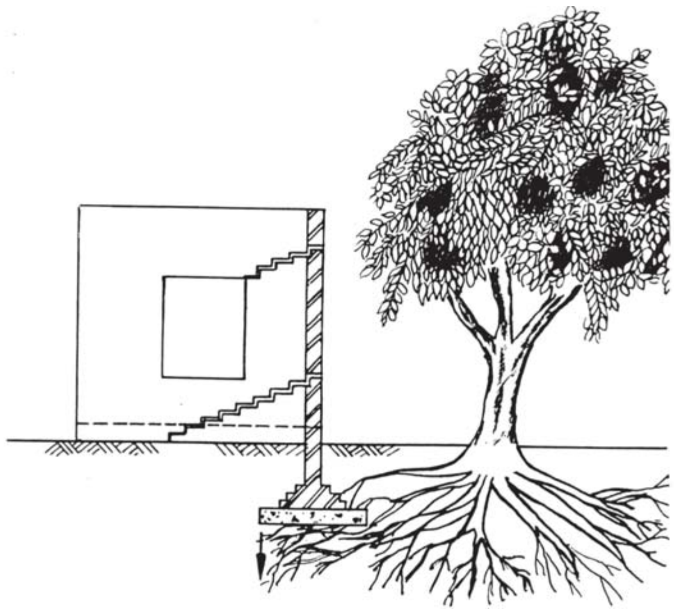


Figure 7.13 Trees Growing close to a building on shrinkable soil may cause cracks in the walls

7.8.6 Repair

The repair for cracks may be undertaken after ascertaining the reasons for the appearance of the crack.

1. Rendering of minor crack less that 1m wide may be done after observing the crack for some time and then sealing it with weak mortar of cement, lime and sand.
2. Cracks where width change with season should be filled up with elastic fillers like silicon or polyurethane compound.
3. Where shear cracks are observed shear keys made of RCC concrete with at least 1.5 percent steel reinforcemeat may be provided at 1 to 1.5m intervals.
4. If cracks are due to movement of soil in black cotton once, prevention of moisture penetration in the surrounding areas has to be ensured by providing a waterproof blanket around the plinth. The masonry wall below ground level should also be separated from the adjoining soil by replacing the existing soil with coarse grain material.

8. RAIN WATER HARVESTING

8. RAIN WATER HARVESTING

Sustainable development is essential for human survival. Water resource is a valuable economic commodity and to prevent its depletion, measures to recharge the aquifers should be extensively practised. There is a growing need to adopt Rainwater Harvesting methods to adequately recharge the aquifers.

8.1 RAINWATER HARVESTING

a) Deliberate Collection of rainwater within a catchment and use for the purpose of drinking, irrigation etc.

b) Collection and storage of rainwater can be made in man-made structures or natural depression in the catchment surface.

c) Catchment includes rooftops, compounds, rocky surface or hill slopes or artificially prepared impervious/semi pervious land surface.

d) Storage generally done in man made tanks, lined pits and small dams.

e) The collection and storage begins and ends with the rainy season

f) Users are left with a fixed volume of water until the next rainy season comes.

g) The amount of water harvested (Collected and stored) depends on the frequency and intensity of rainfall, the catchment characteristics, quantity of water need and capacity of the storage tanks.

8.2 Importance of Rainwater harvesting

Rainwater harvesting is particularly important in arid and semi arid regions, where availability of surface and ground water is meager and in remote isolated habitations in difficult terrains, where the existing water source is chemically contaminated and where it may often provide the only feasible solution for an improved water supply and where there is rapid depletion of groundwater due to over exploitation and where bringing water from the distant source is economically not viable.

8.3 RAINWATER HARVESTING TECHINIQUES

There are two main techniques of rainwater harvesting

a) Storage of rainwater on surface for future use

b) Recharge of groundwater

The storage of rainwater on surface is a traditional technique and structures used were underground tanks, ponds, check dams, weirs, etc., Recharge to groundwater is a new concept of rainwater harvesting and the structures generally used are recharge pits, recharge trenches, dug wells, hand pumps, recharge wells, recharge shafts and spreading techniques.

8.4 REQUIREMENT

- To meet the ever increasing demand for water.
- To reduce the runoff, which is choking the storms and drains
- To avoid flooding of roads
- To augment the groundwater storage and control decline of water levels
- To reduce the groundwater pollution
- To improve the quality of groundwater
- To reduce soil erosion

8.5 ROOF TOP RAINWATER HARVESTING

In Roof top rainwater harvesting, the rainwater is collected from the roof of the buildings and stored in groundwater reservoir for the beneficial use in future. Roof top rainwater harvesting (RRWH) is the most commonly used form of direct rainwater harvesting system of collecting and storing rainwater runoff from roof tops in small tanks, vessels, underground or above the ground or redirecting it into the ground for recharging groundwater. Roof top rainwater harvesting system may be a good proposition to meet the domestic water needs of the population to supplement the available municipal water supplies especially during the dry periods or intermittent dry spells during the monsoon.

8.6 COMPONENTS OF RRWH SYSTEM:

In roof top rainwater harvesting systems, rainwater from the roof is collected in a storage vessel or tank for use during the periods of scarcity. Usually these systems are designed to support the drinking and cooking needs of the family at their doorstep. A typical roof top rainwater harvesting system comprises of the following components

- Roof catchment
- Gutters
- Down pipe and first flush pipe
- Filter unit
- Storage tank
- Collection

8.7 DESIGN OF THE SYSTEM

The actual design of the system depends on system cost, quantity of rain water to be collected, expectations and needs of the owners. The volume of the rain and its distribution over the year and size of the catchment area and the expected run off water ultimately determine the size of the tank.

8.8 CALCULATION OF THE TANK CAPACITY

The capacity of the tank is calculated as:

Capacity (Q) = (n*q*t)

Where n = number of persons

Q = consumption level per capita per day, lpcd

T = number of days or dry period for which water is needed

For example, for 5 numbers of persons in a household, assuming 90 days period of water scarcity for the domestic needs with a percapita requirement of 10 lpcd the size of the storage required will be 4500 litres

8.9 CALCULATION OF RUNOFF PER UNIT ROOF AREA

Run off per unit roof area can be computed by multiplying the total average rainfall over the preceding wet months or monsoon, as per the climatic conditions with the runoff co efficient (f) (0.70 – 0.90) as indicated below

- GI Sheet 0.90
- Asbestos 0.80
- Tiled 0.75
- Concrete 0.70

8.10 AVAILABILITY OF ROOFWATER FOR RAINFALL IN CUM:

Availability of rainwater runoff from different roof top areas for a range of rainfall is given below assuming the co efficient of 0.75

Roof area in sq.m	100 mm	200 mm	300 mm	400 mm	500 mm	600 mm	700 mm	800 mm	900 mm	1000 mm
	Harvested run off in Cum									
10	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50
20	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50	15.00
30	2.25	4.50	6.75	9.00	11.25	13.50	15.75	18.00	20.25	22.50
40	3.00	6.00	9.00	12.0	15.00	18.00	21.00	24.00	27.00	30.00
50	3.75	7.50	11.25	15.0	18.75	22.50	26.25	30.00	33.75	37.50
60	4.50	9.00	13.50	18.0	22.50	27.00	31.50	36.00	40.50	45.00
70	5.25	10.5	15.75	21.0	26.25	31.50	36.75	42.00	47.25	52.50
80	6.00	12.0	18.00	24.0	30.00	36.00	42.00	48.00	54.00	60.00
90	6.75	13.5	20.25	27.0	33.75	40.50	47.25	54.00	60.75	67.50
100	7.50	15.0	22.50	30.0	37.50	45.00	52.50	60.00	67.50	75.00
200	15.0	30.0	45.00	60.0	75.00	90.00	105.0	120.0	135.0	150.0
300	22.5	45.0	67.50	90.0	112.5	135.0	157.5	180.0	202.5	225.0
400	30.0	60.0	90.00	120.0	150.0	180.0	210.0	240.0	270.0	300.0
500	37.5	75.0	112.5	150.0	187.5	225.0	262.5	300.0	337.5	375.0
600	45.0	90.0	135.0	180.0	225.0	270.0	315.0	360.0	405.0	450.0
700	52.5	105.0	157.5	210.0	262.5	315.0	367.5	420.0	472.5	525.0
800	60.0	120.0	180.0	240.0	300.0	360.0	420.0	480.0	540.0	600.0
900	67.5	135.0	202.5	270.0	337.5	405.0	472.5	540.0	607.5	675.0
100	75.0	150.0	225.0	300.0	375.0	450.0	525.0	600.0	675.0	750.0

8.11 SPECIFICATIONS OF VARIOUS COMPONENTS:

8.11.1 Roof Catchment

The roof of the house is used as the catchment for collecting the rainwater. Roofs made of corrugated iron sheet, asbestos sheet, tiles, concrete can be utilized as such for harvesting the rainwater.

8.11.2 Gutter

Gutter collects the rainwater runoff from the roof and conveys the water to the down pipe. Gutter may be constructed in semi circular or rectangular shape. Semi circular gutters 15 – 25 cm of plain galvanized iron sheets are commonly used with a mild slope of around 0.5 % to avoid formation of the stagnant pools of water. PVC pipes of suitable diameter can also be adopted for gutters.

8.11.3 Down Pipe

A vertical down pipe of 75 mm to 110mm diameter may be required to convey the harvested rainwater from the gutters to the storage tank.

8.11.4 First Flush Pipe

The first flush of water from the roof is likely to contain dust, dropping and debris collected on the roof. This contaminated water should be diverted from the storage tank to avoid polluting the stored rainwater. This could be achieved manually by including a ninety-degree elbow on the down pipe so that the pipe can be turned away from the storage tank to divert the first few minutes of a storm.

8.11.5 Filter Units

The filter unit may be a container or a chamber with filter media such as coarse pebbles, gravels and sand to remove the debris and dirt from the water that enters the tank

8.11.6 Storage Tank

Storage tank is used to store the water that is collected from the rooftops. For storing larger quantities of water the system will usually require a bigger tank with sufficient strength and durability. There are unlimited options for the storage tanks which may be of brickwork, cement bricks, Ferro cement, PVC tanks. The storage system can be located

- Just below the roof level.
- On the ground
- Partially above and partially below the ground
- Below the ground.

Just below the roof level is good because water can be drawn by gravity and is therefore the most energy efficient.

Storage Tanks on the ground is easiest for drawal from buckets and easiest to maintain. However, it may restrict movements if the area is small as storage occupies space. Below the ground surface sumps are the cheapest, most un-obstrusive and do not obstruct movement. However, water has to be pumped up and cleaning sumps is a chore. Typically sumps are the most favoured solution.

8.11.7 STORAGE TANK CAPACITY

The storage tank capacity depends on the rainfall pattern, roof area and usage. If the area of the roof is 100 sq.m and daily usage of water is 100 litres per day then for the normal rainfall in Tamilnadu, the thumb rule is 10,000 litre storage tank.

8.11.8 QUALITY OF THE STORED WATER

The roof top harvested water is not stored for use in summer. When it rains, the roof water should be harvested and used as a first choice. If it replaces ground water the ground water is saved for summer. If it replaces piped water, pumping and energy cost is saved. Even if it is stored in the storage tank, it needs three conditions to go as ‘bad’ water i.e., air, sunlight and organic matter. If the organic matter is removed by filtration process, storing water in a closed container without access to sunlight and air, water will remain good for long time.

8.11.9 USES OF ROOF TOP HARVESTED WATER

- For all purposes. But if it is to be used for consumption, then the water quanlity is to be checked before consumption.

Potable water should always be treated well before consumption and wherever possible boiled or sterilized.

8.11.10 PRECAUTIONS

- Keep the roof or terrace as clean as possible. Regular maintenance should be done.
- Storage of insecticides, rusting iron, manure or detergents on the roof must be avoided.
- Pets should be avoided on the rooftop.
- Adequate overflow from storage system should be provided for unexpected heavy rains.
- Chemically polluted water should not be used for ground water recharge.
- Storm water drains to be kept separate from the sewer drains.
- Filter materials have to be either replaced or washed properly before the monsoon.
- Roof outlet on the terrace should be covered with the mesh to prevent entry of wastes.
- First flushing to be done to dispose off the polluted runoff.
- Proper technical guidance before executing the RWH structures.

8.11.11 GROUND WATER RECHARGE

The rainwater is also collected from the rooftop of the building and stored in ground water reservoirs for beneficial use in the future. The ground water is augmented

- To meet the increased demand for water.
- To reduce the runoff, which is choking the storm, drains.
- To avoid flooding of roads.
- To control decline of water levels.
- To reduce the ground water pollution.
- To improve quality of ground water.
- To reduce soil erosion.

8.11.12 ADVANTAGES OF GROUND WATER RECHARGE

- Ideal solution of water problem where there is inadequate ground water supply or surface resources are either lacking or insignificant.
- To utilise the rainfall runoff, which is going to sewer or storm drains.
- Rainwater is bacteriologically pure, free from organic matter and soft in nature.
- It will help in reducing the flood hazard.
- To improve the quality of existing ground water through dilution.
- Rainwater may be harnessed at place of need and may be utilised at time of need.
- The structures required for harvesting rainwater are simple, economical and Eco-friendly.

8.11.13 GROUNDWATER RECHARGE METHODS

Roof top rainwater can be used to recharge the ground water through

- Recharge pit
- Recharge trench
- Recharge pit/trench with borewell
- Abandoned open well
- Abandoned/running borewell

8.11.14 SOIL TYPE

Soil texture is important because it largely determines the retention and infiltration capacity. Sand may get drained too rapidly, whereas in a clayey soil the individual pore spaces being too small, the infiltration capacity is low. Soil texture and colour are identified as model parameters.

Soil can be classified based on size of the grain as detailed below.

Name	Diameter (mm.)
Coarse Gravel	> 2
Fine Gravel	1 – 2
Coarse Sand	0.5 – 1
Fine Sand	0.1 – 0.5
Very Fine Sand	0.05 – 0.1
Silt	0.002 – 0.05
Clay	< 0.002

Hydrologically the soil can be grouped in to four types. The criteria for hydrologic soil group is given below :

Character	Hydrologic soil groups			
	A	B	C	D
Infiltration rate	High	Moderate	Slow	Very slow
Texture	Sand/ gravel	Moderate to coarse	Fine to moderate	Clay
Depth	Deep	Moderate to deep	Deep	Very deep
Drainage	Well to excess	Moderate to well drained	Slow to moderate	Very slow
Water transmission	High	Moderate	Slow	Very slow
Remarks	Low run-off	Moderate - run off	Moderate to high	High run-off

Based on the soil character, thickness and spatial distribution different methods of recharging of the ground water by using rainwater collected from the rooftop can be designed.

8.11.15 TYPE OF STRUCTURES IN DIFFERENT SOILS

Percolation Pits	in the Sandy Areas
Percolation pits with Bore well	when the depth of Clay is more
Dug cum recharge bore wells	to recharge the deeper aquifers
Trench, Trench cum bore wells	in limited open lands, narrow streets
Recharge shafts	sufficiently deep to penetrate the top permeable layer
Percolation ponds	Across nullahs and natural water courses of very small watershed area to impound rainwater and retain for a longer period
Injector wells aquifers	when impervious layers over lie deeper
Sub surface dykes	In hard rock areas to retard the groundwater flow
Spring water harvesting	Natural springs in the hilly areas to be collected in the small lined tanks

8.11.16 Recharge in farm and irrigation lands:

In Gradient lands	Trenches and series of ponds
Plain flat terrain	Storing ponds across canals
Rocky region	Through recharge wells
Totally dry land	Pitting and bunding
Riverbeds	Check dams, sub surface dykes

8.11.17 RECHARGE PIT

1. Recharge pits are constructed for recharging shallow aquifer at less than 3 m depth below ground level
2. These are constructed generally 1 to 2 m wide and 2 to 3m deep.
3. After excavation, the pits are filled with pebbles/gravel at the bottom half depth followed by coarse sand on the top.
4. Water to be recharged should be silt free.
5. Cleaning of the pit should be done periodically.
6. It is suitable for small buildings having rooftop area of less than 100 sq.m.
7. There should be one pit for every 25-30 sq.m area and the spacing between the pits should not be less than 5 m.
8. Recharge pit may be of any shape i.e., circular, square or rectangular.

8.11.18 RECHARGE TRENCH

1. It is constructed when permeable strata of adequate thickness are available at shallow depth.
2. It is a trench of shallow depth of size 10 m X 1 m X 3 m (depending on the availability of land and rooftop area) filled with pebbles at bottom and coarse sand at top.
3. It is suitable for buildings having the roof area of 200 – 300 sq.m
4. Cleaning should be done periodically.

8.11.19 RECHARGE PIT/TRENCH WITH BOREWELL

1. Whenever the depth of the clay or impervious soil is more than 3m – 5m and the aquifer is at deeper depth this method can be adopted.
2. The borehole of 150 – 250mm diameter and depth of 10 to 15 m depending on the soil condition is drilled at the center of the recharge pit/trench.
3. The hole is filled with pebbles/gravel up to the bottom half depth of the pit/ trench and with coarse sand on the top.
4. Two or more boreholes can be provided in the recharge trench.
5. The rooftop rainwater is channeled to the pit/trench and recharges under gravity flow conditions.
6. Recharge water should be silt free.
7. The number of recharging borewells can be determined in limited area available around the buildings depending upon roof top area and aquifer characteristics.

8.11.20 ABANDONED OPEN WELL

1. A dry/unused or even a well under use can be used as recharge structure.
2. Before using the well as recharge structure, its bottom should be cleaned and all the fine deposits should be removed.
3. Recharge water collected from the rooftop should be filtered by suitable filter media and should be silt free.
4. It should be cleaned regularly.
5. It is suitable for large buildings having the roof area of more than 1000 sq.m or even small.
6. Periodic chlorination should be done for controlling any bacteriological contamination.

8.11.21 ABANDONED / RUNNING BOREWELL

1. An abandoned/running borewell fitted with either hand pump or power motor can be used for recharge.
2. Recharge water collected from the rooftop should be filtered by suitable filter media and should be silt free.

3. The filtered water can be let into the borewell either through the draw pipe provided in the hand pump or through the outer casing pipe of the borewell.

4. Filtering can also be made by providing a recharge pit with filter media around the borwell. The casing pipe of the borewell in the recharge pit should be provided with slots of 5 – 8 mm size for flow of filtered water and nylon wire mesh cover in the outer side covering the slots for preventing fine sand inflow in to the borewell.

5. The intake capacity of the borewell either located in the hard rock or soft rock depends on the aquifer characteristics.

6. Periodic chlorination should be done for controlling any bacteriological contamination.

8.11.22 DESIGN OF RAINWATER HARVESTING STRUCTURES IN DIFFERENT BUILDINGS

8.11.22.1 Tiled and sloped terrace building.

In the tiled / sloped building, semi circular gutters of width 15 to 25 cm of plastic or any other material may be provided on the down side roof slopes of the building for harvesting rain water. The gutter may be connected at the down stream end with a down pipe of 75 to 100 mm dia, depending upon roof area and size of tank to convey the harvested rainwater from gutters to a plastic storage tank / sump (through a filter unit). An inlet screen (wire mesh) to prevent entry of dry leaves and other debris into the down- pipe may be fitted.

The collected rainwater from the roof may be allowed to pass through a filter unit. The filter unit is to be filled with suitable filter material such as well-burnt broken bricks (or pebbles) upto 15 cm from top. The top 15 cm may be filled up with coarse sand. The filter unit may be placed either over a storage tank or at bottom of the down pipe.

The filtered rainwater shall be collected in a collection tank or storage tank placed over the ground or underground. The shape of the tank may be cylindrical, rectangular or square of suitable size / capacity ranging from 1000 to 10,000 litres or even higher depending on the roof area.

The material of construction may be brickwork, stone work, cement bricks, ferro-cement, High Density Polyethylene (HDPE), plain cement concrete or reinforced cement concrete. The storage tanks / collection tanks are to be provided with pipe fixtures at appropriate places to draw the water to clean the tank and to dispose of the excess water depending upon use / reuse either to openwell / borewell or to a percolation pit.

8.11.22.2 Small Buildings (Ground + First Floor)

Percolation pits of 30 to 45 cm dia. and of depth not less than one metre to recharge the ground may be made. This pit is to be filled with suitable filter material such as well-burnt broken bricks (or pebbles) upto 15 cm from top. The top 15 cm may be filled up with coarse sand.

The top of this pit may be covered with perforated reinforced concrete cement (RCC) slab or of any other material, wherever considered necessary. The number of such percolation pits may be provided on the basis of one pit per 30 square metres of available open terrace area / plinth area. The cross-distance between the pits should be minimum 3 - 5 metres.

Wherever an open well / bore well is available within the building premises the rain water collected from the open terrace may be collected through pipes 150 mm dia or other suitable sizes and led to a filter pit of size 60 cm x 60 cm x 60 cm (with appropriate filter material) and then led into the open well / borewell through 150mm dia or other suitable pipes.

Wherever existing water storage sumps are available, the rainwater so collected, after it passes through the filter, may be allowed to flow to the sump through closed pipes. An overflow pipe may be provided to the storage sump so that the surplus water is led into the nearby openwell/borewell/percolation pit.

8.11.22.3 MULTI-STORIED BUILDING (GROUND + 2 FLOOR AND ABOVE)

In addition to the percolation pits of 30 cm dia to be provided at 3 metre interval, a pit of 1 to 1.5 metres width and appropriate depth, so as to recharge the ground, shall be provided all along the plinth boundary depending upon the soil classification below ground.

This pit shall be filled with appropriate filter material namely, broken bricks, pebbles, broken stones etc., at the bottom and the top 15 to 25 cm shall be filled with coarse sand. The ground / pavement surface around the building has to be sloped towards the percolation pit so that rain water from terrace and sides, open spaces etc., flow over this sloped surfaces and spread into the filter bed all around.

Masonry dwarf walls of 5 to 7.5 cm or of suitable height depending upon the site conditions may be constructed, if necessary, at the entrance and exit gates to allow the rain water collected within the compound to recharge the ground within the premises itself, and from draining out to the road.

If the sub soil is not a permeable one (namely, clay or black cotton) appropriate recharge structures, namely recharge shaft, or bore pit may be provided below the filtration pits so as to recharge the ground.

8.11.22.4 GROUP BUILDINGS AND INSTITUTIONAL BUILDINGS

The surface runoff rain water, in the open spaces within the Group / industrial / institution premises may be allowed to run towards collection drains of suitable size and these drains will be constructed as rain water-friendly storm water drains.

All the approach and access roads to the buildings within the Group / industrial / institutional premises will also be provided with rain water-friendly storm water drains. These rain water- friendly storm water drains will not have paved bottom. If adequate spaces are available in low-lying areas, percolation ponds of suitable size may be formed and these rain water-friendly storm water drains will be led into the percolation ponds for recharging the ground.

For other localized low-lying areas, recharge pits of size of minimum 1m x 1m x 1m or 1m dia will be provided wherever needed, so as to prevent rainwater stagnation around the building. For other places catch water pit structures of size 30 cm dia and 30 cm depth or higher depth as necessary will be provided wherever necessary. For existing paved storm water drains, catch-water pits of 30 cm dia and 30 cm depth or higher depth, as necessary, may be provided at the bottom of these drains at 10 to15 m intervals. These catch water pits will be filled with appropriate filter material.

8.11.23 Recharge of Structures:

Any Harvesting Structure suggested should augment the Water Resources for local drinking water head works either directly or indirectly.

The following conditions are to be taken into consideration for selection of site.

The first and foremost requisite is the Availability of Runoff. No structure should be suggested in/on-run-off area. Availability of Government land or poromboke needs to be ascertained to avoid unnecessary legal hurdles at later dates.

The permeability of the sub-soil needs to be deciphered. Impermeable locations such as clay, shale or silt deposits are to be avoided. If high permeable formations such as sand is encountered below these impermeable soil cover, special attention need to be paid either to remove shallow impermeable over burden or drill holes to reach the permeable formation if the over burden is thick. If necessary infiltration may be deployed to ascertain the infiltration capacity of the soil covers.

Steep gradient terrain is not suitable for the construction of rainwater harvesting structures. The steep gradients will facilitate fast discharge of run off and also cause instability to the rainwater harvesting structures in view of its velocity impact over the gradient. Normally flat terrain is suggested.

The water table should be deep in the areas where the structures are proposed in order to facilitate more recharge in the vadose zone. On the other hand, the local rain quickly recharges the shallow water table areas before the structure recharges the ground water. In such instances, the water gets charged by the rainwater harvesting structures will merely flow as springs in the down stream. The area where there is steep hydraulic gradient is also not suitable for construction of recharge structures.

Big rainwater harvesting structures should not be designed especially on the first order streams. Similarly, a network of rainwater harvesting structures should not be designed in all the first order stream of the main river. A series of rainwater harvesting structure should not be designed in the form of cascade over a same stream. In all the above cases, the Interest of down stream will be adversely affected which will be against the interest of down stream needs.

If necessary, a calculation on the run off estimation may be worked out before designing the structures based on the rainfall. Thus scientific application is necessary to decide the location of rainwater harvesting structures particularly in the youthful stage of the streams.

The height of the structure plays a vital role in the land submergence. Therefore sufficient care must be exercised while deciding the weight of the structure. The submergence of cultivable land should be avoided.

Pollution of water, both surface and sub-surface needs to be kept in mind in deciding the location of rainwater harvesting structures. Some of the rivers during high rainfall periods carry large amount of pollutants as stream load and gets stagnated in the upstream. These streams are not suitable for the construction of rainwater harvesting structures since it would facilitate the recharge of pollutants into ground. Similarly, some of the streams always carry pollutants irrespective of seasonal flow owing to the constant discharge of pollutants. These streams are also not suitable for recharge purposes.

8.11.24 Surface Run off Harvesting Structures

8.11.24.1 Percolation ponds

These are the most prevalent structure to recharge ground water reservoir both in alluvial as well as in hard rock formations. The efficacy and feasibility of these structures is more in hard rock formations where the rocks are highly fractured and weathered. The percolation ponds are however also feasible in mountain fronts occupied by talus scree deposits.

Percolation pond is also constructed to recharge deeper aquifers where shallow or superficial formations are highly impermeable or clayey with certain modifications. Recharge wells with filters are also constructed in the Percolation pond.

8.11.24.2 Important Aspects of Percolation Ponds:

1. A detailed analysis of rainfall pattern, number of rainy days, dry spells, and evaporation rate and detailed hydrogeological studies to demarcate suitable percolation tank sites.

2. In semi arid climate area like Tamil Nadu, the storage capacity of percolation tank be designed such that the water percolates to ground water reservoir by January since the evaporation losses would be high subsequently.
3. Percolation tanks be normally constructed on second to third order stream since the catchment so also the submergence area would be smaller.
4. The submergence area should be in uncultivable land as far as possible.
5. Percolation pond be located on highly fractured and weathered rock for speedy recharge. In case of alluvium, the boulder formations are ideal for locating Percolation pond.
6. The aquifer to be recharged should have sufficient thickness of permeable vadose zone to accommodate recharge. The benefitted area should have sufficient number of wells and cultivable land to develop the recharge water.
7. Detailed hydrological studies for run off assessment to done and design capacity should not normally be more than 50% of total quantum of rainfall in catchment.
8. Waste weir or spillway be suitably designed to allow flow of surplus water based on single day maximum rainfall after the rank is filled to its maximum capacity.
9. Cut off trench be provided to minimize seepage losses both below and above nalla bed.
10. To avoid erosion of embankment due to ripple action stone pitching be provided upstream upto HFL.
11. Monitoring mechanism in benefitted as well as catchment area using observation well and staff gauges be provided to assess the impact and benefits of percolation pond.

8.11.24.3 Check Dams

Check dams are constructed across small streams having gentle slope and are feasible both in hard rock as well as alluvial formation. The site selected for check dam should have sufficient thickness of permeable bed or weathered formation to facilitate recharge of stored water within short span of time.

The water stored in these structures is mostly confined to stream course and the height is normally less than 2 m. These are designed based on stream width and excess water is allowed to flow over the wall. In order to avoid scouring from excess run off, water cushions are provided at down streamside. To harness the maximum run off in the stream, series of such check dams can be constructed to have recharge on regional scale.

A series of small bunds or weirs are made across selected nala sections such that the flow of surface water in the stream channel is impeded and water is retained on pervious soil/ rock surface for longer body. Nala bunds are constructed across bigger nala of second order streams in areas having gentler slopes. A nala bund acts like a mini percolation tank.

8.11. 24.3.1 Site Characteristic and Design Guidelines:

For selecting a site for Check Dams/Nala bunds the following conditions may be observed.

1. The total catchment of the nala should normally be between 40 to 100 Hectares though the local situations can be guiding factor in this.
2. The rainfall in the catchment should be less than 1000 mm/annum. The width of nala bed should be at least 5 metres and not exceed 15 metres and the depth of and should not be less than 1 metre.
3. The soil down stream of the bund should not be prone to water logging and should have pH between 6.5 to 8.
4. The lands down stream of Check dam/bund should have irrigatable land under well irrigation.
5. The nala bunds should be preferably located in area where contour or graded bunding or lands have been carried out.
6. The rock strata exposed in the area should be adequately permeable to cause ground water recharge through ponded water.
7. Nala bund is generally a small earthen dam, with a cut off core wall of brickwork, though cement bunds/plugs are now prevalent.
8. For the foundation for core wall a trench is dug 0.6 m wide in hard rock or 1.2 metres in soft rock of impervious nature. A core brick cement wall is erected

0.6 m wide to stand at least 2.5 metres above nala bed and the remaining portion of trench is back filled on upstream side by impervious clay.

9. The core wall is buttressed on both sides by a bund make up of local clays and on the upstream face stone pitching is done.

10. Normally the final dimensions of the Nala bund are; length 10 to 15 metres, height 2 to 3 metres and width 1 to 3 metres generally constructed in a trapezoidal form. If the bedrock is highly fractured, cement grouting is done to make the foundation leakage free.

8.11.24.9 Ground Water Dams or Sub-surface Dykes

These are basically ground water conservation structures and are effective to provide sustainability to ground water sources by arresting sub-surface flow. A ground water dam is a sub-surface barrier across stream which retards the natural ground water flow of the system and stores water below ground surface to met the demands during the period of need. The main purpose of ground water dam is to arrest the flow of ground water out of the sub-basin and increase the storage within the aquifer. By doing so the water levels in upstream part of ground water dam rises saturating the otherwise dry part of aquifer.

The underground dam has following advantages: -

1. No evaporation loss from the reservoir takes place.
2. No siltation in the reservoir takes place.
3. The potential disaster like collapse of dams can be avoided.

8.11.24.10 Spring water harvesting

In the hill area like Udhagamandalam, Kollihills, Kodaikanal water springs of sustainable quantity may flow from rock layers, joints. These spring waters are collected through channels and stored in a natural storage pond or by constructing a check dam across the stream. The stored water is fresh and pollution free and no treatment is necessary except chlorination. A delivery pipe of required size is laid from the Check dam to the habitation in the down streamside and distributed for drinking purposes. No pumping is required and O&M cost is reduced.

8.11.24.11 Ooranies

Ooranies are the most common traditional drinking water source of Ramanathapuram and Sivagangai Districts. These are dug up ponds, which collect not only the surface runoff but also the subsurface runoff in certain places. The specific feature is that the depth of these Ooranies are linked by the depth at which the salt water occurs which varies from 3 to 5 meters in the project area. Villagers maintain separate such ponds for drinking, washing and bathing and cattle consumption. Most of these ponds have become almost useless now because of:

- Reduced storage capacity by silting and or encroachments.
- Reduced inflow due to diverting the runoff water to fields and / or absence of proper inlet structures.
- Poor maintenance leading to collapse of sides
- Although there is plenty of scope for rep0airing and remodeling these ponds, there are also quite a few limitations such as:
- The salt water level does not permit any appreciable depending of ponds. Actually in order to ensure enough storage even during summer, one has to increase the depth rather than the surface area because of high rate of evaporation.
- Many ponds were getting fed through feeder channels from large irrigation tanks (Kanmois), which are also not in a position to supply water due to reduced inflow into them. Finding independent Catchment and diversion drains is not all that easy due to objection from people.

8.11.24.12 Typical Design Of An Improved Oorani:

In order to overcome the defects mentioned earlier, the existing Ooranies are suggested for remodelling. The salient features of a typical Oorani development is given as follow:

Name of village	:	Kinnar
Population	:	800

Present source	:	Water supplied through tankers for drinking.
Water for other needs	:	From the nearby irrigation tank
Total annual water demand at the rate of 40 LPCD per head	:	11680 m^3
Size of the Pond:	:	Top Length 104.0 metres Bottom Length: 100 metres
Top width	:	36.0 metres
Bottom width	:	28 metres
Depth	:	4.0 metres
Maximum Storage of the pond	:	13,317 m^3
Available from direct rainfall over the pond	:	104 x 32 x 0.60 = 1997 m^3
Net inflow required from the Catchment	:	11,320 m^3.
Direct inflow from the available Catchment area	:	10,416 m^3

Remaining required quantity of 904 m^3 water has to be taken from the nearby irrigation tank.

Simple inlet and outlet structures are provided.

- A toe wall of stone masonry protects the sidewall against sliding.
- Grass turfing protects the sloping side walls
- The guide bunds and drains divert the runoff water towards the inlet and into the pond.
- A filter trench connected to a draw well outside the pond supplies clean water. No direct withdrawal is allowed.

9. WATER SUPPLY WORKS

9. WATER SUPPLY WORKS

9.1 Objectives of Water Supply Projects

The objectives of water supply projects are to supply to the public :

- **SAFE** water, i.e., the water free from disease producing pathogens such as harmful bacteria, virus and parasites. As a commodity truly safe water is becoming a rarity.
- **CLEAN** water i.e., the water free from excessive concentration of substances,
- In **ADEQUATE** quantities to meet the basic needs and the other requirements,
- At **CONVENIENT** points, preferably through house service connections, and
- At **ECONOMIC** costs.

9.2 Water Demand

- While planning water supply projects, it is not only necessary to find out the total annual water demand at the end of the design period but also to assess the average rate of daily demand. Total annual demand is expressed in Million Litre or Million Cubic Metre.
- Average daily demand as an annual average=Annual demand/365
- Average daily water demand=Future population at the end of design period x Per capita water supply rate in lpcd.
- Average daily water demand for a community is expressed in Million Litre per day (MLD)

9.3 Design Period

The design period depends on

- The useful life of the project components like pumps, machineries, pipes, structures etc.,
- Amount and availability of additional investment likely to be incurred for additional provisions.

- Anticipated rate of population growth.

The design period is fixed with different time period for different component as indicated in Table 1

Table 1. Design periods for Different Components

Sl.No.	Component	Design period years
1.	Storage dams	50
2.	Infiltration Wells	30
3.	• Pump House	30
	• Electrical motors and pumps	15
4.	Water Treatment Units	15
5.	Pipe connection to several treatment units	30
6.	Raw water and clear water transmission mains	30
7.	Clear water reservoirs at head works and service reservoirs	15
8.	Distribution system	30

9.4 Per Capita water demand

- Per capita water demand is the average daily draft in litres per person per day (lpcd) based on the annual average demand.

Factors affecting the per capita water demand are:-

- Size of the villages :- The per capita water demand for larger village is generally larger than smaller village
- Climatic Conditions:- At hotter and dry places, the consumption of water is generally more
- Socio-Economic status:- The quantity of water required is directly dependent upon the economic status of the consumer,

- Quality of water supplies:- If the quality and taste of water supply is good, the consumption will be more since the people will not use othersources such as private wells.

As per IS: 1172-1971 the per capita water demand under normal conditions in an Indian city is expected to be around 135lpcd. The water consumption for drinking, cooking and bathing, generally amounts to 40 to 50% of the total domestic water consumption. The break up of 135lpcd may be approximately taken as shown in Table 2.

Table 2. Average Domestic Water Consumption for Different Uses

Type of Use	Consumption in lpcd	Percentage of total
Drinking	5	3.70
Cooking	5	3.70
Bathing	55	40.80
Washing of clothes	20	14.80
Washing of Utensils	10	7.40
Washing and cleaning of houses	10	7.40
Finishing of toilets etc.,	30	22.20
Total	**135**	**100.00**

9.5 NORMS FOR PROVIDING POTABLE DRINKING WATER IN RURAL AREAS

While implementing the Rural Water Supply Schemes, the following norms are adopted for providing potable drinking water to the population:

40 litres per capita per day (lpcd) for humans to meet the following requirements:

Purpose	Quantity (LPCD)
Drinking	3
Cooking	5
Bathing	15
Washing utensils & house	7
Ablution	10

9.6 QUALITY CONTROL OF WATER SUPPLY WORKS

9.6.1 Water Quality

Water quality is a relative term used to convey the idea of the potential usability of groundwater or surface water for a particular use.

9.6.2 Characteristics of water

The quality of water is determined by its physical, chemical and bacteriological characteristics.

Physical characteristics are represented by temperature, turbidity, colour, taste, and odour.

Chemical characteristics are represented by pH, total dissolved solids, hardness, chloride, sulphate, fluoride, nitrate, iron, manganese etc.,

Bacteriological characteristics of the water is represented by the presence of coliform group of organisms described by the MPN (Most Probable Number) of the coliforms in the water sample.

9.6.3 Drilling of Bore Wells

Drilling of bore wells is performed by one of the following methods depending on the formation into which drilling to be done.

1. Pneumatic drilling for hard rock formation,
2. Percussion method, and
3. Rotary methods for consolidated formation.

9.6.4 Pneumatic drilling in hard rock

Drilling in hard rock is done by Pneumatic drilling methods using compressed air. Compressed air with a pressure range of 5 to 17.5 Kg/sqm is used to operate the drilling hammer depending upon the application. The exhaust air is used for cleaning the cuttings from the borehole.

There are two methods of Pneumatic drilling in hard rocks. They are

- Top Hammer method, and
- Down-the-hole Hammer method

9.6.5 Percussion Method

Percussion method or cable tool method is one of the methods for drilling borehole in sedimentary formation or soft rocks. With percussion method, shallow boreholes can be drilled successfully using hand-boring equipment, while the deep boreholes are drilled using powerful rig machines.

9.6.6 Hand boring method

Hand boring method is a very simple device operated manually, with percussion drilling principle. Hand boring is suitable for soft formation and drilling boreholes of 100 to 300mm in diameter up to 60m depths.

9.6.7 Percussion drilling with rig

Percussion rigs are generally truck or trailer mounted for ready portability.

9.6.8 Hydraulic Rotary Drilling

There are two methods of hydraulic rotary drilling suitable for unconsolidated and sedimentary formations. They are

1. Direct rotary drilling method
2. Reverse rotary drilling method

Design and construction of tube well include the following

- Proper selection of size of the well,
- Selection of material for the construction of casing and screen pipes, and
- Choosing the proper type of pumping equipment.

9.6.9 Gravel Packing

The gravel packing in bore well plays a vital role in giving out sand free water.

- Gravel packing fills the annular space between the borehole and the well screen assembly, so as to create a zone with permeability higher than the aquifer, and prevent the silt and clay particles, entering the well.
- Gravel packing minimizes the rate of incrustation in the screen, and allows the using of large size openings.

9.6.10 Materials for casing and Screen Pipes

The selection of materials for casing and screen pipes in the design and construction of a bore well is very important aspect. The following are the three important factors to be considered in the choice of the material for casing and screen pipe.

i. Water quality; gases like oxygen, hydrogen sulphide and carbon dioxides, present in the groundwater may cause corrosion or incrustation.

ii. The screens must be strong enough to withstand the radial pressure, as well as the vertical column load due to the weight of the casing above them, which could cause their collapse.

iii. Materials generally used for casing pipes and well screens are as follows.

   a. Low carbon mild steel
   b. Leaded brass
   c. FRP, PVC,

d. Galvanized steel wire, and

e. Stainless steel wire

9.6.10.1 Types of Pipes

The various types of pipes commonly used in water transmission are:

1. Cast Iron (CI)
2. Mild Steel (MS)
3. Ductile Iron (DI)
4. Galvanized Iron (GI)
5. Reinforced Cement Concrete (RCC)
6. Pre Stressed Concrete (PSC)
7. Asbestos Cement Pressure (AC)
8. Unplaticised Polyvinyl Chloride (uPVC)
9. Glass-fibre Reinforced Plastic (GRP)
10. High density Polyethylene (HDPE)
11. Medium density Polyethylene (MDPE)

Table-4 Features of different pipes

Types of Pipes	Length (m)	Dia range (m)	Class and Pressure of pipes in ksc			Joints
			Class	WTP	FTP	
CI (Cast Iron)	5.0m, 5.5m	80 to 750	LA A B	35 35 35	6 12 9	Rigid DF Semi-rigid S/S with lead. Flexible S/S with tyton gasket
MS (Mild Steel) #	6m to 12m	150 to 2000	I II III	15 20 25	7.5 10 12.5	Rigid Smaller dia Threaded with socket or coupling, Larger dia Welding
RCC (Reinforced Cement Concrete)	2.5m	200 to 600	P1 P2 P3	2 4 6	1 2 3	Rigid RCC collars with rigid joints Flexible S/S with rubber gasket
PVC (Poly vinyl Chloride)	6m 13	40 to 15 OD	4ksc 6ksc 10ksc	8 12 20	4 6 10	Rigid PVC coupler joint with solvent, Flexible PVC socket with rubber rings

Longer lengths of small diameter are available in coils.

Table-5 Advantages and disadvantages of different types of pipe

Type of Pipes	Advantages	Disadvantages
C.I	• Suitable for slightly aggressive soil and water • Suitable for pressure and distribution mains	• Carrying capacity (C-Value) reduces with ageing • Heavy weight, more transportation cost • Low tensile stress; not suitable for beam action due to support of longer spacing
M.S	• Longer length and hence lesser number of joints; less leakage • Small shell thickness; Lesser weight and lesser transportation cost • Can withstand high tensile stress; Longer spacing of supports; • Suitable for undulating ground	• Liable to corrosion; to be coated/lined • High cost; more than 10% of C.I pipes • Direct tapping for HSC is not possible
RCC	• Good resistance to corrosion • Suitable for gravity main with small pressure	• Heavy weight; more transportation cost than all other pipes • Not suitable for pressure pipe line • Shorter length hence more number of joints; Liable for more leakage
PVC	• Economical than CI and AC for size ranging from 80 to 200mm • Light weight; easy to handle and for laying and jointing • Resistance to corrosion, • Rigidity • Immune to galvanic and electrolytic attack in corrosive soil/ water • Resistance to deformation due to subsidence in soil	• Not suitable for laying above ground • Not suitable for diameter larger than 315mm OD • Liable to damage due to heat, sun shine and impact of load • Liable to lose shape when the load is high and line is empty

9.7 PUMPS

9.7.1 Function of Pumps

The function of the pumps in water supply system are;

i. To raise the water from one elevation to another, as in the case of pumping water from a well, and

ii. To move the water through a pipe system from a point of source or treatment to a point distant use.

9.7.2 Classification of Pumps

Pumps are classified into two major groups

1. Displacement Pumps and
2. Velocity Pumps

Displacement pumps discharge substantially the same volume of water against any head within their operating capacity. In the case of velocity pumps, the volume of water discharged varies inversely with the head against which the pump operates.

9.7.3 Velocity Pumps

Velocity pumps are of the following two major types;

1. Centrifugal pump, and
2. Jet pump

9.8 WATER TANK

9.8.1 Storage Capacity of the OHT

The storage capacity of the OHT depends upon the following

1. Maximum rate of demand,
2. Maximum rate of pumping, and
3. Duration and actual scheduling of pumping and distribution in a day.

Table-6 Storage Capacities of OHT

Duration of supply or pumping	Storage capacity of OHT as Percentage of daily requirement
Above 16 to 24 hours	20 to 25%
Above 12 to 16 hours	33.33%
Above 8 to 12 hours	50%
Less than 8 hours	100%

9.8.2 Design aspects of OHTs

9.8.2.1 Location of the OHT

The location of the OHT is of importance for regulating the pressure in the WDS. The OHT is generally located at the highest point as far as possible at the centre of the area (zone) to be served. The town is divided into number zones to facilitate effective and equitable distribution. Independent OHT is provided for each of the zones.

9.8.2.2 Elevation of the OHT

In order to maintain the minimum residual pressure in the distribution system, the elevation of the L.W.L of the OHT should be fixed consistent with the provision of economic sizes of pipes in the distribution network. The LWL of the OHT is fixed considering the following aspects.

i. The minimum residual pressure to be maintained in the distribution system,

ii. The G.L at the farthest point in the d-system and its distance from the OHT,

iii. The G.L at the highest elevation in the d-system other than the location of the OHT, and

iv. The loss of head due to friction over the distance to the farthest point from the reservoir.

9.8.2.3 Shapes of the OHT

OHTs are constructed in square, rectangular and circular shapes.

Table-7 Storage Capacities of OHT

Capacity of OHT (in lakh litres)	Depth of water (in metres)
Up to 1.00	2.5 – 3.0
1.0 to 10.00	3.0 – 4.0
10.00 to 20.00	4.0 – 5.0
> 20.00	6.0

9.9 WATER DISTRIBUTION SYSTEM

Table-8 Health Effects of vasious water quality parameters

Parameter	BIS Guideline value (Maximum)	General & Health Effects
Total dissolved solids	2000 mg/L	Undesirable taste; gastro intestinal irritations; corrosion or incrustation
PH	6.5 - 8.5	Affects mucous membrane; bitter taste; corrosion; affects aquatic life
Alkalinity	600 mg/L	Boiled rice turns yellowish
Hardness	600 mg/L	Poor lathering with soap; deterioration of the quality of clothes; scale forming; skin irritation; boiled meat and food become poor in quality
Calcium	200 mg/L	Poor lathering and deterioration of the quality of clothes; incrustation of pipes; scale formation
Magnesium	100 mg/L	Poor lathering and deterioration of clothes; with sulfate laxative
Iron	1.0 mg/L	Poor or sometimes bitter taste, color and turbidity; staining of cloth materials; iron bacteria causes slime
Manganese	0.3 mg/L	Poor taste, color and turbidity; staining; black slime
Aluminum	0.2 mg/L	Neurological disorders; Alzheimer's disease
Copper	1.5 mg/L	Liver damage; mucosal irritation, renal damage and depression; restricts growth of aquatic plants
Zinc	15 mg/L	Astringent taste; opalescence in water; gastro intestinal irritation; vomiting, dehydration, abdominal pain, nausea and dizziness
Ammonia	-	Indicates pollution; growth of algae

Nitrite	-	Forms nitrosamines which are carcinogenic
Nitrate	100 mg/L	Blue baby disease (methemogloineamia);algal growth
Sulphate	400 mg/L	Taste affected; laxative effect; gastro intestinal irritation
Chloride	1000 mg/L	Taste affected; corrosive
Fluoride	1.5 mg/L	Dental and skeletal fluorosis; non skeletal manifestations
Phosphate	-	Algal growth
Arsenic	0.05 mg/L	Toxic; bio-accumulation; central nervous system affected; carcinogenic
Mercury	0.001 mg/L	Highly toxic; causes 'minamata' disease-neurological impairment and renal disturbances; mutagenic
Cadmium	0.01 mg/L	Highly toxic; causes 'Itai-Itai' disease-painful rheumatic condition; cardio vascular system affected; gastro intestinal upsets and hyper tension
Lead	0.05 mg/L	Causes plumbism-tiredness, lassitudes, abdominal discomfort, irritability, anaemia; bio-cumulation; impaired neurological and motor development and damage to kidneys
Chromium	0.05 mg/L	Carcinogenic; ulcerations, respiratory problems and skin complaints
Pesticide	0.001 mg/L	Affects central nervous system
Detergent	-	Undesirable foaming

Table-9 Guideline value of Drinking Water

Sl. No.	Parameter	CPHEEO*	BIS* 1983	BIS* 1991	WHO*
1.	Colour Pt/Co Scale	25	50	25	15
2.	Turbidity NTU	10	25	10	5
3.	Total Dissolved solids mg/L	2000	3000	2000	1000
4.	pH	6.5-9.2	6.5-9.2	6.5-8.5	6.5-8.5
5.	Alkalinity (as CaCo3) mg/L	600	-	600	-
6.	Total hardness (as CaCo3) mg/L	600	600	600	500
7.	Calcium (as Ca) mg/L	200	200	200	-
8.	Magnesium (as Mg) mg/L	150	100	100	-
9.	Sodium (as Na) mg/L	-	-	-	200
10.	Iron (as Fe) mg/L	1.0	1.0	1.0	0.3
11.	Manganese (as Mn) mg/L	0.5	0.5	0.3	0.1
12.	Chloride (as Cl) mg/L	1000	1000	1000	250
13.	Fluoride (as F) mg/L	1.5	1.5	1.5	1.5
14.	Sulphate (as SO4) mg/L	400	400	400	400
15.	Nitrate (as NO3) mg/L	45	45	100	45
16.	Copper (as Cu) mg/L	1.5	1.5	1.5	1.0
17.	Cadmium (as Cd) mg/L	0.01	0.01	0.01	0.01
18.	Selenium (as Se) mg/L	0.01	0.01	0.01	0.01
19.	Mercury (as Hg) mg/L	0.001	0.001	0.001	0.001
20.	Arsenic (as As) mg/L	0.05	0.05	0.05	0.05
21.	Lead (as Pb) mg/L	0.05	0.10	0.05	0.05
22.	Zinc (as Zn) mg/L	15	15	15	5
23.	Chromium (as Cr) mg/L	0.05	0.05	0.05	0.05
24.	Cyanide (as CN) mg/L	0.05	0.05	0.05	0.01

Sl. No.	Parameter	CPHEEO*	BIS* 1983	BIS* 1991	WHO*
25.	Anionic Detergents (as MBAS) mg/L	1.0	1.0	1.0	-
26.	Phenolic compounds mg/L	0.002	0.002	0.002	-
27.	Mineral oil mg/L	0.03	0.03	0.03	-
28.	Pesticides mg/L	-	-	0.001	-
29.	Residual Free Chlorine mg/L	-	0.2	0.2	-
30.	Aluminium mg/L	0.2	-	0.2	0.2
31.	Boron mg/L	-	-	5	-
32.	Alpha emitters Bq/L	0.1	0.1	0.1	0.1
33.	Beta emitters Bq/L	1.0	1.0	1.0	1.0
34.	Faecal coliform Counts/mL	0	0	0	0
35.	Protozoa	-	Nil	Nil	Nil
36.	Helminths	-	Nil	Nil	Nil
37.	Free living organisms	-	Nil	Nil	Nil

CHEEO : CENTRAL PUBLIC HEALTH & ENVIRONMENTAL ENGINEERING ORGANIZATION

BIS : BUREAU OF INDIAN STANDARDS

WHO : WORLD HEALTH ORGANIZATION

9.9.1. CONDITIONS FOR SUPPLY AND DELIVERY OF DEEP BOREWELL (INDIA MARK-II) – HAND PUMP SETS AND SPECIALS TO VILLAGE PANCHAYATS

- The Validity of the Contract is for one year from the date of approval.
- The rate is fixed and inclusive of all packing charges, taxes including delivery charges at Panchayats/Panchayat Unions.
- The supply should be recorded by Assistant Engineer/Union Engineer and should be check measured by the Assistant Executive Engineer for Panchayats.
- Brand Name and ISI mark should be printed on the materials.
- Payment for the supply should be made by Block Development Officer/ Panchayat President.
- The materials should be delivered to all consignees at the places specified by them within 15 days from the date of receipt of the supply orders, failing which the consignee is empowered to purchase from other approved suppliers without notice.
- Pre-delivery inspection for hand pumps should be conducted by third party inspection and inspection certificate should be enclosed along with the consignment. Regarding hand pumps, pre-delivery inspection should be done by Assistant Executive Engineer (R.D.) for all small quantities guarantee clause will only apply.
- If any materials are found damaged at the time of taking measurement the firm will be responsible to replace the materials at their own cost.
- Proper acknowledgement for the delivery of materials should be given by Block Development Officer/Panchayat President before taking measurement by the concerned Engineer.
- All water supply works should be carried out after sanctioning of Estimates by the Assistant Executive Engineer (R.D).
- For all water supply works, measurement, preparation of bills, etc., must be done by the Assistant Engineer and check measurement done by Assistant Executive Engineer (RD).
- The rates approved by the District Purchase Committee must be invariably followed in Panchayat/Panchayat Union for all the items.
- The Collector has been empowered to Cancel/Modify this order at any time without assigning any reasons.

DEEP BOREWELL (INDIA MARK-II) HAND PUMP SETS AND SPECIALS -

Supply and delivery of complete Hand pump sets as detailed below:-

Sl No.	Description
	INDIA MARK II DEEP WELL HANDPUMP WITH 30 METERS(10 NOS. X 3 MTR) CONNECTING RODS WITH TELESCOPIC STAND AND CYLINDER ASSEMBLY AS PER IS.9301
I	**PUMP HEAD ASSEMBLY ITEMS**
1	Hexagonal Bolt M 12 x 40mm long
2	Flange Bolt Unit (1 No. of M 12 x 40mm Bolt Plus 2 Nos. of M12 Nuts)
3	Hexagonal Nut M12
4	Third plate(Additional Flange)
5	Front cover
6	Hexagonal bolt M 12 x 20mm long
7	Head weldment (without cover and third plate)
8	Head with cover and third plate(including for extra Deep well hand pump)
9	Handle bar weldment (without above accessories) for Mark II and V.L.O.M
9a	Handle Bar weldment for Extra Deep well Hand pump
10	Handle Axle (S.S.)
11	Ball bearing 6204 Z
12	Space(Handle)
13	Special Washer M12 x 4 mm thick Galvanized
14	Chain with coupling
15	High tensile Hexagonal Bolt M10 x 40mm
16	Chain Bolt Unit (M10 x 40mm long bolt with M10 Nylon nut)
17	Hexagonal Nylon Unit
II	**PUMP HANDLE ASSEMBLY ITEMS**
18	Handle Bar Assembly complete with bearing chain coupling handle, axle high tensile bolt, nylon Nut & Spacer for India Mark II and VLOM Pumps

Sl No.	Description
18a	Handle bar assembly complete for Extra Deep well Hand pumps
19	Head Assembly with handle assembly(Complete with cover, Chain coupling and third plate)
III	**RAISER PIPE ITEMS**
20	Raiser pipe(32mm NB-Galvanized pipe without coupler) of 3m length
21	Raise pipe fitted with socket at one end 3m length(32mm NB-Galvanized)
22	Pipe socket(32 mm NB- Galvanized coupler)
23	Water tank (Galvanized) for mark II and Extra Deep well hand pump
23a	Water Tank for VLOM Hand pump
24	Stand (Telescopic) (Gal)for Mark II and V.L.O.M Pumps
24a	Stand (Telescopic) for Extra Deep well Hand pump
IV	**CONNECTION ROD ASSEMBLY**
25	Connecting Rod MS.(12mm dia x 3m long)
26	Hexagonal Coupler (m12 x 50mm long) electro galvanized
V	**CYLINDER ASSEMBLY ITEMS**
27	Cylinder Assembly (Complete set with Plunger rod) for India Mark II Hand pumps
27a	Cylinder Assembly for Extra Deep well Hand pump
27b	Cylinder Assembly for V.L.O.M. Hand pump
28	Cylinder body fitted with Brass liner and Reducer cap
29	Reducer cap
30	Upper valve assembly complete set consisting of Plunger rod, plunger yoke body, Rubber seating(Small) upper valve guide, Spacer, follower & Pump buckets
31	Lower valve Assembly Complete set consisting of Check Valve Guide, Check Valve seat, Rubber seat Retainer and Rubber Seating(Big)
32	Follower
33	Plunger Yoke Body
34	Check Valve Guide

Sl No.	Description
35	Check Valve Seat
36	Rubber seat Retainer
37	Pump Bucket(Veg. Tanned Leather)
38	Realing ring(Chrome Tanned Leather)
39	Rubber Seating(Small) for Upper Valve
40	Rubber Seating(Big)
41	Plunger Rod(450mm long)
42	Pump bucket(Nitrile rubber only to be used with Modified spacer)
43	Upper valve Guide fitted with rubber seating(Small)
44	Modified spacer
45	Sealing Ring Nitrile Rubber
VI	**TOOLS: Special Erection and Maintenance tools for India Mark II items consisting of 14 Nos. inclusive of M.S. Tools Box**
1	Self locking clamp
2	Connecting rod
3	Bearing Seater
4	Lifting Spanner
5	Tank pipe Lifter
6	Coupling Spanner
7	Handle Axle Punch
8	Chain coupling Supporting tool
9	Crank Spanner
10	Connecting rod lifter
VII	**Standard tools for India Mark II Pumps (2 Items consisting of 27 Nos. inclusive of M.S. Tools Box)**
1	Die Set for 32mm Pipe with handle
2	Button Die-12mm with handle
3	Pipe Wrench-450mm
4	Double End Spanner m 17 x m 19
5	Pipe Wrench-60mm

Sl No.	Description
6	Adjustable Spanner-250mm
7	Screw Driver-300mm x 8mm
8	Screw Driver-100mm x 6mm dia
9	Hacksaw frame with 6 blades
10	Flat file-250mm
11	Half Round pipe-250mm
12	Hall pen Hammer
13	Oil can Half pint
14	Wire brush
15	Centre Punch
16	Nylon Rope 3mm dia x 75 mtr.
17	Lithium Grease (for bearing - 1Kg.)
18	Graphite Grease (for Chain 1 Kg.)
19	M.S. Tool Box
20	Pipe Wrench 300mm
21	Ring Spanner M 17 x 19

9.10 SANITATION

WHO's recent estimate reveals that 2.4 billion people around the world do not have access to basic sanitation facilities, while 1.1 billion people do not have access to safe drinking water.

The domestic sewage is the second largest source of pollution in water ways. The treated sewage is discharged into rivers as point source. But in the absence of organized sanitation system the human excreta excreted in open land, is washed into water bodies as non-point sources causing surface water pollution.

9.10.1 Impact of Human Waste

The quality of surface water and shallow groundwater resources are affected largely due to the organic and faecal pollution caused by the human waste either through open defecation or due to inadequate sanitation facilities. The polluted water resources become unfit for the domestic water supply. Diseases related to polluted drinking water, are the leading causes of ill-health in children. Diarrhoea and dysentery alone strike several billion young children every year and annually kill over 2 million even before their fifth birthday.

9.10.2 Present Status of Sanitation

Only about 35% of the people in India have the access to basic sanitation. Open-air defecation has been the accepted practice in India for generations, practiced by about 85% of the rural population in most parts of the country as well as the slum population in urban areas. In house latrines are uncommon in most rural households and more than 40% of urban households.

9.10.3 Physical Constraints

- Lack of space for locating the soakage pits, dispersion trenches etc.,
- Impermeable substrata that affects the dispersing of liquid fraction of the waste into the subsoil.
- High water table conditions that interfere with the functions of sanitation systems.

9.10.4 Social Constraints

Social constraints include the participation of the community in planning and implementation of the sanitation programme, sharing of the financial burden and involving the community in the O&M of the sanitation facilities provided.

9.10.5 Institutional Constraints

The users and the officials of the local body must be fully aware of the need for maintenance of the sanitation facilities and the know-how to maintain them. Policies, organizational arrangements and financial resources must be legally established to ensure continuity of efforts in this sector.

9.10.6 Financial Constraints

The cost of installation of various components of the sanitation system and their annual O&M cost are generally high. Lack of funds with local authorities is the main reason for the non implementation of sanitation facilities. The community should be motivated to bear the annual O&M costs and some portion of the capital cost.

9.10.7 Community Participation

Community Participation is one of the fundamental components of any sanitation project. Training women and involving them in the O&M of water and sanitation is essential as women are the most affected by the faulty water and sanitation systems. Techniques for decision-making involving the community should be developed and included in the training programme.

9.10.8 Ten Commandments

- Should not involve human beings for handling the waste
- Should not expose the waste to flies, vectors or animals,
- Should not cause odours or unsightly conditions,
- Should not cause surface water contamination,
- Should not cause groundwater contamination,
- Should not cause soil contamination
- Should not require huge investments to construct,
- Should be simple and inexpensive to operate and maintain,
- Should require small quantity of water for operation,
- Should recycle the nutrients in the waste to be utilized in agricultural lands.

9.10.9 Appropriate Sanitation Technology

The most appropriate sanitation technology (AST) is that which is culturally appropriate, locally responsible, socially acceptable, functionally sustainable, environmentally compatible and economically viable. Sustainable sanitation utilizes minimum inputs and provides maximum useful outputs.

The selection of AST is influenced by the following factors:-

1. Availability of water within the house,
2. Availability of adequate open space near the house for locating the facilities.

3. Presence of highly permeable subsoil to facilitate quick dispersion of liquid content of excreta, and
4. Deep groundwater condition, which would not interfere with the dispersion of liquid.

9.10.10 Sustainable Sanitation Technologies

Environmental sustainability means disposal of human waste in a way that protects environment both for human beings and other living things, which share earth with us. The following sanitation technologies are environmentally sustainable.

1. Compost toilet,
2. Two-pit pour flush toilet, and
3. Septic tanks with effluent disposal arrangements.

9.10.10.1 Direct leach pit with water trap

Sanitary pans manufactured with Cement concrete in production centre should be fixed on the top of Leach pit.

9.10.10.1.1 Rectangle shape cement slab production:-

A cement slab with a size of 4’ length, 4’ width and 2" thickness in the centre part of which sanitary pan should be fixed. While preparing cement slabs, cement mortar should be in the ratio of 1:2:4.

9.10.10.1.2 Construction of leach pit:-

- Earth work in the size of 3.5 feet length, 3.5 feet width and 4 feet depth should be done.
- If the earth is rigid, there is no need to construct encircling wall.
- In respect of floppy earth, pit such as sandy and black cotton soil, construction work should be done to a size of mason trowel with certain gap in the shape of honey comb by using either bricks or wreckage stone. Otherwise, RCC rings with 3 feet dia may be sunk into the pit and fixed.

- If the cement slab fixed with sanitary pan is fixed without checking the sprit level, water trap will not function properly and bad smell will spread out.
- For constructing cement slab toilet with RCC rings with 3 feet dia, the steps already explained may be followed.
- While constructing round shape Leach pit with RCC slab, the pit should have 3' dia width.

9.10.10.1.3 Construction of building above the toilet:-

- It is easy to clean the septic tank, if the toilet is constructed till ground level with temporary coverage like tin sheet having some bends or thatched roof with the surrounding of coconut leaf wall, gunny bags and so on around the toilet.
- But, the house owner himself should decide the type of toilet.
- Permanent building should not be constructed above the direct leach pit.

9.10.10.2 Double Leach Pit with water trap

- Depth of the Leach pit may be decided according to the strength of soil. As far as flood prone areas are concerned, stage of toilet should be at sufficient height from the ground level.
- Leach pit, place of fixing sanitary pan and so on should be marked initially before starting construction.
- On the basis of the lines drawn as marked, earth work should be done.
- While starting construction work, water trap should be fixed by checking sprit level.
- It should be tested by flowing water into the sanitary pan and ensured whether water trap is functioning properly.
- On all sides of the sanitary pan should be packed tightly by filling sand.
- Sanitary pan should be fixed by using plain cement concrete.
- Sufficient slope should be provided for free flow of human waste and water.
- Foot steps of the pan should be fixed so as to use both children and aged persons.

- In respect of floppy earth pit such as sandy and black cotton soil, construction work should be done to a size of 3.5’ dia and 4’ depth with certain gap in the shape of honey home by using either bricks or wreckage stone.
- Leach pit should be closed by a cement slab having 2" thickness with cement Concrete so as not to enter air into the Leach pit.

9.10.10.3 Construction of Soak pit steep:-

- ➢ Pit should be made to a depth of 3’ with 3’ length and 3’ width so as the waste water to reach the pit easily.
- ➢ Under the bottom portion of the Soak pit, some big size stones (Coconut size) should be filled to 1/3 of the tank and some small size stones (Mango size) should be filled to another 1/3 of the pit.
- ➢ In order to retard the flow of silt and so on, a small mud pot with a small hole to a size of 1cm in its bottom should be fixed by putting coconut coir into it in the place of water flowing. Besides, small size stone chips (Lemon size) should be filled.
- ➢ The surface of them should be covered by gunny bag so as to be open the mouth of the pot. The earth on surface should be leveled to the ground level.
- ➢ A pipe or way should be fixed/provided to flow waste water through the pot.

Note: - After having passed one year, the pot as well as stones may be either replaced or cleaned and use again. Likewise, the pit also may be cleaned and used.

In the circumstance of not sucking water, the stones already put may be cleaned, dried and again feed as done previously.

9.10.10.4 Septic Tank

The septic tank is an enclosed receptacle designed to collect wastewater, segregate settleable and floatable solids (sludge and scum), accumulate, consolidate and store solids, digest organic matter and discharge treated effluent. Currently more than one –third of the nation’s waste water treatment is provided by septic tank systems. The septic tank may be the single most important component used in all onsite treatment and collection alternatives.

9.10.10.4.1 Design criteria

Rational design of a septic tank should be based upon the function it is expected to perform, and the tank should have an effective capacity large enough to provide for the above three requirements.

- Sedimentation to remove the maximum possible amounts of suspended solids from sewage
- Digestion of the settled sludge resulting in a much reduced volume of dense and digested sludge
- Storage sludge and scum accumulating in between successive cleanings thereby preventing their escape.

9.10.10.4.2 Sewage Flow

The maximum flow to the tank is based on the number of plumbing fixtures discharging simultaneously rather than the number of users and per capita waste water flow expected to reach the tank.

9.10.10.4.3 Tank Dimensions

Sedimentation – Both surface area and detention or depths are important factors in the settling of flocculent particles such as sewage solids. For average Indian conditions at a temperature of 25^{o}C, the surface area required will be 0.92 sqm for every 10 lpm peak flow rate. This is based on 75 percent removal of sewage particles of size 0.05mm and above with a specific gravity of 1.2. A minimum depth of sedimentation of 25-30 cm is necessary. The length is maintained at 2 to 4 times the breadth.

9.10.10.4.3 SEPTIC TANK SIZE:

Users	Length (M)	Breadth (m)	Height (M)
5	1.5	0.75	0.95
10 to 15	2.0	0.90	0.95
20	2.3	1.10	1.40
50	4.0	1.40	1.60

Septic tanks can be cleaned after 2 to 5 years time.

Free Board : 30 cm

Length : 2 to 4 times width

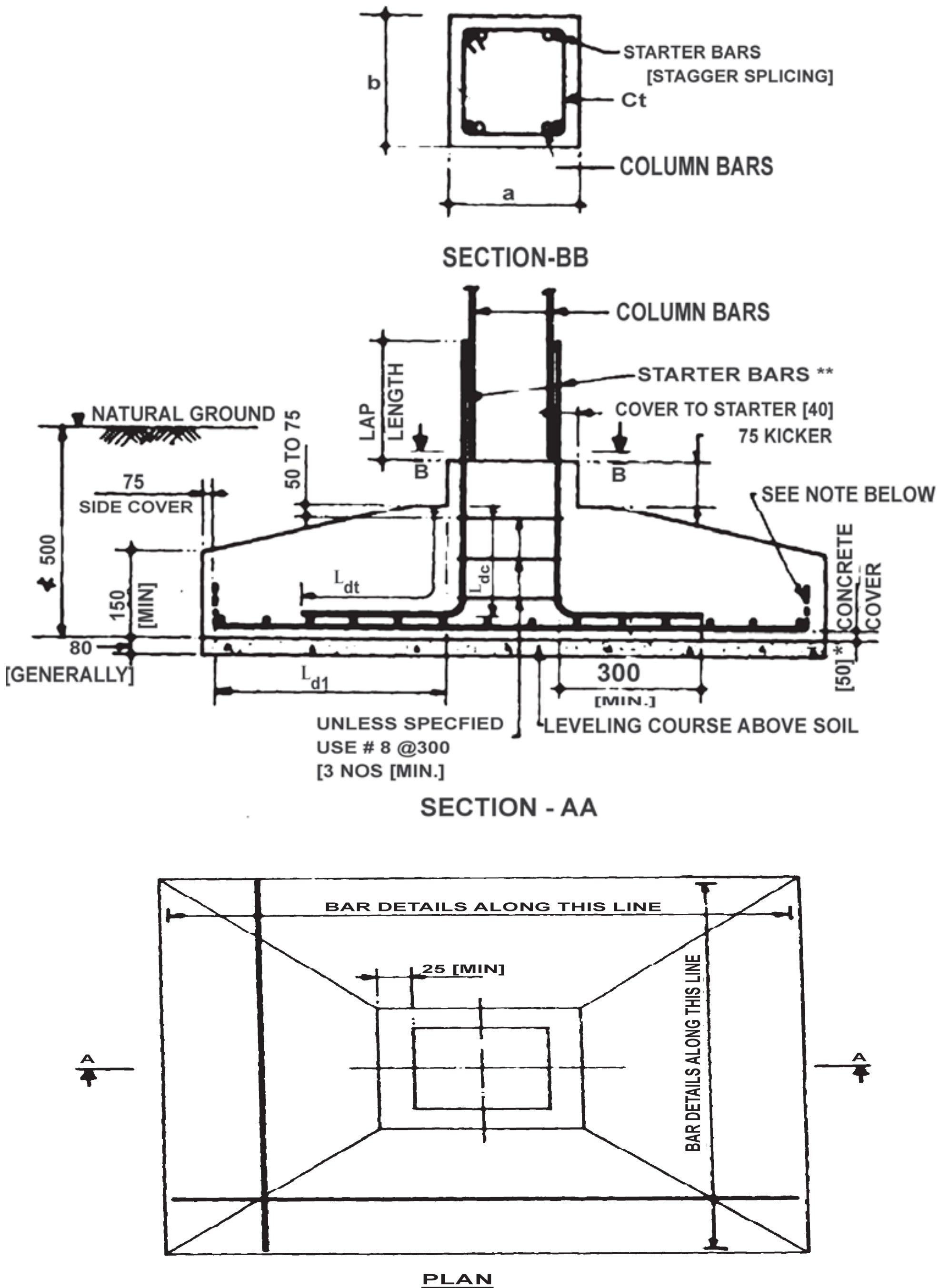
Max.width : 3.00 m

Max.liquid depth : 2.10 m

*Septic Tank Drawing is available in the Chapter 12 of this Hand Book

10. REINFORCEMENT DETAILS FOR STRUCTURAL ELEMENTS

10. REINFORCEMENT DETAILS FOR STRUCTURAL ELEMENTS



* Use starter bar or continous bars depend upon the distance between the first floor level on the level of foundation.

Note 1-Provide standard 90^0 bend,if the bar is required to be bent upwards to get the required development length

Note 2 -In case a pedestal is provided,the development length is to be considered from the top level of pedestal.

Figure. 1 Isolated footing Details

(Ref : fig 6.1 of SP 34 (S&T) - 1987)

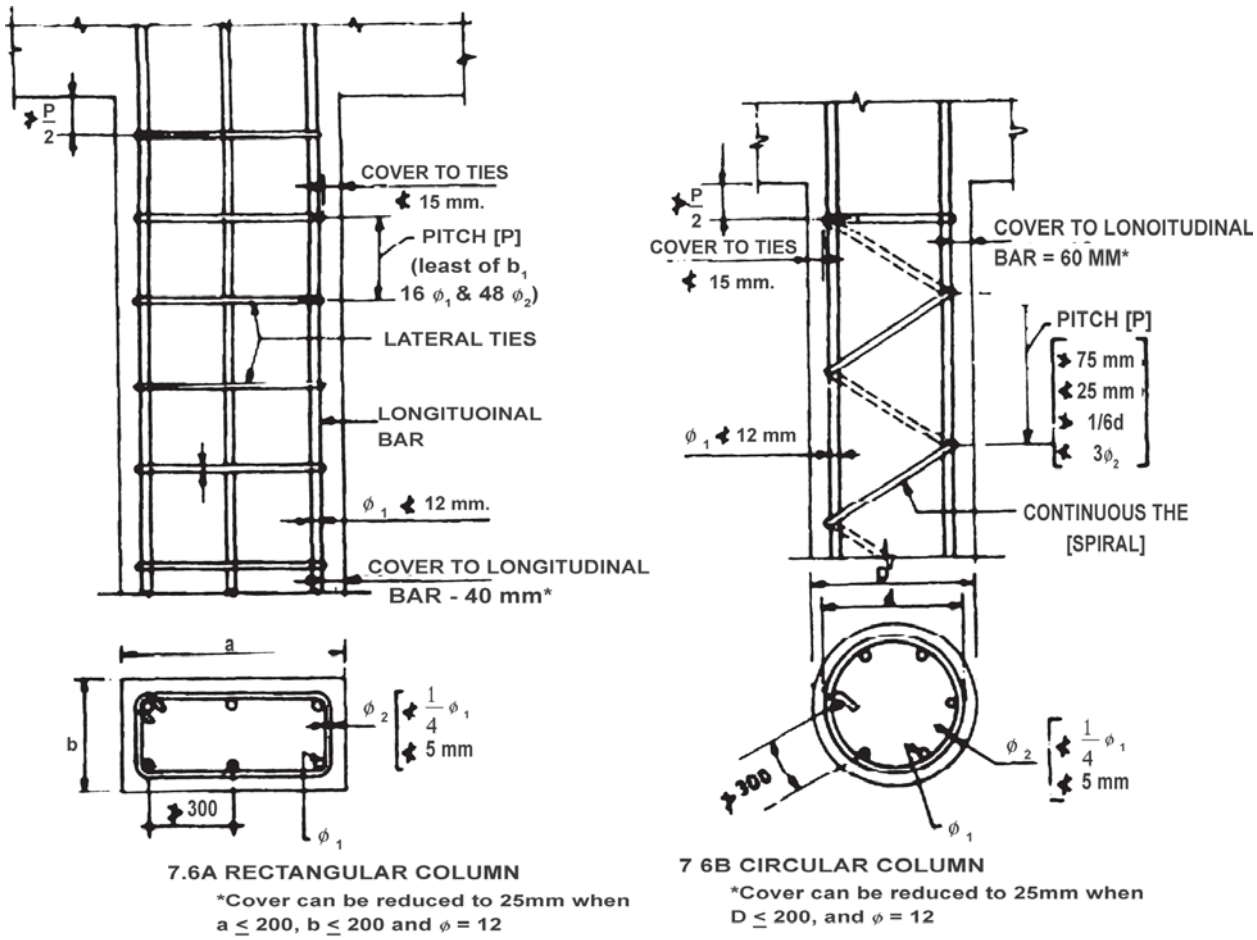


Figure.2 Column Reinforcement Details
(Ref : fig 7.6 of SP 34 (S&T) - 1987)

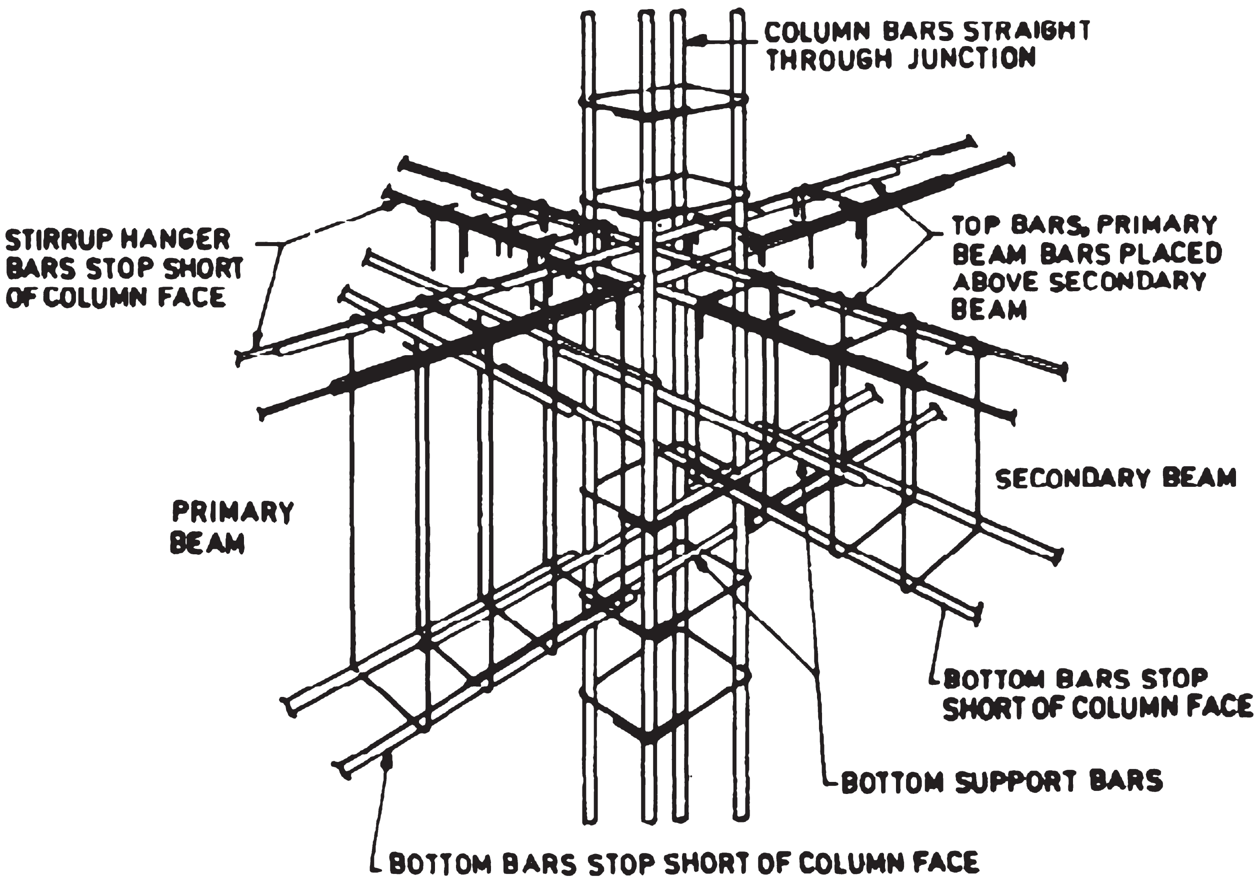
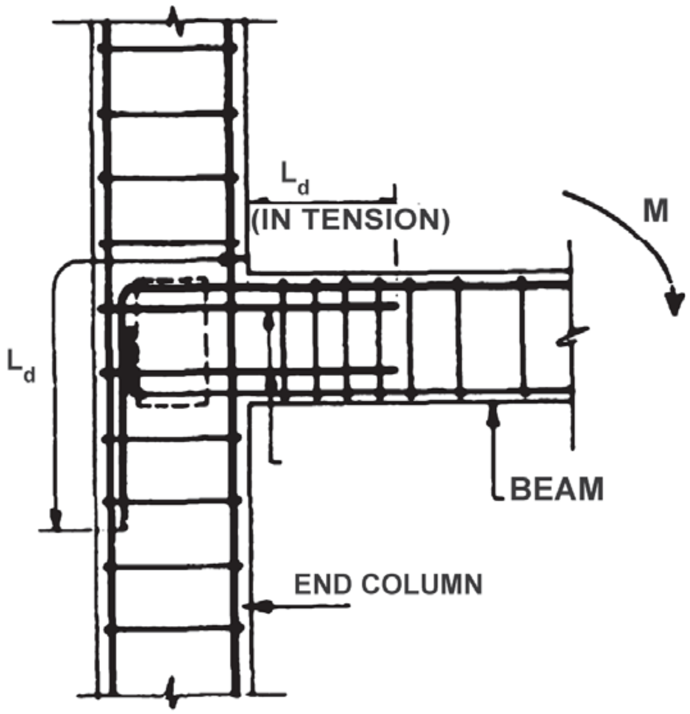
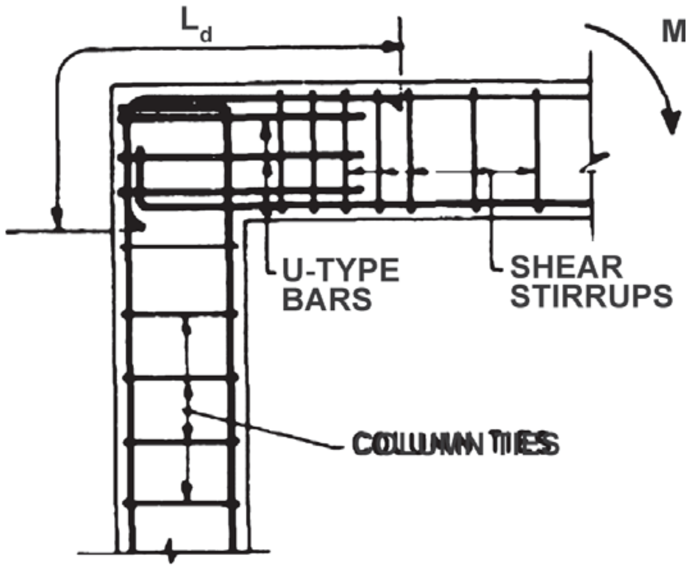


Figure.3 Beam- Column Joint Details
(Ref : fig 7.13 of SP 34 (S&T) - 1987)



Typical details of a beam Column Junction at exterior column
(Ref : fig 7.15 of SP 34 (S&T) - 1987)



Fixed end joint in a column

Figure.4 Beam- Column Joint Details
(Ref : fig 7.14 of SP 34 (S&T) - 1987)

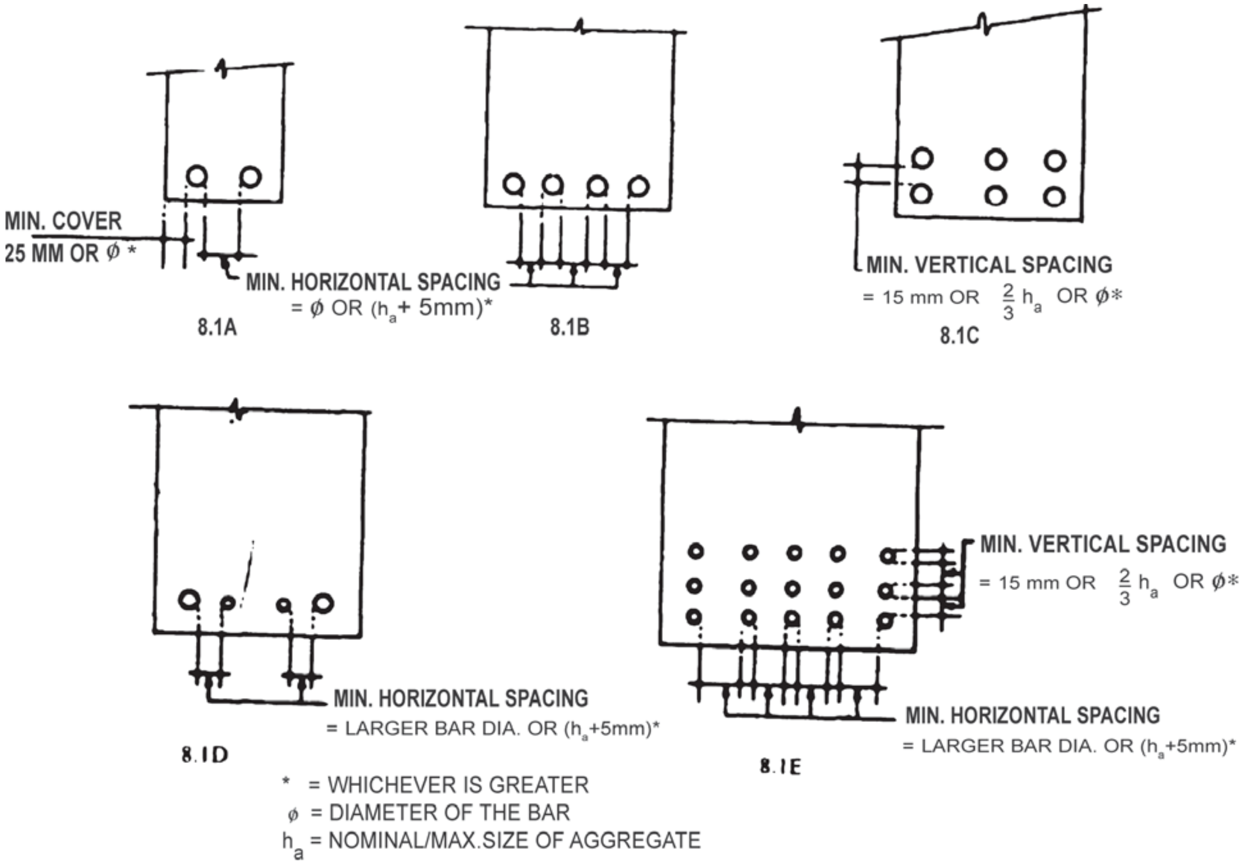
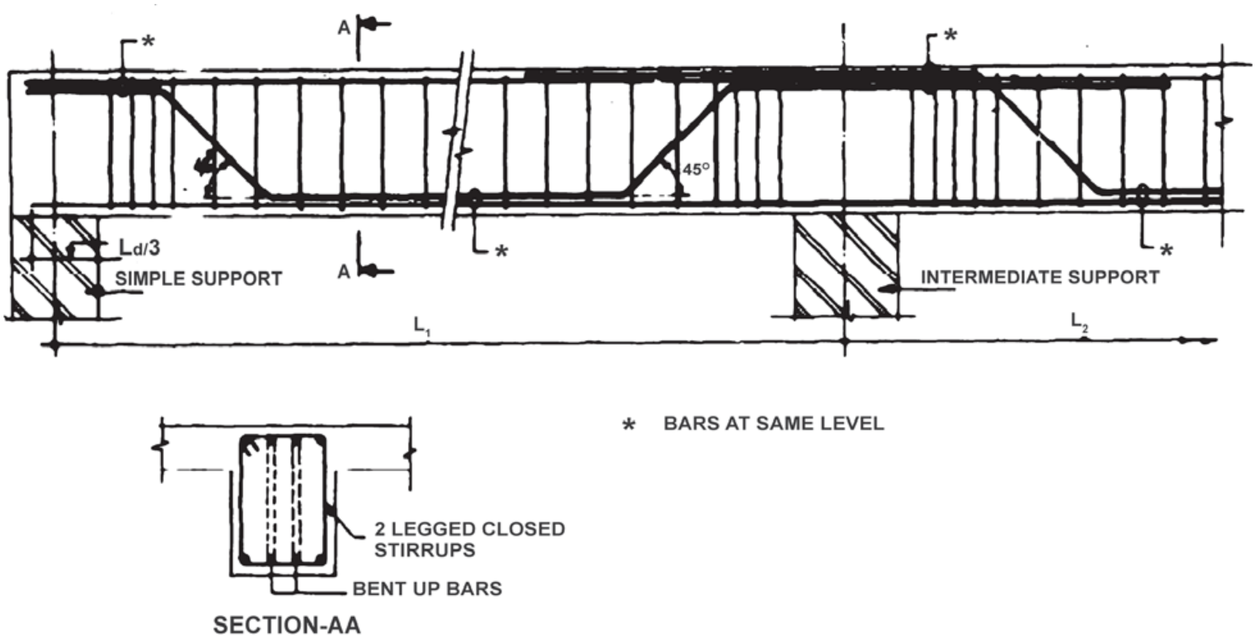


FIG. 8.1 MINIMUM CLEARANCE BETWEEN INDIVIDUAL BARS



8.7B TYPICAL ARRANGEMENT OF BENT UP BARS AND VERTICAL STIRRUPS IN A CONTINOUS BEAM

FIG 8.7 BENT-UP BARS

Figure.5 Beam Reinforcement Details

(Ref : fig 8.78 of SP 34 (S&T) - 1987)

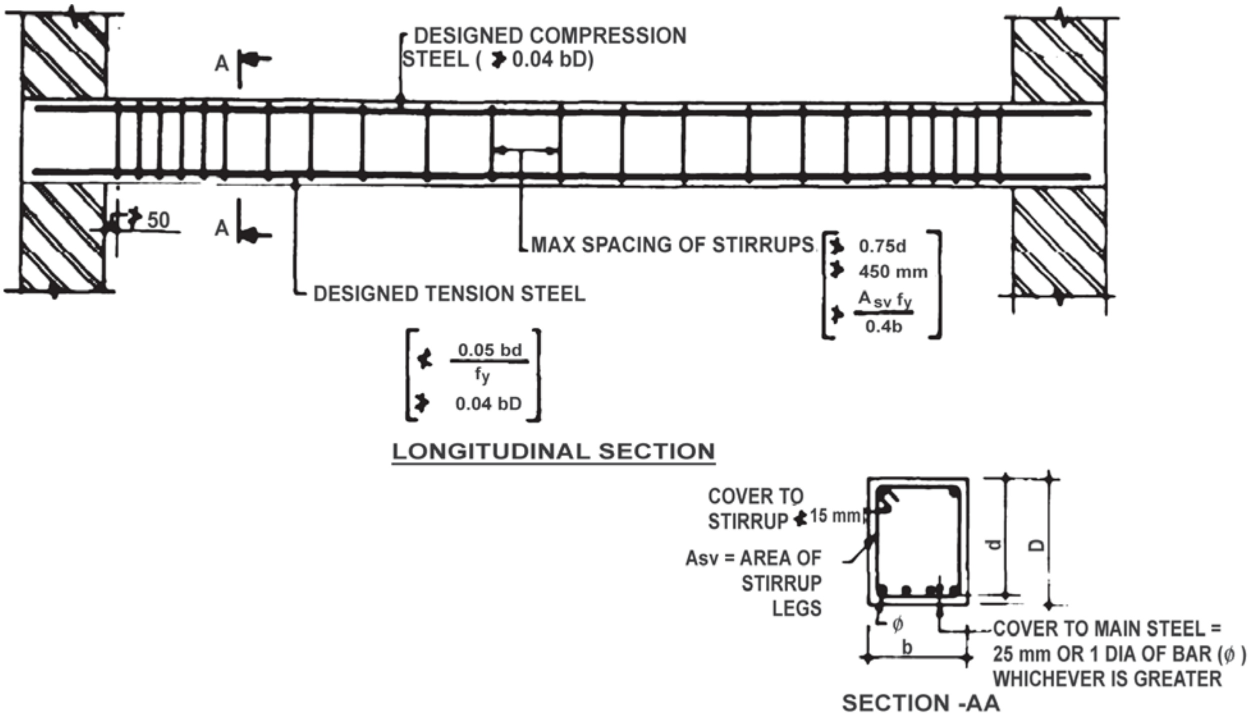


FIG. 8.11 REINFORCEMENT REQUIRMENTS FOR BEAMS

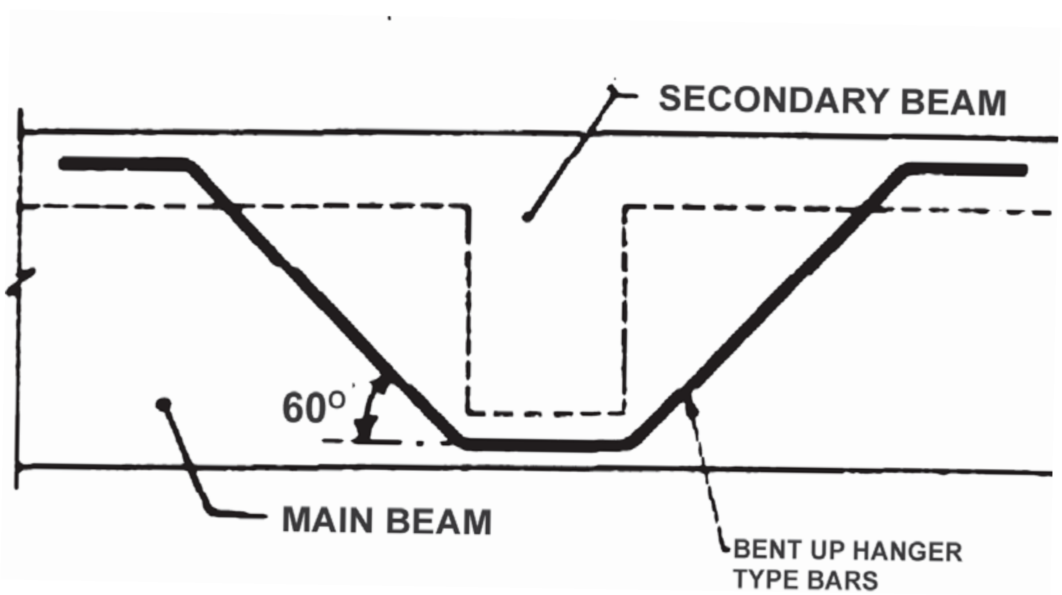
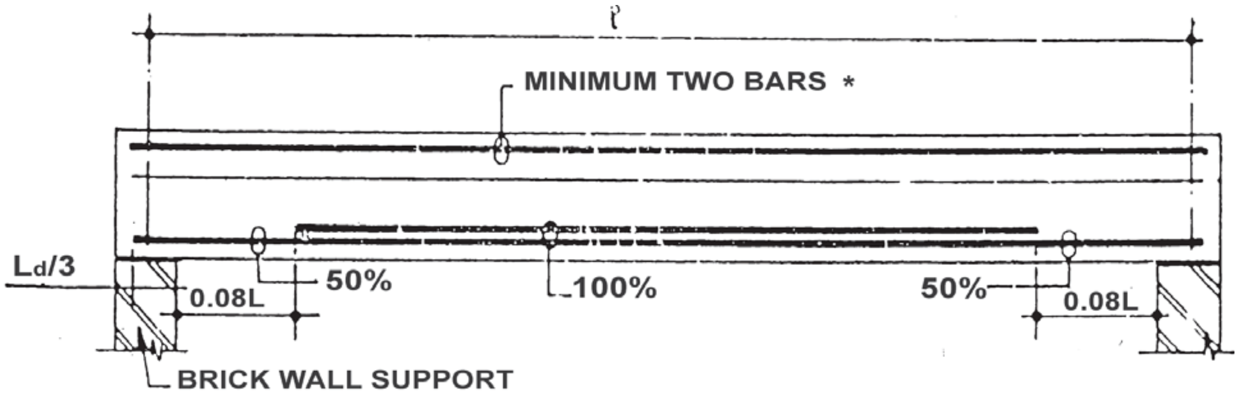


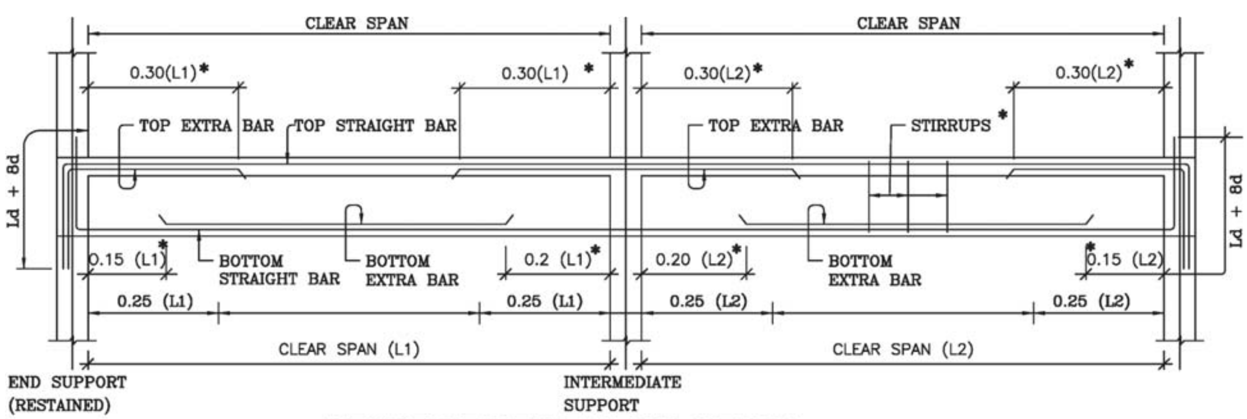
Figure.6 Beam Reinforcement Details
(Ref : fig 8.13 of SP 34 (S&T) - 1987)



*In case parcially restraint members 35 percent of the reinforcement shall also be provided for negative mombent at the support and fully anchored.

FIG. 20 SIMPLIFIED CURTAILMENT RULES FOR SIMPLY SUPPORTED BEAM

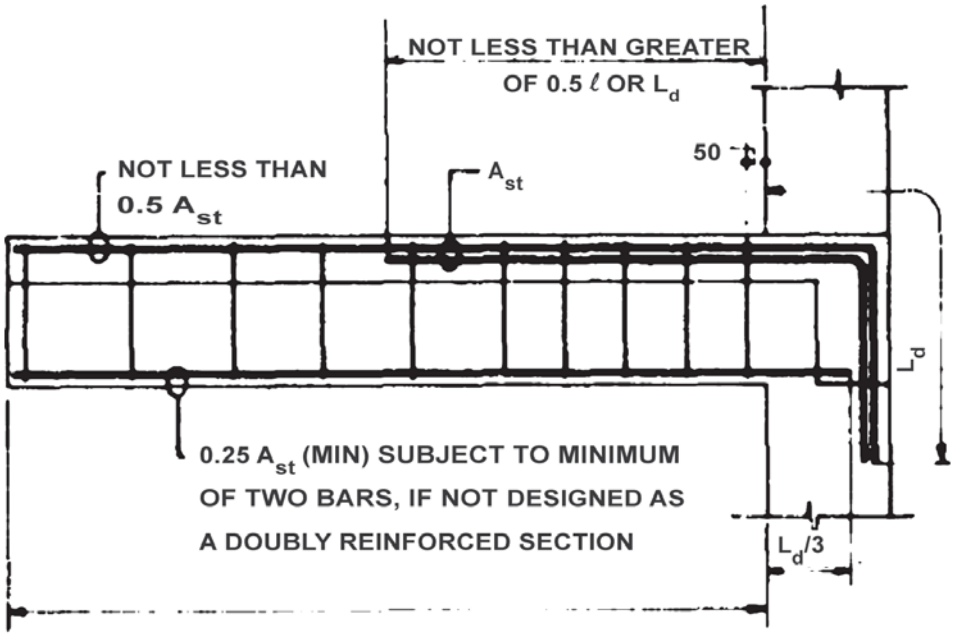
Figure.7 Simply Supported Beam Reinforcement Details (Ref : fig 8.16 of SP 34 (S&T) - 1987)



REINFORCEMENT IN BEAM

(* OR AS SHOWN IN SCHEDULE)
(Ld = LAP LENGTH IN TENSION)

Figure.8 Continuous Beam Reinforcement Details



8.17 A CANTILEVER BEAM PROJECTING FROM A COLUMN

Figure.9 Cantilever Beam Reinforcement Details
(Ref : fig 8.17A of SP 34 (S&T) - 1987)

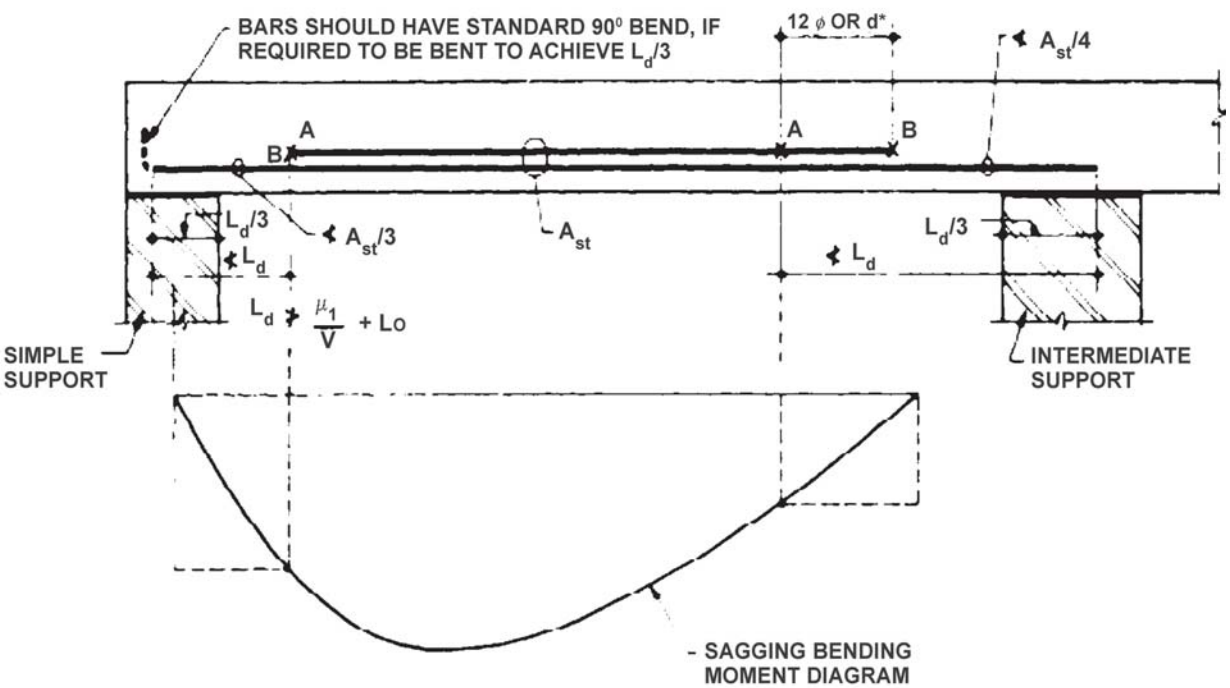
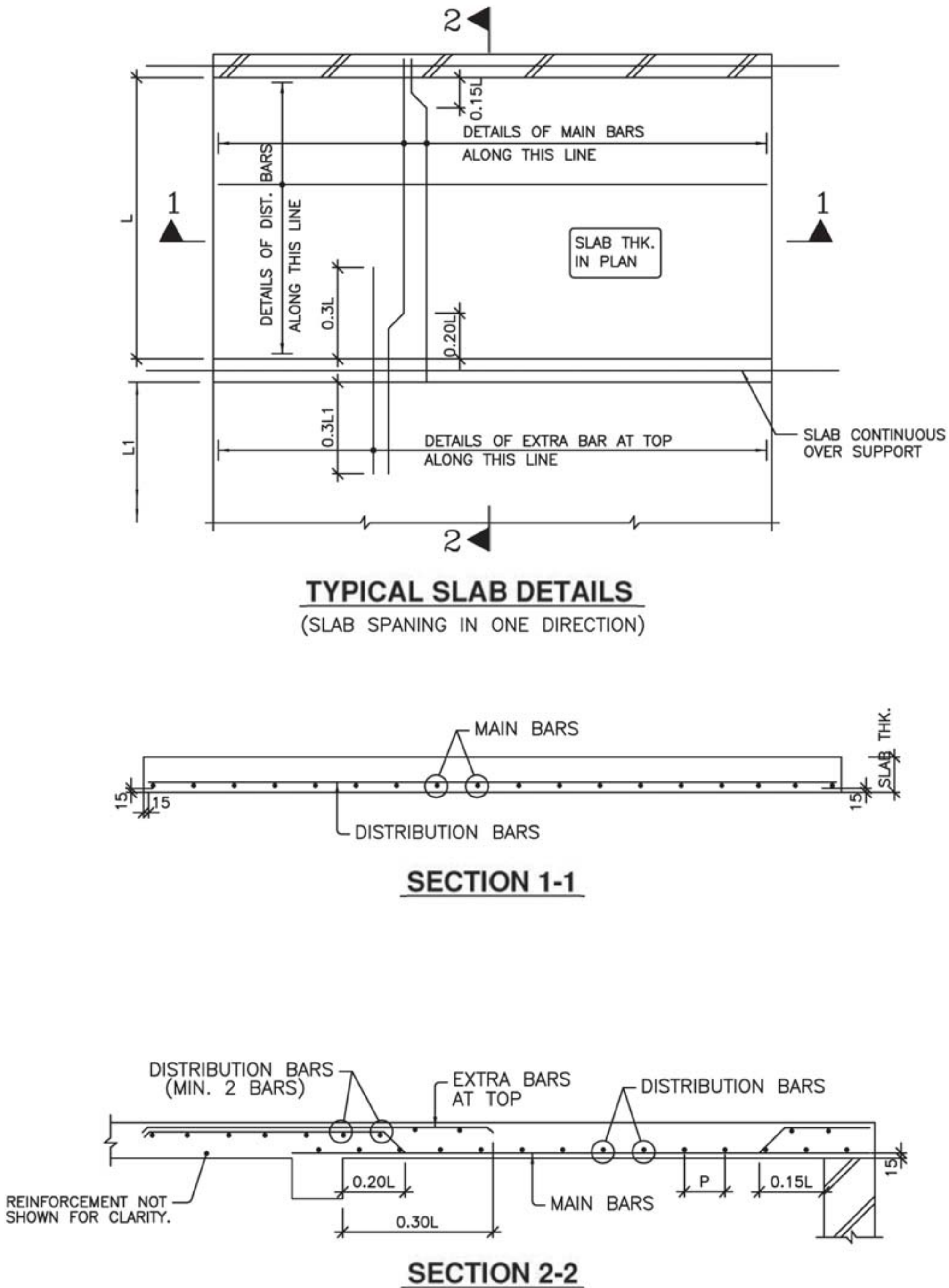


Figure.10 Slab Reinforcement Details
(Ref : fig 4.18 of SP 34 (S&T) - 1987)

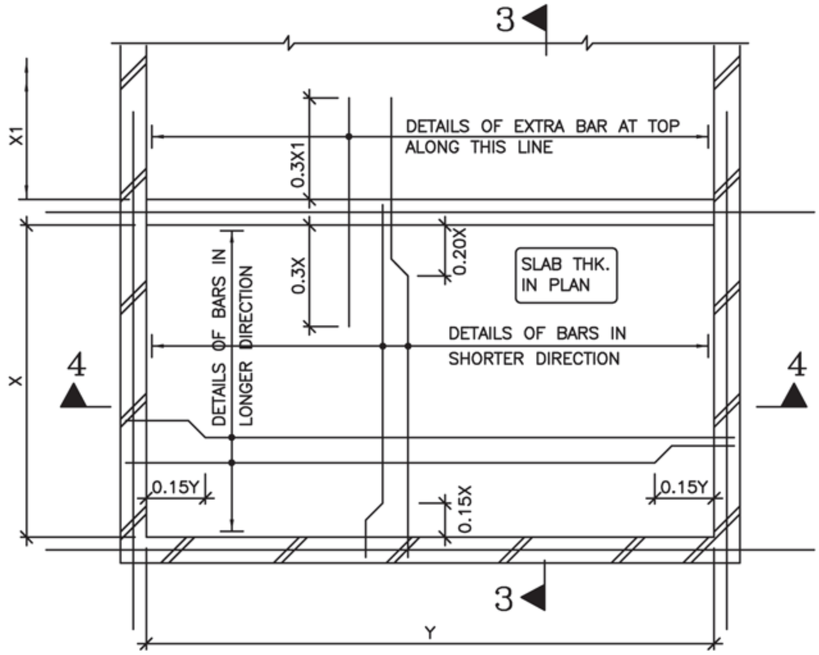


PLAN

Note 1. Diameter $\nless$ 8mm for deformed bars; 10mm for plain bars, Spacing $\ngtr$ 3d or 450mm

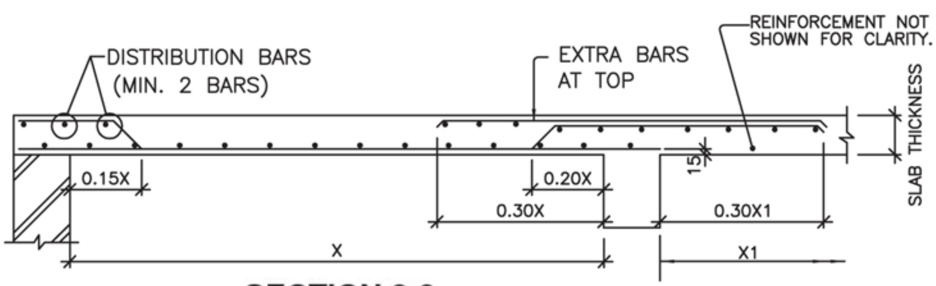
Note 2. Diameter $\nless$ 6mm; Spacing $\ngtr$ 5d or 450mm

Figure.11 One Way Slab Reinforcement Details

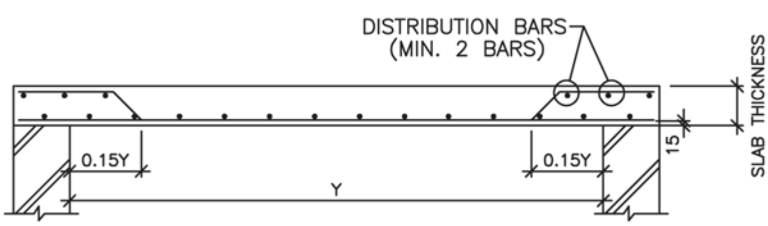


TYPICAL SLAB DETAILS

(SLAB SPANING IN TWO DIRECTION)



SECTION 3-3



SECTION 4-4

Figure.12 Two Way Slab Reinforcement Details

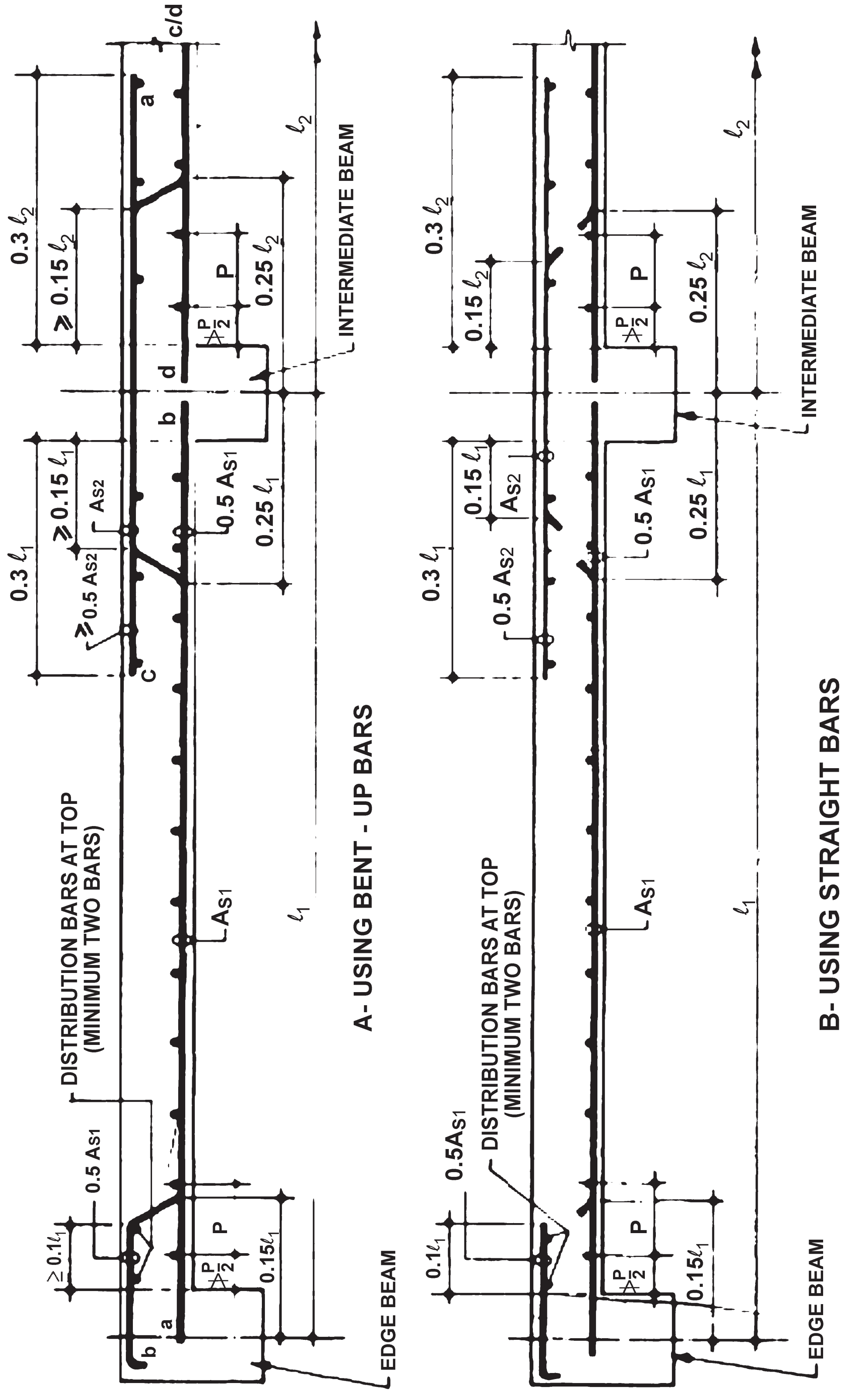


FIG 9.5 SIMPLIFIED RULES FOR CURTAILMENT OF BARS - SECTION THROUGH MIDDLE STRIP

Figure.12a Slab Reinforcement Details
(Ref : fig 9.5 of SP 34 (S&T) - 1987)

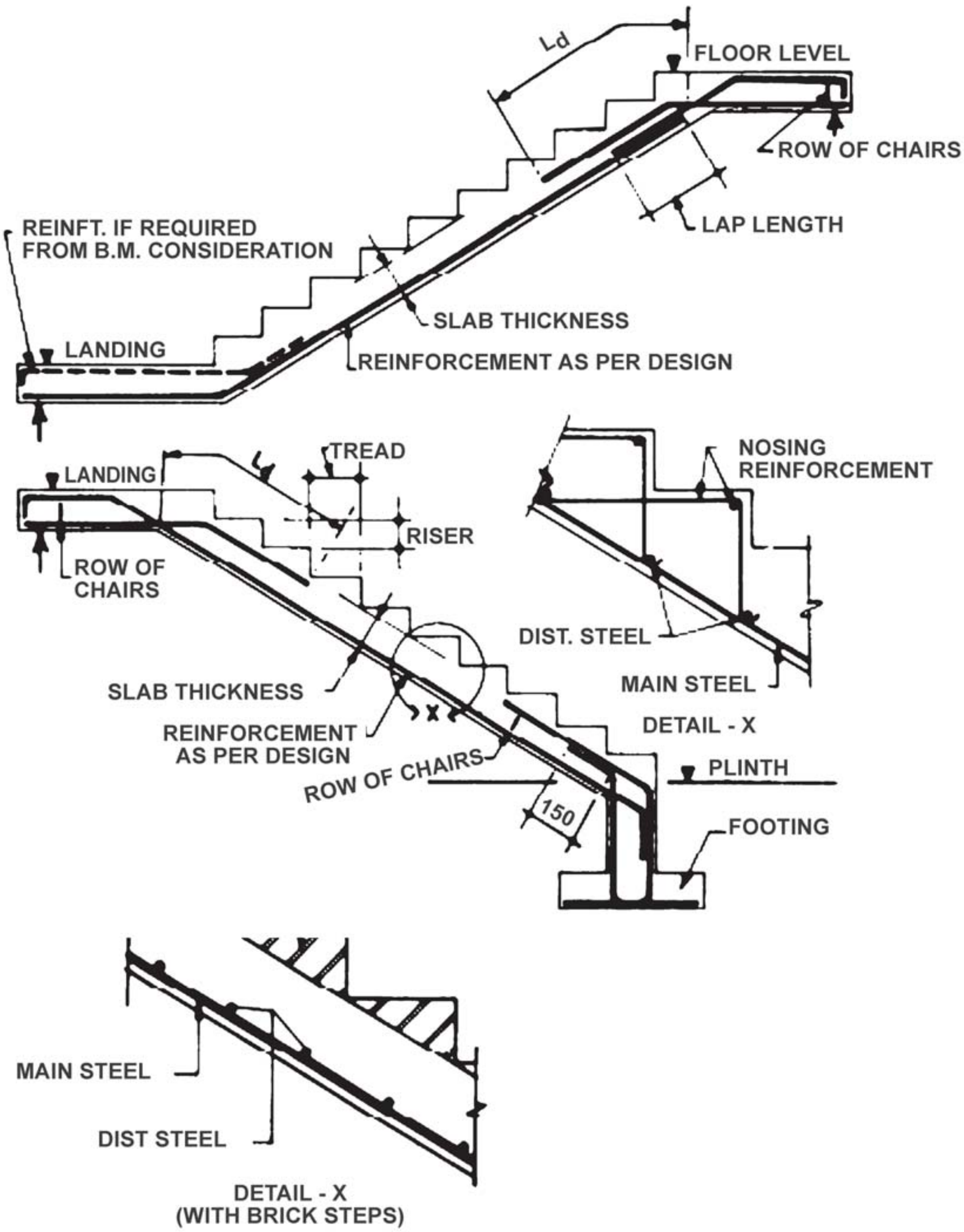


FIG. 10.3. STAIRS SUPPORTED AT ENDS OF LANDINGS - SHOWING POSITION OF MAIN REINFORCEMENT

Figure.13 Staircase Reinforcement Details
(Ref : fig 10.3 of SP 34 (S&T) - 1987)

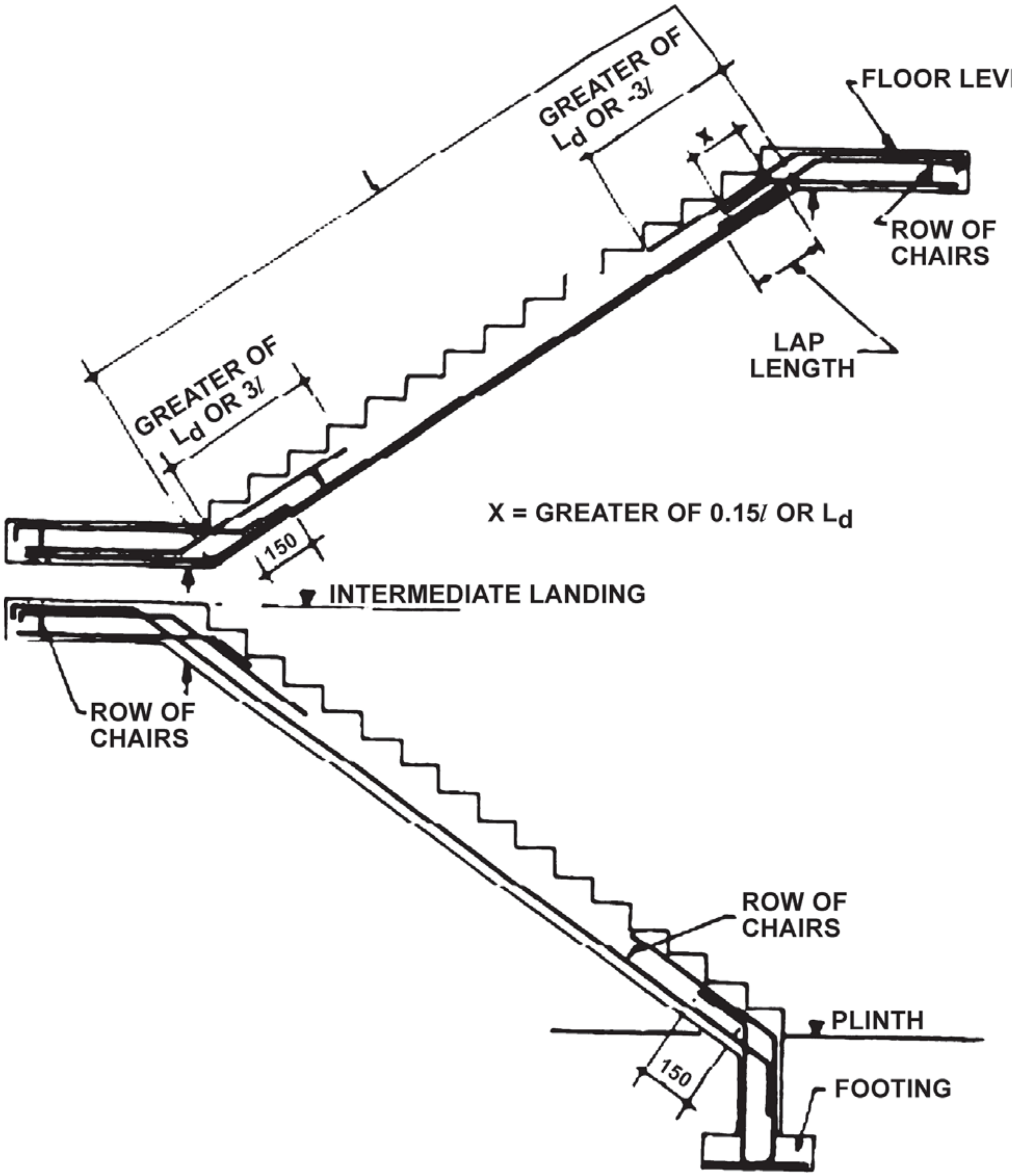


FIG 10.4 STAIRS SUPPORTED AT ENDS OF FLIGHTS - SHOWING MAIN REINFORCEMENT

Figure.14 Staircase Reinforcement Details
(Ref : fig 10.4 of SP 34 (S&T) - 1987)

11. TENDER ACT AND RULES

11.1. THE TAMIL NADU TRANSPARENCY IN TENDERS ACT, 1998

(TAMIL NADU ACT NO.43 OF 1998)

THE TAMIL NADU TRANSPARENCY IN TENDERS ACT, 1998

TAMIL NADU ACT NO.43 OF 1998

The following act of the Tamil Nadu Legislative Assembly received the assent of the President on the 11th December 1998 and is hereby published for general information:-

An Act to provide for transparency in the public procurement and to regulate the procedure in inviting and accepting tenders and matters connected therewith or incidental thereto.

WHEREAS to maximize economy and efficiency in Government procurement;

AND WHEREAS to foster and encourage effective participation by tenderers in the process of tenders;

AND WHEREAS to promote healthy competition among tenderers;

AND WHEREAS to provide for fair and equitable treatment of all tenderers;

AND WHEREAS it is expedient to eliminate irregularities, interference and corrupt practices in the matters relating to tender processes by providing transparency in such matters;

AND WHEREAS to promote the integrity of the process of tenders and to promote fairness and public confidence in the processing of tenders by ensuring transparency in the procedure relating to procurement;

Short title, extent and Commencement

Be it enacted by the Legislative Assembly of the State of Tamil Nadu in the Forty-ninth year of the Republic of India as follows:-

1. (1) This Act may be called the Tamil Nadu Transparency in Tenders Act, 1998.

(2) It extends to the whole of the State of Tamil Nadu.

(3) It shall come into force on such date[1] as the Government may, by notification, appoint.

1 1st day of October 2000 (*Vide G.O.Ms.No.445, Finance (Salaries) Department., dated 26th September 2000*)

Definitions :-

2. In this Act, unless the context otherwise requires,-

(a) '**Construction**' means all works associated with the construction, reconstruction, demolition, repair or renovation of a building, structure or any other related works;

[2](aa) **'domestic small scale industrial unit'** means an industrial unit in which the investment in fixed assets in plant and machinery, whether held in ownership or on lease or by hire purchase, does not exceed rupees one hundred lakhs, and which manufactures the goods within the State and registered with the Director of Industries and Commerce.

(b) '**Goods**' means raw materials, products, equipment and other objects of every kind and description and includes electricity;

(c) '**Government**' means the State Government;

(d) '**Procurement**' means acquisition by any means by purchase of goods or services and also of construction;

(e) '**procuring entity'** means the entity specified in the Schedule to this Act;

(f) '**Tender**' means the formal offer made in pursuance of an invitation by the procuring entity;

(g) '**Tender Bulletin'** means the bulletin published for each district or State, containing details of invitation and acceptance of tender;

(h) '**Tender Bulletin Officer'** means any officer appointed by the Government to publish the district or State Tender Bulletin;

(i) '**Tender Document'** means a set of papers containing schedule of works, rates, requirement of goods or services, technical specifications, procedure and criteria as may be prescribed for

2 This clause was inserted by section 2(1) of the Tamil Nadu Transparency in Tenders (Amendment) Act, 2001 (Tamil Nadu Act 14 of 2001) which came into effect on the 1st day of December 2001. [*G.O .Ms.No .451, Finance (Salaries) Dept. Dated 16th November 2001*]

evaluation and comparison of tenders and such other particulars as may be prescribed;

[1]"Provided that such criteria for evaluation and comparison of tenders shall also provide for a price preference, -

(a) not exceeding fifteen percent for the domestic small scale industrial units;

(b) not exceeding ten percent for the Public Sector Undertakings of the Government in respect of products and quantities manufactured by them."

Prohibition of Procurement except by tender :-

3.(1) No procurement shall be made by the procuring entity except by tender.

(2) The provisions of sections 9 and 10 shall not apply to any procurement made by a procuring entity, in the normal course, if it is for carrying on business of selling and buying goods; Provided that in case of procurement by the procuring entities on behalf of and for sale to Government or Government organisations for any Government programme, such procurement shall be only by tender.

Regulation of tenders :-

4. No tender shall be invited or accepted by any authority after the commencement of this Act, except in accordance with the procedure specified in this Act and the rules made there under.

Appoinment of tender bulletin officers :-

5. The Government may, by notification appoint,-

(a) an officer of the Government not below the rank of a Deputy Secretary to Government as State Tender Bulletin Officer[2];

(b) an officer not below the rank of a Deputy Collector as District Tender Bulletin Officer[3] for every district;

1 This proviso was added by section 2(i) of the Tamil Nadu Transparency in Tenders (Amendment) Act, 2001 (Tamil Nadu Act 14 of 2001) which came into effect on the 1st day of December 2001. [G.O.Ms.No.451, Finance (Salaries) Dept., Dated 16th November 2001]

2 The Director, Information and Public Relations was appointed as State Tender Bulletin Officer[Vide G.O.Ms.No.233,Finance(Salaries)Dept, dated 15th June, 2001].

3 The District Public Relation Officer attached to the Collector of every district was appointed as District Tender Bulletin Officer for respective districts [Vide G.O.Ms.No.447, Finance (Salaries) Dept., dated 26th September, 2000].

Functions of Bulletin officers :-

6.(1) On receipt of intimation relating to details of notice of invitation of Tender, from the Tender Inviting Authority, information relating to acceptance of tender together with a comparative analysis and reasons for acceptance of tenders from the Tender Accepting Authority, the State or as the case may be, the District Tender Bulletin Officer shall, publish the same in the State or District Tender Bulletin, as the case may be within such time as may be prescribed;

Provided that, if the procurement covers more than one district, the invitation and the acceptance of tenders shall be published in the State Tender Bulletin and also in the District Tender Bulletin of such districts.

(2) The Tender Bulletin shall be made available for sale in the office of the Tender Bulletin Officer and at such other places as may be specified by him.

Appointment of tender inviting authority and accepting authority:-

7. (1) The Government or the procuring entity, may, by order, appoint an officer under its control as Tender Inviting Authority for carrying out the functions assigned to it under this Act.

(2) The Government or the procuring entity, may, by order, appoint an officer or a committee consisting such number of officers as may be prescribed as Tender Accepting Authority for carrying out the functions assigned to it under this Act.

(3) Notwithstanding anything contained in sub-sections

(1) and (2), -

(a) where the Government is the Tender Accepting Authority, Tamil Nadu Government Business Rules shall be followed for tender acceptance ensuring adherence to the other provisions of this Act;

(b) where a Multi-member Tender Accepting Authority is discharging its functions under other Acts, such Multimember Authority shall be deemed to be Tender Accepting Authority under this Act.

Opening of tender :-

8. The Tender Accepting Authority or any other officer authorised by it, shall open the tenders in the presence of tenderers present and who have submitted tenders in such time and in such place as may be specified in the tender document;

Functions of tender inviting authority :-

9. (1) The Tender Inviting Authority shall invite tenders in the form of a notice containing such particulars as may be prescribed.

(2) The Tender Inviting Authority shall communicate the notice inviting tenders to the Bulletin Officers according to the value of the procurement and within such time as may be prescribed, so as to publish the same in the appropriate Tender Bulletin.

(3) The Tender Inviting Authority shall also publish the notice inviting tenders in Indian Trade Journal and in daily newspapers having wide circulation depending upon the value of the procurement prescribed.

(4) The Tender Inviting Authority shall supply the schedule of rates and tender documents in such manner and in such places as may be prescribed to every intending tenderer who has applied for such document.

Evaluation and acceptance of tender :-

10. (1) The Tender Accepting Authority shall cause an objective evaluation of the tenders taking into consideration the schedule of rates as mentioned in the tender document and the prevailing market rate for procurement and comparison of the tenders in accordance with the procedure and criteria specified in the tender document.

(2) After evaluation and comparison of tenders as specified in sub-section (1), the Tender Accepting Authority shall accept the lowest tender ascertained on the basis of objective and quantifiable factors specified in the tender document and giving relative weights among them.

(3) Notwithstanding anything contained in sub-section (2), if the Tender Accepting Authority decides that the price of the lowest tender is higher with reference to the prevailing market rate or the schedule of rates, he may negotiate for a reduction of price with that tenderer.

(4) If at any time before the acceptance of tender, the Tender Accepting Authority receives information that a tenderer who has submitted tender has been banned by any procuring entity, he shall not accept the tender of that tenderer even if it may be the lowest tender.

(5) In case where two or more tenderers quoted the same price, the Tender Accepting Authority shall split the procurement among such tenderers taking into consideration the experience and credentials of such tenderers. Where such splitting is not possible or could not be done equally, he shall record reasons for the same.

(6) If the Tender Accepting Authority proposes to accept the tender as per the provisions of this section, he shall pass orders accepting the tender together with reasons for such acceptance.

(7) The Tender Accepting Authority shall intimate the information regarding the name and address of the tenderer whose tender has been accepted along with the reasons for rejection of other tenders to the appropriate Tender Bulletin Officers.

Appeal :-

11. (1) Any Tenderer aggrieved by the order passed by the Tender Accepting Authority under section 10 may appeal to the Government within ten days from the date of receipt of order and the Government shall dispose the appeal within fifteen days from the date of receipt.

(2) In disposing of an appeal under sub-section (1), the Government may, after giving the party an opportunity of making his representations, pass such order thereon as they may deem fit.

(3) The order of the Government on such appeal shall be final.

(4) The Government may, pending the exercise of their powers under this

section pass such interlocutory orders as they may deem fit.

Right to reject tender :-

12. (1) After negotiation with the tenderer and before passing the order accepting a tender as under sub-section (6)of Section 10, if the Tender Accepting Authority decides that the price quoted by such tenderer is higher by the percentage as may be prescribed over the schedule of rates or prevailing market price, he shall reject the tender.

(2) The Tender Accepting Authority before passing the order accepting a tender, may also reject all the tenders for reasons such as changes in the scope of procurement, new technologies or

substantial design changes, lack of anticipated financial resources, court orders, accidents or calamities and other unforeseen circumstances.

Power to obtain information :-

13. Notwithstanding anything contained in this Act or in any other law for the time being in force, the Government may with a view to ensuring transparency in tender process, by order in writing, call for any information relating to transparency from the Tender Inviting Authority or from the Tender Accepting Authority on any matter in tender processing and the said Authority shall furnish the same to the Government.

Power of Government to call for records :-

14. The Government may at any time, with a view to ensuring transparency in tender process, require any authority,-

(a) to produce records relating to invitation and acceptance of tenders;

(b) to furnish the tender document, estimate, statement, accounts or statistics relating to such tenders; and

(c) to furnish any report.

Procedure to be followed in certain cases :-

15. The provisions of this Act to the extent they are not consistent with the procedure prescribed in the Projects funded by International Agreements or by International Financial Agencies shall not apply.

Provisions of this act not to apply in certain cases :-

16. The provisions of sections 9 and 10 shall not apply to procurement,-

(a) during natural calamities and emergencies declared by the Government;

(b) available from a single source only from a supplier or cases in which a particular supplier or contractor has exclusive rights in respect of the goods or services or construction and no reasonable alternative or substitute exists or where the procuring entity having procured goods, equipment, technology from a supplier or contractor determines that additional supplies must be procured from that specific supplier or contractor for reasons of standardization and compatibility with the existing goods, equipment or technology;

Provided that a committee of three experts consisting one technical representative of the procuring entity, one technical representative of a State or Central Government Organisation dealing with similar procurement and one representative from a reputed Academic or Research Institution or Non-commercial Institution having expertise in such line, declares it as single source procurement;

(c) from certain departments of Government, public sector undertakings, statutory boards and such other institutions only in respect of goods manufactured or services provided by them for a period not exceeding **eleven years**[1] from the date of commencement of this Act;

(d) of low value and local purchases as may be prescribed; [2](dd) from domestic small-scale industrial unit for the reserved items identified by the Central Government:

1 These words were substituted for the words "six years" by Section 2 of the Tamil Nadu Transparency in Tenders (Amendment) Act, 2006 (Tamil Nadu Act 28 of 2006) which came into effect on the 1st day of October 2006.(This provision of section 16 (c) was extended by the Government in two spells of two years each from 01.10.2002 and from 01.10.2004 i.e., upto 30.09.2006 by amendments issued to the Act in Gazette Notification No.757, dated 18.11.2002 and in Gazette Notification No.305, dated 09.12.2004)

2 This clause was inserted by section 3(a) of the Tamil Nadu Transparency in Tenders (Amendment) Act, 2001 (Tamil Nadu Act 14 of 2001) which came into effect on the 1st day of December 2001.

Provided that where a procuring entity intends to procure any of such reserved items, the procuring entity shall procure such item from the domestic small-scale industrial units and the provisions of section 9 and 10 shall apply to such procurement;

(e) from the rate contracts of Director-General of Supplies and Disposals and Association of State Road Transport Undertakings; and

(f) by spot purchase of cotton by Spinning Mills, Oil Seeds and Oils by Tamil Nadu Agro Industries Corporation or Tamil Nadu Cooperative Oil Seeds Growers' Federation Limited,

animals from shanties, Sugarcane by Sugar Mills, Paddy by direct purchase centres of the Tamil Nadu Civil Supplies Corporation, Clothing by Co-optex from registered Primary Weaver Co-operatives, Milk by Tamil Nadu Cooperative Milk Producers Federation from Districts and Primary Milk Co-operative Societies, Palm oil by Tamil Nadu Civil Supplies Corporation from Tamil Nadu Cooperative Oil Seeds Growers' Federation for Noon Meal Scheme, Clothing by Government Departments, Public Sector Undertakings and statutory departments from Co-optex and similar organisations and materials as may be **notified**[1] by Government.

[1]National Textile Corporation, Coimbatore has been notified for purchase of uniform cloth by Police Department [Vide G.O.Ms.No.179, Finance (Salaries) Dept., Dated: 17th May, 2002].

The Ordnance Factory and the Defence Research and Development Organisation of the Ministry of Defence, Government of India and the Bureau of Police Research and Development Organisation of the Ministry of the Home Affairs, Government of India have been notified for purchase of defence and security related items by Director General of Police. [Vide G.O.Ms.No.166, Finance (Salaries) Dept., Dated: 28th May, 2003].

The procurement of weaning food directly from Women's Industrial Cooperative Societies to the extent of 65% of the requirement or upto the optimum level that could be supplied by the said societies whichever is less and entrustment of work relating to stitching of school uniforms intended for free supply to school going children to the Women's Co-operative Tailoring Societies registered with the Director of Social Welfare as on the date of entrustment of work have been notified (Vide G.O.Ms.No.63, Finance (Salaries) Department, dated 16.2.2007).

The Tamil Nadu Salt Corporation Limited, Chennai has been notified for supply of Double Fortified Salt to all the Nutritious Meal Programme Centresin all the Districts so as to enable the Government to procure the entire quantity of Double Fortified Salt required for the Nutritious Meal Programme Centres under Puratchi Thalaivar MGR Nutritious Meal Programme.(Vide G.O.Ms.No.239, Finance (Salaries) Department, dated 12.06.2007)

The procurement of wooden and steel furniture including computer furniture from Tamil Nadu Small Industries Corporation Limited (TANSI), by the procuring entities under the Act, subject to the condition that Tamil Nadu Small Industries Corporation Limited (TANSI) shall effect the supplies within the time stipulated by the procuring entities has been notified (Vide G.O.Ms.No.401, Finance (Salaries) Department, dated 29.08.2007).

Entrustment of the work of redesigning the Perambur fly-over with the assistance of a suitable consultant to the Anna University, Chennai has been notified (Vide G.O.Ms.No.472, Finance (Salaries) Department, dated 01.10.2007).

Entrustment of works taken up under Namakku Naame Thittam to the contributors themselves on optional basis in respect of the works in which the Governmentcontribution is 50% or less in terms of the value of the work has been notified(Vide G.O.Ms.No.548, Finance (Salaries) Department, dated 14.11.2007).

Delhi Metro Rail Corporation Limited, a joint venture of Government of India and Government of Delhi, as Interim Consultants for a period of one year andsubsequently as Prime Consultants has been notified for Chennai Metro Rail Project (Vide G.O.Ms.No.45, Finance (Salaries) Department, dated 13.02.2008).

The procurement of indigenous coal by Tamil Nadu Electricity Board from the Public Sector Undertakings of Government of India at the prices as notified by the Government of India and import of coal through Central Public Sector Undertakings which have been in the business of importing coal and supplying to Government owned power utilities, at the price negotiated with the concerned Central Public Sector Undertakings or import of coal through Tamil Nadu Newsprint and Papers Limited, procured by means of competitive bidding, without prejudice to the right of Tamil Nadu Electricity Board to procure imported coal through competitive bidding as per the TNTIT Act has been notified (Vide amendment to notification issued in G.O Ms No.417,Finance (Salaries)Department, dated 28.08.2009 to the notification issued in G.O.Ms.No.172, Finance (Salaries) Department, dated 28.04.2008).

The award of execution of works by the Tamil Nadu Electricity Board under Rajiv Gandhi Grameen Vidyutikaran Yojana in 26 districts of Tamil Nadu and all future works under Rajiv Gandhi Grameen Vidyutikaran Yojana to M/s.Tamil Nadu Small Industries Corporation, a Government of Tamil Nadu Undertaking on total turnkey contract basis has been notified (VideG.O.Ms.No.242, Finance (Salaries) Department, dated 16.06.2008).

The procurement of services of training by Government Departments and other procuring entities under the said Act from the State Government and the Government of India Educational and Training Institutes and the Universities established by the State and Central Government has been notified (VideG.O.Ms.No.437, Finance (Salaries) Department, dated 07.10.2008).

The procurement of milk and milk products from the Tamil Nadu Cooperative Milk Producers Federation (Aavin) and controlled essential commodities such as Rice, Wheat, Sugar, Rava and Maida from the Tamil Nadu Civil Supplies Corporation Limited by the Prison Department subject to the condition that the said corporation shall supply Rice at above poverty line rate fixed by the Government of India has been notified (VideG.O.Ms.No.483, Finance (Salaries) Department, dated 11.11.2008) .

The appointment of the Centre of Environmental Studies, Anna University, Guindy, Chennai-600 025 as the consultant for a period of 4 months to assess the Environmental Impact to the new complex for the Tamil Nadu Legislative Assembly to be constructed by the Public Works Department has been notified (Vide G.O.Ms.No.500, Finance (Salaries) Department, dated 19.11.2008) .

The award of construction of the Dairy-cum-powder plant with a capacity of 2.00 Lakhs Litre per day with 20 metric tonnes of powder plant at Thiruvannamalai on turnkey basis to the National Dairy Development Board by the Commissioner for Milk Production and Dairy Development has been notified (Vide G.O.Ms.No.540, Finance (Salaries) Department, dated 18.12.2008). The appointment of the Tamil Nadu Urban Infrastructure Financial

Services Limited as consultant to render advice to the Tourism and Culture Department for the “Miniature Tamil Nadu” project till the completion of the works has been notified (Vide G.O.Ms.No.4, Finance (Salaries) Department, dated 06.01.2009.

The procurement of provision of Common User Group Mobile Phone services from Bharat Sanchar Nigam Limited (BSNL) by the Tamil Nadu Police Department has been notified (Vide G.O.Ms.No7, Finance (Salaries) Department, dated 07.01.2009).

The entrustment of the project on Geographical Information System (GIS) by the Public (Elections-II) Department for electoral Rolls updation, rationalization of Polling Stations as per the terms and conditions of the orders issued in Government Order Ms No. 88, Public(Elections-II) Department, dated 22.01.2009 in all the districts of Tamil Nadu except Thiruvallur district to the Bharathidasan University, Tiruchirappalli has been notified (Vide G.O.Ms.No73, Finance (Salaries) Department, dated 23.02.2009).

The procurement of groceries (other than the commodities viz., Rice, Wheat. Sugar, Rava and Maida notified in the Government Order Ms. No.483, Finance(Salaries) Department, dated 11.11.2008) and vegetables required by the Prison Department directly from the Co-operative Societies has been notified (Vide G.O.Ms.No 115, Finance (Salaries) Department, dated 24.03.2009).

The appointment of the Tamil Nadu Road Development Company Limited (TNRDC) as the Managing Associate, for the work of calling for tenders and coordination of the execution of works during the period of construction of Outer Ring Road from Vandalur to Nemilichery under Build, Operate and Transfer - Annuity basis, as per the terms and conditions laid down in paragraph 5 of G.O.Ms.No.32, Highways and Minor Ports (HF2) Department, dated 25.02.2009 has been notified (Vide G.O.Ms.No 116, Finance (Salaries) Department, dated 24.03.2009) .

The spot purchase of domestically produced Toor Dhal from the production centres by the Tamil Nadu Civil Supplies Corporation (TNCSC) for the Public Distribution System till 30.06.2009 has been notified (Vide G.O.Ms.No 142, Finance (Salaries) Department, dated 13.04.2009).

The procurement of coal by the Tamil Nadu Cements Corporation Limited either from the Tamil Nadu Electricity Board or from the Tamil Nadu Newsprint and Papers Limited whichever is advantageous has been notified (Vide G.O.Ms.No 179, Finance (Salaries) Department, dated 04.05.2009) .

The procurement of khaki cloth, white poplin cloth, blue casement cloth and blue half saree cloth by the Director of Handloom and Textiles required for the free supply of uniforms to the beneficiaries covered under Puratchi Thalaivar M.G.R Nutritious Meal Programme from the Tamil Nadu Textile Corporation, subject to the condition that the procurement will be restricted to the said categories of cloth which are actually produced by the mills owned by the Tamil Nadu Textile Corporation has been notified (Vide G.O.Ms.No.181 Finance (Salaries) Department, dated 05.05.2009).

The procurement of provision of Common User Group Mobile Phone services from Bharat Sanchar Nigam Limited(BSNL) by the Tamil Nadu Forest Department has been notified (Vide G.O.Ms.No302, Finance (Salaries) Department, dated 17.07.2009).

The appointment of the “Indian National Trust for Art and Cultural Heritage” (INTACH) as the consultant to render Consultancy, Monitoring and Supervising Services for the Tranquebar Development Project has been notified (Vide G.O.Ms.No303, Finance (Salaries) Department, dated 17.07.2009)

The procurement of provision of Common User Group mobile phone services from Bharat Sanchar Nigam Limited(BSNL) by the Tamil Nadu Fire and Rescue Services Department has been notified (Vide G.O.Ms.No403, Finance (Salaries) Department, dated 24.08.2009).

The Tamil Nadu Urban Infrastructure Financial Services Limited has been notified as optional consultancy providing/procuring agency, subject to the condition that in each case, Government will fix the consultancy fee, wherein the Tamil Nadu Urban Infrastructure Financial Services Limited itself carries out the consultancy and service charges, in case external consultancy is procured by the Tamil Nadu Urban Infrastructure Financial Services Limited(Vide G.O.Ms.No.484, Finance (Salaries) Department, dated 06.10.2009).

The entrustment of Rapid Environmental Impact Assessment Studies to the Centre for Environmental Studies, Anna University, Chennai- 25 on nomination basis in connection with the formation of flood carrier canal from Kannadian Channel to drought prone areas of Sathankulam and Thisaiyanvilai by inter-linking Thamirabarani, Karumeniyar and Nambiyar Rivers in Tirunelveli and Thoothukudi Districts has been notified (Vide G.O.Ms.No.561, Finance (Salaries) Department, dated 22.12.2009).

The New Tirupur Area Development Corporation Limited(NTADCL) has been notified as the Consultant for preparation of Detailed Project Report for Water Supply Improvement Schemes and Sewerage Works and Project Management Consultancy in respect of Tirupur Corporation (Vide G.O.Ms.No.77, Finance (Salaries) Department, dated 11.03.2010).

The entrustment of the improvement work of auditoriums and formation of mini auditoriums for the conduct of World Tamil Classical Language Conference to Coimbatore District Small Scale Industries Association (CODISSIA) Intec Technology Centre, Coimbatore, subject to the conditions laid down in para 9 of the G.O (Ms) No.119, Tamil Development, Religious Endowments and Information Department, dated 13.04.2010, has been notified (Vide G.O.Ms.No 125, Finance (Salaries) Department, dated 30.04.2010).

The entrustment of the preparation of Three Master Plans for Mamallapuram Local Planning Area, Ariyalur Local Planning Area and Sriperumbudur New Town Development Area using Geographical Information System(GIS) to the Institute of Remote Sensing, Anna University, Guindy, Chennai under IKONOS/Quick Bird Method has been notified (Vide G.O.Ms.No.220, Finance (Salaries) Department, dated 28.07.2010)

The procurement of 2.0 lakh tonnes fine variety of boiled rice from Andhra Pradesh State Civil Supplies Corporation procured from the millers of Andhra Pradesh at the levy rate fixed by the Government of India, by the Tamil Nadu Civil Supplies Corporation for the Public Distribution System(PDS) has been notified (Vide G.O.Ms.No.221, Finance (Salaries) Department, dated 28.07.2010).

The procurement of the services of Bharat Sanchar Nigam Limited (BSNL) for telecom solutions such as provisions of Landline, ISDN,PRI and 100 Mbps Internet leased line at Anna Centenary Library, Kotturpuram, Chennai by the Director of Public Libraries has been notified (Vide G.O.Ms.No.363, Finance (Salaries) Department, dated 15.09.2010).

The appointment of Dr A.R.Santhakumar (Retired Professor of Anna University) as a consultant on nomination basis to study the safety of the Mullai Periyar Main Dam and Baby Dam and their resistance to earthquake, using 3 Dimensional Finite Element Method has been notified (Vide G.O.Ms.No.393,Finance (Salaries) Department, dated 13.10.2010).

The entrustment of the work of transportation of Electronic Voting Machines (EVMs) from Uttar Pradesh to Tamil Nadu by rail to the Container Corporation of India Limited (CONCOR) has been notified (Vide G.O.Ms.No.12, Finance (Salaries) Department, dated 07.01.2011).

The appointment of Confederation of Indian Industries (CII) as State Consultant for the implementation of "Employable Skill Training to the Unemployed Educated Youth Scheme" of Labour and Employment Department has been notified (Vide G.O.Ms.No.47, Finance (Salaries) Department, dated 15.02.2011).

The entrustment of the preparation of Detailed Project Report(DPR) in respect of second phase of Chennai Metro Rail Project to the Delhi Metro Rail Corporation(DMRC) has been notified (Vide G.O.Ms.No.55, Finance (Salaries) Department, dated 24.02.2011).

The appointment of M/s Wipro Limited as Implementing Agency in the State Portal and State Services Delivery Gateway (SSDG) has been notified (Vide G.O.Ms.No.56, Finance (Salaries) Department, dated 24.02.2011).

The entrustment of the work of providing Broadband connectivity to Polling Stations, Internet leased line connectivity to the office of Chief Electoral Officer, District Election Officers and Returning Officers, purchase of SIM cards and any other similar services required to be provided as per the directions of the Election Commission of India for the ensuing General Elections to Tamil Nadu Assembly, 2011 to M/s Bharat Sanchar Nigam Limited(BSNL) has been notified(Vide G.O.Ms.No.97, Finance (Salaries) Department, dated 28.03.2011).

The appointment of National Institute of Oceanography (NIO) and National Environmental Engineering Research Institute (NEERI) to take up Environmental Impact Assessment Study (EIA) for disposal of the effluents from textile dyeing units under the Marine Discharge Project has been notified (Vide G.O.Ms.No.142, Finance (Salaries) Department, dated 19.05.2011).

The procurement of gold coins from Public Sector Banks/State Bank of India and its Associates by the Director of Social Welfare for providing 4 (four) grams of 22 ct. (twenty two carat) gold at "free of cost" for making "Thirumangalyam" to the beneficiaries under the following marriage assistance schemes, namely:-

1. "Moovalur Ramamirtham Ammaiyar Ninaivu Marriage Assistace Scheme.
2. Dr.Dharmambal Ammaiyar Ninaivu Widow Remarriage Assistance Scheme.
3. E.V.R. Maniammaiyar Ninaivu Marriage Assistance Scheme for Daughters of poor widows.
4. Annai Theresa Ninaivu Marriage Assistance Scheme for Orphan Girls and
5. Dr.Muthulakshmi Reddy Ninaivu Inter-Caste Marriage Assistance Scheme". has been notified (Vide G.O.Ms.No.190, Finance (Salaries) Department, dated 12.07.2011).

The entrustment of work to M/s Health Sprint Networks Private Limited, Chennai for providing software solution and the following trained manpower through outsourcing as an interim arrangement till the implementation of Comprehensive Health Insurance Scheme:-

(a) Doctors for preauthorisation and claim process - 20 Numbers.
(b) Accounts Manager and Accounts Executive for claim settlement-3 Numbers.
(c) Claim Validators – 2 Numbers.
(d) MIS Specialist for reporting – 1 Number.
(e) IT Support Staff – 1 Number.
(f) Call centre team for providing customer support – 2 Numbers.
(g) Manager for overall management of preauthorisation and claim process –1 No. has been notified (Vide G.O.Ms.No.207,Finance (Salaries) Department, dated 29.07.2011).

The engagement of Pallavan Transport Consultancy Services Limited for the preparation of Feasibility Study on Mono Rail Project in Chennai has been notified (Vide G.O.Ms.No.216,Finance (Salaries) Department, dated 05.08.2011).

The entrustment of the wave tranquility model studies of Colachel Fishing Harbour to Central Water and Power Research Station, Pune for the construction of Fishing Harbour at Colachel in Kanniyakumari District has been notified (Vide G.O.Ms.No.227,Finance (Salaries) Department, dated 25.08.2011).

16. (g) [1] of cement from the Tamil Nadu Cement Corporation Limited, or of paper from the Tamil Nadu Newsprints and Papers Limited: Provided that**,—**

(a) a committee consisting of the Secretary to Government, Industries Department, the Secretary to Government, Finance Department and the Chairman-cum-Managing Director or the Managing Director, Tamil Nadu Cement Corporation Limited shall determine the price of cement to be procured;

(b) the price of paper shall be negotiated with the Tamil Nadu Newsprints and Papers Limited by the procuring entity."

Officers deemed to be Public servants :-

17. Every Officer acting under or in pursuance of the provisions of this Act or rule or order or notification made there under, shall be deemed to be public servant within the meaning of section 21 of the Indian Penal Code.

Indemity :-

18. No suit or other legal proceeding shall lie against the Government or any officer or authority of the Government in respect of anything which is in good faith done or intended to be done.

Bar of Jurisdiction :-

19. Save as otherwise provided in this Act no order passed or proceeding taken by any officer or authority under this Act shall be called in question in any court, and no injunction shall be granted by any court in respect of any action taken or to be taken by such officer or authority in pursuance of any power conferred by or under this Act.

Act to over ride other laws :-

20. The provisions of this Act shall have effect notwithstanding anything inconsistent therewith contained in any other law for the time being in force or any custom or usage or agreement or decree or order of a Court or a Tribunal or other Authority.

1 This clause was added by section 3(b) of the Tamil Nadu Transparency in Tenders (Amendment) Act, 2001 (Tamil Nadu Act 14 of 2001) which came into effect on the 1st day of December 2001.

Power to remove difficulties :-

21. If any difficulty arises in giving effect to the provisions of this Act, the Government may, by an order published in the *Tamil Nadu Government Gazette*, make such provisions, not inconsistent with the provisions of this Act as appear to them to be necessary or expedient for removing the difficulty[2]

Power to make rules :-

22. (1) The Government make rules for carrying out the purposes of this Act.

(2) (a) All rules made under this Act shall be published in the *Tamil Nadu Government Gazette* and unless they are expressed to come into force on a particular day, shall come into force on the date on which they are so published.

(b) All notifications issued under this Act shall, unless they are expressed to come into force on a particular day, come into force on the day on which they are published.

(3) Every rule made or notification or order issued under this Act shall, as soon as possible, after it is made or issued, be placed on the table of the Legislative Assembly; and if, before the expiry of the session in which it is so placed or the next session, the Assembly makes any modification in any such rule or notification or order, or the Assembly decides that the rule or notification or order should not be made or issued , the rule or notification or order shall thereafter have effect only in such modified form or to be of no effect, as the case may be, so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule or notification or order.

23. All the existing rules, regulations, departmental codes, manuals, orders shall so far as they are not inconsistent with the provisions of this Act and the rules made there under, continue in force.

2 ["Provided that no such order shall be made after the expiry of a period of two years from the date of commencement of this Act".] This proviso was omitted by Section 3 of the Tamil Nadu Transparency in Tenders (Amendment) Act, 2002 (Tamil Nadu Act 43 of 2002) which came into effect on the 30th day of September 2002

THE SCHEDULE

[See Section 2 (e)]

Procuring Entity

1. Government Departments.
2. Public Sector Undertakings of the Government.
3. Statutory Boards formed by the Government.
4. Local Bodies in the State.
5. Co-operative Institutions in the State.
6. Universities.
7. Societies formed by the Government

MANUSCRIPT SERIES

FINANCE (SALARIES) DEPARTMENT

G.O.Ms.No.445, DATED 26th September, 2000

(Vikkirama, Purattasi-11, Thiruvalluvar Aandu 2031)

Act - Tamil Nadu Transparency in Tenders Act, 1998 (Tamil Nadu Act 43 of 1998) – Date of coming into force of the Act - Notified.

ORDER: -

The following Notification will be published in the *Tamil Nadu Government Gazette*, Extraordinary dated the 1st October, 2000.

NOTIFICATION

In exercise of the powers conferred by sub-section(3) of section 1 of the Tamil Nadu Transparency in Tenders Act, 1998 (Tamil Nadu Act 43 of 1998), the Governor of Tamil Nadu hereby appoints the 1st day of October 2000 as the date on which the said Act shall come into force.

(BY ORDER OF THE GOVERNOR)

P.V. RAJARAMAN,
SECRETARY TO GOVERNMENT.

To

The Works Manager, Government Central Press, Chennai-79.
(for the publication of the notification and send 200 copies to Government)
All Secretaries to Government.
xxx xxx xxx xxx xxx xxx xxx xxx xxx.
Stock File/Spare Copies.

-/ Forwarded : By Order /-

sd/-
SECTION OFFICER.

11.2. Tamil Nadu Transparency in Tender Rules, 2000

Chapter -I

PRELIMINARY.

1. Short title and commencement.-

(a) These rules may be called the Tamil Nadu Transparency in Tenders Rules, 2000.

(b) They shall come into force on the date 1st October, 2000.

2. Definitions.- In these rules, unless there is anything repugnant in the subject or context,-

(a) "Act" means the Tamil Nadu Transparency in Tenders Act, 1998 (Tamil Nadu Act 43 of 1998);

(b) "supply and installation contract" means a contract under which the tenderer is required to supply, erect, test and commission the equipment at the place specified by the procuring entity;

(c) "fixed rate contract" means a contract where a set of rates and terms and conditions are fixed for the supply of unit quantities of goods or certain standardized services;

(d) "pre-qualification" means the process by which the tenderers are first screened for their capability and resources to implement the contract before they are permitted to offer their tenders;

(e) "two-cover system" means a procedure under which the tenderers are required to simultaneously submit two separate sealed covers, one containing the Earnest Money Deposit and the details of their capability to undertake the tender which will be opened first and the second cover containing the price quotation which will be opened only if the tenderer is found qualified to execute the tender;

(f) "earnest money deposit" means the amount required to be remitted by a tenderer along with his tender indicating his willingness to implement the contract; and

(g) "piece-work contract" and "lump-sum contract" shall have the same meaning as in the Tamil Nadu Public Works Department code.

Chapter-II

GENERAL

3. Categories of procurement.-

(1) For the purposes of the application of these rules, procurement is categorized as follows, namely:-

(i) Construction; and

(ii) Supply of goods and services.

(2) While the provisions of these rules shall apply in general to each of the categories of procurement in sub-rule (1), where a specific provision has been made in the rules regarding any specific category, that specific provision shall prevail as against any general provision in so far as that category of procurement is concerned.

4. Methods of tendering.-

(1) Procurement of different categories shall be effected by the following methods of tendering, namely:-

(i) Piece-work contract;

(ii) Lump-sum contract;

(iii) Turn-key contract;

(iv) Multi-stage contracting including pre-qualification and two cover system; and

(v) Fixed rate contract.

(2) The tender inviting authority shall decide the method of tendering to be followed in each case having regard to the category, size and complexity of the procurement.

(3) While the provisions of these rules shall apply to each of the methods of procurement indicated in sub-rule(1) generally where a specific provision has been made in these rules regarding a particular method of tendering, such specific provision shall prevail as against any general provision in so far as that particular method of tendering is concerned.

Chapter -III

PUBLICITY

5. Publication of tender bulletin:-

(1) The District Tender Bulletin shall be published by the District Bulletin Officer at least once in every week.

(2) The State Tender Bulletin shall be published by the State Tender Bulletin Officer at least once in every week.

(3) The Tender Bulletin Officer shall cause to be published all notices inviting tenders and intimations of acceptance of tenders received upto twenty four hours prior to the actual publication of the bulletin.

(4) In case a notice inviting tender or information relating to acceptance of the tender needs to be published urgently, then the Secretary to Government of the concerned administrative department in the case of the State tender bulletin or the District Collector in the case of the District tender bulletin can for reasons to be recorded in writing, direct the respective tender bulletin officers to publish an extraordinary issue of the tender bulletin.

6. Distribution of tender bulletins.-

(1) The Tender Bulletin Officer shall make the tender bulletin available at any office of a Government department, local authority, statutory board, public sector undertaking, local body, university or cooperative institution.

(2) The Tender Bulletin Officer shall make available adequate copies of the tender bulletin at the office of the Tender Inviting Authority whose notice inviting tenders and intimation of tender acceptance finds place in the bulletin.

(3) Any person or institution can be enrolled as a regular subscriber to the tender bulletin on payment of a fixed fee annually, half-yearly or quarterly, as the case may be.

7. Tender Bulletin to Contain Information only :-

(1) The tender bulletin shall contain only information of the notice inviting tenders and the orders accepting a tender and does not in itself create a legal right or liability.

(2) A notice inviting tender will not be invalidated merely on the grounds that the notice although published in newspapers has not been published in one or the other of the District Tender Bulletins or State Tender Bulletins or when published in the State Tender Bulletin could not be published in a District Tender Bulletin or vice versa.

8. Information to be published in the district tender bulletin:-

Subject to the provisions of rule 10, notices inviting tenders and decisions on tenders in all cases where the value of the procurement exceeds rupees five lakhs or below rupees twenty five lakhs shall be published in the District Tender Bulletin of the district where the headquarters of the Tender Inviting Authority is located and in the district where the work is to be executed or the goods and services supplied.

9. Information to be published in the State tender bulletin:-

The notice inviting tenders and decisions on tenders shall be published in the State Tender Bulletin in cases where.-

(a) The value of procurement exceeds rupees twenty five lakhs;

(b) The Tender Inviting Authority is a Secretary to Government, or a head of a Government department, or Local Authority or the Chief Executive of a Public Sector Undertaking, Statutory Board, Apex Cooperative Institution, University or State Level Society formed by the Government.

(c) In any other case, where the Tender Inviting Authority deems it fit.

10. Details to be mentioned in notice inviting tenders.-

The Notice Inviting Tenders shall contain the following details, namely:-

(a) The name and address of the procuring entity and the designation and address of the Tender Inviting Authority;

(b) Name of the scheme, project or programme for which the procurement is to be effected;

(c) The date upto which and places from where the tender documents can be obtained;

(d) The amount of earnest money deposit payable;

(e) The last date and time for receipt of tenders;

(f) The date, time and place for opening of tenders received; and

(g) Any other information the Tender Inviting Authority considers relevant.

11. Publication of notice inviting tenders in newspapers.-

(1) The Tender Inviting Authority shall have the notice inviting tenders published in the Indian Trade Journal in all cases where the value of procurement exceeds rupees [1]**fifty crores**.

(2) The number, editions and language of the newspapers in which the notices inviting tenders shall be published will be based on the value of procurement.

(3) In cases where publication of Tender Notices is to be done only in Newspapers with circulation within the District, the Information and Public Relations Officer attached to the District Collectorate shall be the competent authority to release the advertisement and in all other cases the competent authority to release the advertisement shall be the Director of Information and Public Relations, Chennai.

(4) The notice inviting tender shall be given due publicity in Newspapers and also on notice boards in the District Offices. For tenders above rupees fifty lakhs, Director of Information and Public Relations will publish the Notice Inviting Tenders as per instructions of the tendering department. For other tenders, Director of Information and Public Relations will publish keeping in mind the request of the department. There should not be any additional insertion and no publication of Notice Inviting Tenders in newspapers not requested by the tendering departments for tenders above rupees fifty lakhs.

12. Sending notice inviting tenders to all possible tenderers.-

The Tender Inviting Authority may if he considers necessary, send the Notice Inviting Tenders to all possible tenderers including registered contractor, past supplier, any potential supplier and any other well known company or firm directly.

1 This word substituted for the word “ ten crores ” by the orders issued in G.O Ms. No. 392, Finance(salaries) Department, Dated 18th August 2009.

Chapter-IV

NOTICE INVITING TENDERS AND TENDER DOCUMENTS

13.Technical specifications contained in the tender documents.-

(1) The technical specifications contained in the tender documents shall include a detailed description of what is proposed to be procured.

(2) Unbiased technical specifications shall be prepared by observing the following safeguards, namely:-

(a) use of brand names and catalogue numbers shall be avoided and where it becomes unavoidable, along with the brand name the expression “or equivalent” shall be added;

(b) wherever possible the appropriate Indian Standards with the number shall be incorporated;

(c) in the case of construction tenders, detailed estimates shall be prepared by the competent technical authorities based on the schedule of rates and standard data as revised from time to time provided that for large and prestigious projects, the Government shall permit any procuring entity to engage a qualified private architect or consultant to prepare the design and estimates; and

(d) in case alternative designs or materials are permitted, the conditions for their acceptability and the method of their evaluation shall be clearly stated.

14. Commercial conditions.-

(1) The tender documents shall require all tenderers without exception to pay an earnest money deposit ordinarily not exceeding one per cent of the value of the procurement by means of a demand draft, bankers cheque, specified small savings instruments or where the procuring entity deems fit, irrevocable bank guarantee in a prescribed form. The tender documents shall clearly state that any tender submitted without the earnest money deposit in the approved form be summarily rejected provided that any category of tenderers specifically exempted by the Government from the payment of earnest money deposit will not be required to make such a deposit.

(2) The tender documents shall specify the period for which the tenderer should hold the prices offered in the tender valid:

Provided that the initial period of validity shall not be less than ninety days.

(3) The tender documents shall require that as a guarantee of the tenderer's performance of the contract, a security deposit be taken from the successful tenderer subject to the conditions that -

(a) The amount of the deposit not exceeding five per cent of the value of the orders placed: and

(b) The deposit being in the form of demand draft or bankers' cheque or specified small savings instruments or where the procuring entity deems fit, irrevocable bank guarantee in a prescribed form.

(4) The tender documents shall clearly indicate the payment terms conforming to the following requirements.-

[1](a) "Payment shall ordinarily be effected only on completion of delivery against the orders placed.

Provided that payment of advance may be made in the following cases for sufficient reasons to be recorded by the procuring entity:-

(i) in cases where goods, commodities and services are procured through imports requiring opening of Letter of Credit;

(ii) in cases where there is single source of supply only and where the practice of paying advance is already in vogue as a standard practice;

(iii) in cases of purchase during natural calamities and emergencies declared by the Government under clause (a) of section 16 of the Act;

(iv) in cases of purchase of life saving drugs; and

1 This clause was substituted for the expression, "Payment shall ordinarily be effected only on completion of delivery against the orders placed, subject to the exceptions specified in the tender documents". [G.O.Ms.No.107, Finance (Salaries) Department, Dated 23-3-2004]

(v) in cases where the standard commercial terms of supply require payment of advance by the procuring entity, such as the machinery and equipment manufacturers for sugar and cement plants".

(b) Mobilization advances may be paid in the case of construction or supply and installation contracts of a large and complex nature, for a value exceeding rupees one crore provided that such mobilization advances shall not ordinarily exceed ten per cent of the value of the contract, shall be secured against irrevocable bank guarantee and shall be recovered in the subsequent bills payable along with interest as per specific terms set in the tender documents provided that in case of mobilisation advances for plant machinery and equipment, they are also hypothecated to the Governor of Tamil Nadu in addition to other requirements;

(c) Percentage of payment to be withheld for the effective performance of the contract, provided that withheld amounts do not exceed ten per cent of the total value of contract;

(d) Payment terms for imports shall be based on standard terms of international trade and the payment may be effected through irrevocable letters of credit drawn on banks;

(5) The tender documents shall clearly indicate whether any variations in the commercial terms prescribed in the documents will be permitted and if so to what extent such variations would be considered.

(6) The tender documents and the contract shall include a clause for payment of liquidated damages and penalty payable by the tenderer in the event of non-fulfillment of any or whole of the contract.

(7) The tender documents shall clearly indicate the terms on which the tenderers will be required to quote their price which should be inclusive of all costs of delivery at the final destination such as transportation, payment of duties and taxes leviable, insurance and any incidental services and giving the break up thereof.

[1](7-A)The tender documents shall clearly indicate the criteria for evaluation and comparison of tenders and shall also provide for a price preference of fifteen percent for domestic small scale industrial units and ten percent for the Public Sector Undertakings of the Government in respect of products and quantities manufactured by them.

(8) The tender documents shall include a price adjustment clause to reflect any changes either upward or downward in major cost components such as labour, equipment, material and fuel, based on a prescribed formula in the case of large contracts where the period of execution is likely to exceed eighteen months.

(9) The tender documents shall indicate the quantity proposed to be procured in the tender, and the Tender Accepting Authority shall be ordinarily permitted to vary the quantity finally ordered only to the extent of twenty five percent either way of the requirement indicated in the tender documents.

15. Tender documents to clearly specify evaluation criteria.-

(1) The tender documents shall clearly indicate the criteria in addition to price which are to be adopted for evaluating the tenders and how such criteria will be quantified or evaluated; and

[2](2) The qualification criteria in terms of the registration of contractors in the cases where the procuring entity has a system of registration of contractors, the required experience, available manufacturing and construction capacity, technical and other manpower and financial status shall be clearly stated in the tender documents.

16. Supply of tender documents.-

(1) The Tender Inviting Authority shall make available the tender documents from the date of publication of the tender.

1 This sub-rule was inserted by the notification issued in G.O.Ms.No.452, Finance (Salaries) Department, Dated 16-11-2001.

2 This clause was substituted for the expression, “The qualification criteria in terms of the required experience, available manufacturing and construction capacity, technical and other manpower and financial status shall be clearly stated in the tender documents.” (G.O.Ms.No.177, Finance (Salaries) Department, dated 22nd May 2007).

[2](2) "The Tender Inviting Authority shall ensure that the tender documents are made available to any person who is willing to remit the cost of such documents".

[3](3) (a) The tender documents shall be made available at:-

(i) the office of the Tender Inviting Authority;

(ii) any other office or place indicated by the procuring entity.

[4](b) In respect of procurement where the estimated value of procurement is Rupees Twenty Five Lakhs and above in value for construction and Rupees Ten Lakhs and above in value for all other categories of procurement inclusive of consultancies for construction, the tender document shall be made available for downloading free of cost at the website designated for this purpose by the Government. Tender documents may also be made available free of cost at such other web sites as may be indicated by the Tender Inviting Authority."

(4) The Tender Inviting Authority shall send by registered post or courier the tender documents to any prospective tenderer who makes a request for the documents on payment of cost along with postal charges at the risk and responsibility of the prospective tenderer.

2 This clause was substituted for the expression, "Tender Inviting Authority shall ensure that the tender documents are made available to any person who is willing to remit the cost of the documents provided that in the cases where the procuring entity has a system of registration of contractors, the tender documents will be supplied only to registered contractors in the appropriate class." (G.O.Ms.No.177, Finance (Salaries) Department, dated 22nd May 2007)

3 This clause was substituted for the expression, "(3) The tender documents shall be made available at the following offices, namely:- (i) the office of the Tender Inviting Authority; (ii) any other office or place indicated by the procuring entity." (G.O.Ms.No.177, Finance (Salaries) Department, dated 22nd May 2007).

4 This clause was substituted for the expression, "In respect of procurement where the estimate value of procurement is Rupees Ten Lakhs and above, the tender document shall be made available for downloading free of cost at the web site designated for this purpose by the Government. Tender documents may also be made available free of cost at such other web sites as may be indicated by the Tender Inviting Authority" (G.O.Ms.No.91,Finance (Salaries) Dept, dated 23rd March 2010)

17. Clarification to tender documents.-

[1](1) At any time after the issue of the tender documents and before the opening of the tender, the Tender Inviting Authority may make any changes, modifications or amendments to the tender documents and shall send intimation of such change to all those who have purchased the original tender documents and upload corrigendum for the information of those who have downloaded the tender documents from the website.

[2](2) In case any one tenderer asks for a clarification to the tender documents before 48 hours of the opening of the Tender, the Tender Inviting Authority shall ensure that a reply is sent and copies of the reply to the clarification sought shall be communicated to all those who have purchased the tender documents without identifying the source of the query and upload such clarification to the designated website for the information of those who have downloaded the tender documents from the website, without identifying the source of the query .

1 This clause was substituted for the expression, "At any time after the issue of the tender documents and before the opening of the tender, the Tender Inviting Authority may make any changes, modifications or amendments to the tender documents and shall send intimation of such change to all those who have purchased the original tender documents.

" (G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007).

2 This clause was substituted for the expression, "In case any one tenderer asks for a clarification to the tender documents before 48 hours of the opening of the Tender, the Tender Inviting Authority shall ensure that a reply is sent and copies of the reply to the clarification sought will be communicated to all those who have purchased the tender documents without identifying the source of the query."

(G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007).

Chapter -V

RECEIPT OF TENDERS AND TENDER OPENING

18. Place and time for receipt of tenders.-

[1](1) The Tender Inviting Authority shall ensure that adequate arrangements are made for the proper receipt and safe custody of the tenders at the place indicated for the receipt of tenders. Such of the tenders that are received through electronic mail shall be kept electronically locked.

(2) The Tender Inviting Authority shall take all measures to ensure that no intending tenderer is hindered in submitting his tender.

[2](3) The Tender Inviting Authority shall permit the submission of tenders by post or courier or by electronic submission through the designated website, wherever applicable, provided that the Tender Inviting Authority shall not be responsible for any delay in transit in such cases".;

[3](4) The Tender Inviting Authority shall not accept any tenders submitted by facsimile (fax)

[4](5) The Tender Inviting Authority may extend the last date and time for receiving tenders "which shall be published on the designated website also" after giving adequate notice to all intending tenderers in cases where: -

(a) the publication of the tender notice has been delayed;

(b) the communication of changes, in the tender documents to the prospective tenderers under sub rule (1) of rule 17 took time;

1 This clause was substituted for the expression, "The Tender Inviting Authority shall ensure that adequate arrangements are made for the proper receipt and safe custody of the tenders at the place indicated for the receipt of tenders." (G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007).

2 This clause was substituted for the expression, "The Tender Inviting Authority shall permit the submission of tenders by post or courier, provided that the Tender Inviting Authority shall not be responsible for any delay in transit in such cases." (G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007).

3 This clause was substituted for the expression, "The Tender Inviting Authority shall not accept any tenders submitted by facsimile (fax) or by electronic mail". (G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007).

4 This clause was substituted for the expression, "The Tender Inviting Authority may extend the last date and time for receiving tenders after giving adequate notice to all intending tenderers in cases where:-" (G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007).

(c) any of the tenderers requested clarifications communication of which took time to all the tenderers; and

(d) any other reasonable grounds exist, for such extension which shall be recorded in writing by the Tender Inviting Authority.

19. Marking of covers in which the tender is submitted.-

The tenderer shall be responsible for properly superscribing and sealing the cover in which the tender is submitted and the Tender Inviting Authority shall not be responsible for accidental opening of the covers that are not properly superscripted and sealed as required in the tender documents before the time appointed for tender opening.

20. Minimum time for submission of tenders.-

(1) The Tender Inviting Authority shall ensure that adequate time is provided for the submission of tenders and a minimum time is allowed between date of publication of the Notice Inviting Tenders in the relevant Tender Bulletin or in the newspapers whichever is later and the last date for submission of tenders. This minimum period shall be as follows.-

(a) for tenders upto rupees two crores in value, fifteen days; and

(b) for tenders in excess of rupees two crores in value, thirty days.

(2) Any reduction in the time stipulated as per sub-rule (1) has to be specifically authorized by an authority superior to the Tender Inviting Authority for reasons to be recorded in writing.

21. Opening of tenders.-

(1) All the tenders received by the Tender Accepting Authority shall be opened at the time specified in the Notice Inviting Tenders and in cases where an extension of time for the submission of tenders has been given subsequent to the original Notice Inviting Tenders in accordance with sub-rule (5) of Rule 18 at the time so specified subsequently. [1]"The e-submitted tenders may be permitted to be opened by a Tender

1 This clause was added for the expression, "All the tenders received by the Tender Accepting Authority shall be opened at the time specified in the Notice Inviting Tenders and in cases where an extension of time for the submission of tenders has been given subsequent to the original Notice Inviting Tenders in accordance with sub-rule (5) of Rule 18 at the time so specified subsequently." (G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007).

Inviting Authority or a member of the Tender Scrutiny Committee from their new location if they are transferred after the issue of Notice Inviting Tender and before tender opening and where the new incumbent is yet to obtain his digital signature certified.";

(2) The time specified for the opening of tenders shall be immediately after the closing time specified for the receipt of tenders allowing a reasonable period, not exceeding one hour, for the transportation of the tenders received to the place they are to be opened in the presence of the tenderers who choose to be present.

(3)The tenders will be opened in the presence of the tenderers or one representative of the tenderer who chooses to be present.

22. Procedure to be followed at tender opening.-

The following procedure shall be followed at the tender opening.-

[1](a) All the envelopes containing tenders and the tenders received through the electronic mail in the designated website shall be counted.

(b) All the tenders received in time shall be opened.

[2](c) Any tender received subsequently shall not be opened and shall be returned unopened to the tenderer and in the case of tenders submitted through electronic mail in the designated website, a report on the late submission of tenders shall be generated and the same shall be sent to the tenderers concerned". ;

(d) On opening the tender, the members of the Tender Scrutiny Committee shall initial the main bid including the prices and any corrections;

(e) A record of the corrections noticed at the time of the bid opening shall be maintained;

1 This clause was substituted for the expression, "All the envelopes received containing tenders shall be counted." (G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007).

2 This clause was substituted for the expression "Any tender received subsequently shall not be opened and shall be returned unopened to the tenderer." (G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007).

(f) The name of the tenderers and the quoted prices should be read out aloud.

(g) the fact whether earnest money deposit has been submitted and other documents required produced may be indicated, but this shall be merely an examination of the documents and not an evaluation;

(h) Minutes of the tender opening shall be recorded. The signatures of the tenderers present shall be obtained unless any of the tenderers or his representative refuses to sign the minutes.

23. Changes and alterations not to be permitted after tender opening.-

No changes, amendments which materially alter the tendered prices shall be permitted after the opening of the tender, except as per the procedure prescribed in sub-section (3) of section 10 of the Act.

24. Tender scrutiny committee.-

(1) A Tender Scrutiny Committee may be constituted to scrutinize the tender documents, supervise opening of tenders, to carry out the preliminary examination and detailed evaluation of the tenders received and to prepare an evaluation report for the consideration of the Tender Accepting Authority.

(2) The constitution of a Tender Scrutiny Committee will be obligatory in all cases where the value of the procurement exceeds limit as may be specified.

Chapter -VI

TENDER EVALUATION.

25. Tender evaluation to be in accordance with evaluation criteria.-

The Tender Accepting Authority shall cause the evaluation of tenders to be carried out strictly in accordance with the evaluation criteria indicated in the tender documents.

26. Time taken for evaluation and extension of tender validity.-

(1) The evaluation of tenders and award of contract shall be completed, as far as may be practicable, within the period for which the tenders are held valid.

(2) The Tender Accepting Authority shall seek extension of the validity of tenders for the completion of evaluation.

(3) In case the evaluation of tenders and award of contract is not completed within extended validity period, all the tenders shall be deemed to have become invalid and fresh tenders may be called for.

27. Process of tender evaluation to be confidential until the award of the contract is notified.-

(1) Subject to the provision of Sections 12 and 13 of the Act, the Tender Inviting Authority shall ensure the confidentiality of the process of tender evaluation until orders on the tenders are passed.

(2) The Tender Accepting Authority shall cause the information on orders passed on the tenders published in the Tender Bulletin.

(3) Tenderers shall not make attempts to establish unsolicited and unauthorised contact with the Tender Accepting authority, Tender Inviting Authority or Tender Scrutiny Committee after the opening of the Tender and prior to the notification of the Award and any attempt by any tenderer to bring to bear extraneous pressures on the Tender Accepting Authority shall be sufficient reason to disqualify the tenderer.

(4) Notwithstanding anything contained in sub-rule (3), the Tender Inviting Authority or the Tender Accepting Authority may seek bonafide clarifications from tenderers relating to the tenders submitted by them during the evaluation of tenders.

28. Initial examination to determine substantial responsiveness.-

(1) The Tender Inviting Authority shall cause an initial examination of the tenders submitted to be carried out in order to determine their substantial responsiveness.

(2) The initial examination shall consider the following factors, namely:-

(a) Whether the tenderer meets the eligibility criteria laid down in the tender documents;

[1](b) (i) whether the crucial documents have been duly signed;

(ii) whether the documents have been authenticated by digital signature, in the case of tenders submitted through electronic mail in the designated website.

(c) Whether the requisite earnest money deposit has been furnished;

(d) Whether the tender is substantially responsive to the technical specifications, commercial conditions set out in the bidding documents including the testing of samples where required.

(3) Tenders which on initial examination are found not to be substantially responsive under any of the clauses under sub-rule (2) may be rejected by the Tender Accepting Authority.

29. Determination of the lowest evaluated price.-

(1) Out of the tenders found to be substantially responsive after the initial examination the tenderers who has bid the lowest evaluated price in accordance with the evaluation criteria or the tenderers scoring the highest on the evaluation criteria specified as the case may be shall be determined.

2) In determining the lowest evaluated price, the following factors shall be considered, namely:-

1 This clause was added as per the orders issued in G.O.Ms.No.471, Finance (Salaries) Department, dated 30th September 2007.

(a) the quoted price shall be corrected for arithmetical errors;

(b) in cases of discrepancy between the prices quoted in words and in figures, lower of the two shall be considered;

(c) adjustments to the price quoted shall be made for deviations in the commercial conditions such as the delivery schedules and minor variations in the payment terms which are quantifiable but deemed to be non-material in the context of the particular tender;

[1](d) "the evaluation shall include all central duties such as customs duty and central excise duty and sales tax as a part of the price, as detailed below: -

(i) in evaluation of the price of an imported item, the price has to be determined inclusive of the customs duty;

(ii) in evaluation of the price of articles which are subject to excise duty, the price has to be determined inclusive of such excise duty;

(iii) in a tender where all the tenderers are from within the State of Tamil Nadu, or where all the tenderers are from outside the State of Tamil Nadu, the sales tax shall be included for the evaluation of the price; and

(iv) In a tender where the tenderers are both from the State of Tamil Nadu as well as from outside the State of Tamil Nadu, **the sales tax under the Tamil Nadu General Sales Tax Act, 1959** (Tamil Nadu Act 1 of (1959)[2] shall be excluded for the evaluation of the price".

(e) in the case of purchase of equipment, the operation and maintenance and spare part costs for appropriate periods as may be specified in bid documents may be quantified, where practicable and considered.

[3](f) the evaluation and comparison shall include fifteen percent price preference for domestic small scale industrial units and ten percent price preference for the Public Sector Undertakings of the Government in respect of products and quantities manufactured by them.

1 This clause was substituted for the expression, "the evaluation shall include all central duties such as customs duty and central excise duty as a part of the price, but shall exclude sales tax if the bidders are from other States and Tamil Nadu;". [G.O.Ms.No.412, Finance (Salaries) Department, Dated 09-10-2003

2 The expression was substituted for the expression, “sales tax” by the notification issued in G.O.Ms.No.17, Finance (Salaries) Department, Dated 17.01.2005.

3 This clause was added by the notification issued in G.O.Ms.No.452 Finance (Salaries) Department, Dated 16-11-2001.

(3) In order to secure the best possible procurement price, negotiations with tenderer determined as per clauses (1) and (2) above are permissible subject to provisions in section 10 of the Act.

30. Preparation of evaluation report and award of tenders:-

(1) The Tender Scrutiny Committee or the officer evaluating the tender shall prepare detailed evaluation report which shall be considered by the Tender Accepting Authority before taking a final decision on the tender.

2) The evaluation report shall be prepared in the standardized format as may be prescribed.

(3) As soon as the tenderer qualified to perform the contract is identified, in accordance with section 10(6) of the Act, the Tender Accepting Authority shall pass orders accepting the tender and communicate the order of acceptance to the successful tenderer. The Tender Accepting Authority will also send to the Tender Bulletin Officer a statement of evaluation of the tenders with a comparative statement of tenders received and decision thereon for publication in the Tender Bulletin.

(4) Within such reasonable time as may be indicated in the tender documents, the tenderer whose tender has been accepted will be required to execute the contract agreement in the prescribed format.

(5) In case the successful tenderer fails to execute necessary agreements as prescribed within the period specified, then his Earnest Money Deposit shall be forfeited and his tender held as non-responsive.

Chapter -VII

EVALUATION AND AWARD OF TENDERS IN SPECIAL CASES.

31. Procurement in special cases.-

In the case of purchase of goods where the quantity offered at the lowest price is less than the total quantity required, the Tender Accepting Authority may, after placing orders with the lowest evaluated tenderer for the entire quantity offered by such tenderer subject to his ability to supply, adopt either or both of the following procedures to procure the balance quantity.-

price and require them to match the price offered by the lowest evaluated tenderer and place orders until the entire quantity required is ordered; or

(2) Require all the other eligible tenderers who participated in the tender and offered a price higher than that offered by the lowest evaluated tenderer, to submit sealed offers of the quantity they would be willing to supply at the price quoted by the lowest evaluated tenderer, and thereafter place orders for the remaining required quantity with all those who match the lowest evaluated price such that those who bid lower prices in the original tender get a higher priority for supply.

(3) In case the bidders other than the lowest evaluated bidder fail to agree to accept the lowest price or the total quantity offered by them at the price quoted by the tenderer with lowest evaluated price is less than the required quantity the Tender Accepting Authority may place orders for remaining required quantity at different rates with different suppliers in the ascending order of evaluated price until the entire quantity required is covered:

Provided that, where different quantities have to be procured at more than one price from one or more tenderers, the Tender Accepting Authority may decide not to procure beyond a price considered economical although the entire quantity originally stated to be required in the tender documents is not ordered.

(4) In cases where, the Tender Accepting Authority such as Tamil Nadu Electricity Board, Tamil Nadu Civil Supplies Corporation, Project Director, Integrated Child Development Scheme (ICDS)[1] and Tamil Nadu State Transport Corporations is of the view that the commodity to be purchased is so vital in nature and the failure in supply would affect the public interest and that it is necessary to have more than one supplier, the Authority may place orders on the tenderer quoting the lowest evaluated price for not less than 60% of the quantity covered in the tender at the price quoted by him and place orders for the remaining quantity on the tenderers quoting the next lowest evaluated prices at the lowest evaluated price and shall specify this in the tender documents.

[2]"Provided that the commodity to be purchased by the Tamil Nadu State Transport Corporations shall be restricted to bus chassis only".

7.2. Pre-qualification procedure.-

(1) The Tender Inviting Authority shall for reasons to be recorded in writing provide for pre-qualification of tenderers on the basis of,-

(a) experience and past performance in the execution of similar contracts;

(b) capabilities of the tenderer with respect to personnel, equipment and construction or manufacturing facilities;

(c) financial status and capacity

(2) Only the bids of pre-qualified bidders shall be considered for evaluation.

7.3. Low value procurement.-

For the purposes of clause (d) of section 16 of the Act, “low value procurement” means any procurement, which is less than rupees [3] **twenty five lakhs in value for construction and which is less than rupees ten lakhs in value for all other categories of procurement inclusive of consultancies for constructio**n.

1 This expression was inserted by the notification issued in G.O.Ms.No.107,Finance (Salaries) Department, Dated 23-03-2002.

2 This proviso was added by the notification issued in G.O.Ms.No.286, Finance (Salaries) Department, Dated 13-08-2002.

3 The word “two” was substituted by the word "five" by the notification issued in G.O.Ms.No.452, Finance (Salaries) Department, Dated 16-11-2001.Subsequently the words in bold were substituted for the word “five lakhs in value” by the notification issued in G.O Ms.No.392, Finance (Salaries) Department, dated 18th August 2009.

MANUSCRIPT SERIES

FINANCE (SALARIES) DEPARTMENT
G.O.Ms.No.446, DATED 26th September, 2000
(Vikkirama, Purattasi-11, Thiruvalluvar Aandu 2031)
Rules - Tamil Nadu Transparency in Tenders Rules, 2000 - Framing of the

Rules -Notified.

ORDER:

The following Notification will be published in the Tamil Nadu Government Gazette, Extraordinary dated the 1st October, 2000.

NOTIFICATION.

In exercise of the powers conferred by sub-section(1) of section 22 of the Tamil Nadu Transparency in Tenders Act, 1998 (Tamil Nadu Act 43 of 1998), the Governor of Tamil Nadu hereby makes the following Rules:-

RULES

(BY ORDER OF THE GOVERNOR)

P.V. RAJARAMAN,

SECRETARY TO GOVERNMENT.

To
The Works Manager, Government Central Press, Chennai-79.
(for the publication of the notification and send 200 copies to Government)
All Secretaries to Government.
xxx xxx xxx xxx xxx xxx xxx xxx xxx.
Stock File/Spare Copies.

-/ Forwarded : By Order /-

sd/-

SECTION OFFICER.

12. IMPORTANT TABULATIONS

12. IMPORTANT TABULATIONS

12.1 **Minimum Cement Content, Maximum Water-Cement Ratio** and **Minimum** Grade of Concrete for Different Exposures with **Normal Weight Aggregates of 20 mm** Nominal Maximum Size

(Clauses 6.1.2, 8.2.4.1 and 9.1.2 of IS: 456 - 2000)

S.No	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content Kg/m^3	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content Kg/m3	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
i)	Mild	220	0.60	-	300	0.55	M20
ii)	Moderate	240	0.60	M15	300	0.50	M25
iii)	Severe	250	0.50	M20	320	0.45	M30
iv)	Very Severe	260	0.45	M20	340	0.45	M35
v)	Extreme	280	0.40	M25	360	0.40	M40

NOTES:

1. Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio, if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolana and slag specified in IS 1489 (Part -1) & IS 455 respectively.

2. Minimum grade for plain concrete under mild exposure condition is not specified.

12.2 Maximum size aggregate. For other sizes of aggregate they should be changed as given in below. Adjustments to Minimum Cement Contents for Aggregates Other Than 20 mm Nominal Maximum Size (Clause 8.2.4.1 of IS 456 - 2000)

Sl.No.	Nominal Maximum Aggregate Size mm	Adjustments to Minimum Cement Contents Given in Table 5kg/m3
i)	10	+40
ii)	20	0
iii)	40	-30

12.2.1 Maximum cement content

Cement content not including fly ash and ground granulated blast furnace slag in excess of 450 kg/m3 should not be used unless special consideration has been given in design to the increased risk of cracking due to drying shrinkage in thin sections, or to early thermal cracking and to the increased risk of damage due to alkali silica reactions.

12.2.2 Proportions for Nominal Mix Concrete (Clause 9.3 and 9.3.1 of IS : 456 : 2000)

Grade of Con crete	Total Quantity of Dry Aggregates byMass per 50 kg of Cement, to beTaken as the Sum of the Individual Masses of Fine and Coarse Aggregates, kg, Max	Proportion of Fine Aggregate to Coarse Aggregate (by mass)	Quantity of Water per 50 kg of Cement, Max
M5	800	Generally 1:2 but subject to an upper limit of 1:1.5 & a lower limit of 1:2.5	60
M7.5	625		45
M10	480		34
M15	330		32
M20	250		30

12.3 Clear Distance Between Bars (Clause 26.3.3 of IS : 456 : 2000)

f_y	Percentage Re-distribution to or from Section considered				
	-30	-15	0	+15	+30
	Clear Distance Between Bars				
N/mm² (1)	mm (2)	mm (3)	mm (4)	mm (5)	mm (6)
250	215	260	300	300	300
415	125	155	180	210	235
500	105	130	150	175	195

NOTE : The spacings given in table are not applicable to members, subjected to particularly aggressive environments unless in the calculation of the moment of resistance f_y has been limited to 300 N/mm² in limit state design and σ_{st} limited to 165 N/mm² in working stress design.

12.4 Slabs

1) The horizontal distance between parallel main reinforcement bars shall not be more than three times the effective depth of solid slab or 300 mm whichever is smaller.
2) The horizontal distance between parallel reinforcement bars provided against Shrinkage & temperature shall not be more than five times the effective depth of a solid slab or 450mm whichever is smaller.

12.4.1 Nominal Cover to Meet Specified Period of Fire Resistance

Minimum values of nominal cover of normal-weight aggregate concrete to be provided to all reinforcement including links to meet specified period of fire resistance shall be given in Table. 16A of IS 456.

12.4.2 Nominal Cover to Meet Durability Requirements (Clause 26.4.2 of IS : 456 : 2000)

Exposure	Nominal Concrete Cover in mm not Less Than
Mild	20
Moderate	30
Severe	45
Very Severe	50
Extreme	75

NOTES

1. For main reinforcement upto 12mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.

(v) MINIMUM & MAXIMUM REINFORCEMENT DIAMETER FOR BEAMS

Type	Minimum	Maximum	
		Light Structure	Heavy Structure
Tension or compression	12mm	32mm	50mm
Stirrup hangers (if provided)	8mm	16mm	16mm
Shear reinforcement	6mm	16mm	20mm

(based on IS 456 - 2000)

Clear Covers Normally followed in Practice

Structural Member	Clear Cover
Footings	50mm (Sides)
Columns	40mm
Beams	30mm
Slabs	20mm
sunshade & Lintels	20mm

* for coastal zones above covers can be increased by 10mm from the given values

DETAILING RULES FOR SLABS BASED ON 26.5.2.1, 26.5.2.2, 26.3.3(B) OF IS 456 - 2000

Dia Meter		Quantum of Reinforcement		Clear spacing between bars		
Min	Max	Min	Max		Main bars (Max)	Distribution bars(Max)
6mm	Least of: i) one eighth overall depth of slab ii) 16mm	0.12% of gross sectional area of slab (either way) for HYSD. 0.15% of gross sectional area of slab (for MS)	2% of gross sectional area of slab	Greatest of: i) 1.5 times the max. size of coarse aggregate ii) Diameter of needle, where needle vibrators are used iii) 5cm	Lesser of: i) 30 cm ii) Three the effective depth of slab	Least of: i) 45cm ii) Five times the effective depth of slab

* DETAILING RULES FOR COLUMNS

Area of reinforcement		Diameter ofbars		Number of bars (Min)	Spacing max.
Min.	Max.	Min	Max		
1. Longitudinal reinforcement 0.8% of the gross sectional area of column	6% of the gross sectional area of column	12mm	50mm	i) 4 bars for rectangular columns ii) 6 bars for circular column	30 cm when measured along theperiphery of thecolumn
2.Transverse reinforcement greatest of i) 6mm ii) One fourth of dia of the largest longitudinal bar	16mm				Least of i) Least lateral dimension of column ii) 16 times the dia of smallest longitudinal bar iii) 300mm

In columns that have larger concrete cross sectional area than required, the above should be based upon the actual area of concrete required to resist the direct load acting on the column, but in no case the reinforcement shall be less than 0.4% of the gross sectional area of the column

STAIRCASE READY RECKONER

M20 - CONC GRADE FE415 - STEEL

Span (m)	Waist thickness D(mm)	IL = 3.00 KN/m² W = 10 KN/m		IL = 5.00 KN/m² W = 12 KN/m	
		MAIN REBARS	**DISTRIBUTORS**	**MAIN REBARS**	**DISTRIBUTORS**
2.40	115	8mm @ 200mm c/c	8mm @ 250mm c/c	8mm @ 180mm c/c	8mm @ 250mm c/c
3.00	125	8mm @ 150mm c/c	8mm @ 250mm c/c	8mm @ 125mm c/c	8mm @ 250mm c/c
3.50	125	8mm @ 100mm c/c	8mm @ 250mm c/c	10mm @ 125mm c/c	8mm @ 250mm c/c
4.00	135	10mm @ 125mm c/c	8mm @ 250mm c/c	12mm @ 150mm c/c	8mm @ 250mm c/c
4.50	150	12mm @ 180mm c/c	8mm @ 250mm c/c	12mm @ 150mm c/c	8mm @ 250mm c/c
5.00	175	12mm @ 180mm c/c	8mm @ 250mm c/c	12mm @ 150mm c/c	8mm @ 250mm c/c
5.50	175	12mm @ 150mm c/c	8mm @ 250mm c/c	12mm @ 125mm c/c	8mm @ 250mm c/c
6.00	200	12mm @ 125mm c/c	8mm @ 230mm c/c	12mm @ 100mm c/c	8mm @ 230mm c/c
6.50	200	12mm @ 100mm c/c	8mm @ 230mm c/c	12mm @ 100mm c/c	8mm @ 230mm c/c
7.00	230	12mm @ 100mm c/c	8mm @ 200mm c/c	12mm @ 100mm c/c	8mm @ 200mm c/c

TABLES FOR RC SLABS

Selection of Thickness in one way slabs

Simply supported slab

Load kN/m²	Span (m)										
	2.50	2.75	3.00	3.25	3.50	3.75	4.0	4.25	4.50	4.75	5.00
2(L) +C	110	120	130	140	150	160	180	190	200	210	230
3(L) +C	110	120	130	140	160	170	180	190	210	220	230
4(L) +C	110	130	140	150	160	170	190	200	210	220	240

Notation:

L Live load in KN/m^2,

C Partitions + Finishing Load + Self Weight of Slab in KN/m^2

Water requirements for Buildings Other than Residences

Sl. No.	Type of Building	Consumption per day, Litres
(1)	(2)	(3)
i)	Factories where bath rooms are required to be provided	45 per head
ii)	Factories where no bath rooms are required to be provided	30 per head
iii)	Hospital (including laundry) :	
	a) Number of beds not exceeding 100	340 per head
	b) Number of beds exceeding 100	450 per head
iv)	Nurses' homes and medical quarters	135 per head
v)	Hostels	135 per head
vi)	Hotel (up to 4 Star)	180 per head
vii)	Hotel (5 Star and above)	320 per head
viii)	Offices	45 per head
ix)	Restaurants	70 per seat
x)	Cinemas, concert halls and theatres	150 per seat
xi)	Schools:	
	a) Day schools	45 per head
	b) Boarding schools135 per head	

REQUIREMENT OF WATER SUPPLY FOR FIRE FIGHTING INSTALLATIONS

Sl. No	Type of Building / Occupancy	Requirements for water supply	
		Under ground tank in litres	Terrace tank in litres
1	Apartment building below 15m in height	Nil	Nil
2	Apartment buildings		
	a) Above 15 m but not exceeding 24 m	Nil	10000
	b) Exceeding 24m but not exceeding 45 m	50000	20000
	c) Above 24 m and not exceeding 35m with shopping area upto 250 sq.m and restricting the shopping areas to the ground floor only	50000	20000
	d) Above 24 m and not exceeding 35m with shopping area exceeding 250 sq.m	100000	20000
	e) Above 45 m and not exceeding 60 m	100000	20000
	f) Above 60 m in height, but not exceeding 92 m (apartment building above 92 m should not be permitted)	150000	20000
3	Non-apartment buildings:		
	a) Educational and industrial upto 15 m in height	50000	Nil
	b) Storage and hazardous up to 15 m in height	100000	20000
	c) Above 15 m in height but not exceeding 24m except for educational buildings	150000	20000
	d) Educational building above 15 m but not exceeding 24m in height	Nil	20000
	e) Educational and commercial buildings above 24 m but not exceeding 35 m	150000	20000
	f) Educational and commercial buildings above 35 m but not exceeding 60 m	200000	Nil
	g) Educational and commercial buildings above 35 m but not exceeding 92 m	250000	Nil

CEMENT ADEQUACY STATEMENT

(Adopting 1 cum cement = 1440 kg)

Sl No.	Description	Calculation	Cement in Kg	per
1	CC 1:5:10 using 40mm metal	0.45/5 x 1440	129.60	Cum.
2	CC 1:4:8 using 40mm metal	0.45/4 x 1440	162.00	Cum.
3	CC 1:3:6 using 40mm metal	0.45/3 x 1440	216.00	Cum.
4	CC 1:2:4 using 20mm metal	0.45/2 x 1440	324.00	Cum.
5	CC 1:1.5:3 using 20mm metal	0.45/1.5 x 1440	432.00	Cum.
6	Brick work using I class bricks (metric 19cm x 9cm x 9cm)			
	Cm 1:3 mix	0.22/3 x 1440	105.60	Cum
	Cm 1.4 mix	0.22/4 x 1440	79.20	Cum
	Cm 1:5 mix	0.22/5 x 1440	63.36	Cum
	Cm 1:6 mix	0.22/6 x 1440	52.80	Cum
8	Brick work using II&III class bricks (19cm x 9cm x 5.7cm)			
	Cm 1:3 mix	0.27/3 x 1440	129.60	Cum
	Cm 1.4 mix	0.27/4 x 1440	97.20	Cum
	Cm 1:5 mix	0.27/5 x 1440	77.76	Cum
	Cm 1:6 mix	0.27/6 x 1440	64.80	Cum
9	Brick work using Country bricks (23cm x 11cm x 7cm)			
	Cm 1:3 mix	0.25/3 x 1440	120.00	Cum
	Cm 1.4 mix	0.25/4 x 1440	90.00	Cum
	Cm 1:5 mix	0.25/5 x 1440	72.00	Cum
	Cm 1:6 mix	0.25/6 x 1440	60.00	Cum
10	Brick work using wire cut bricks (23cm x 11.5cm x 7.6cm)			
	Cm 1:3 mix	0.20/3 x 1440	96.00	Cum
	Cm 1.4 mix	0.20/4 x 1440	72.00	Cum
	Cm 1:5 mix	0.20/5 x 1440	57.60	Cum
	Cm 1:6 mix	0.20/6 x 1440	48.00	Cum

Sl No.	Description	Calculation	Cement in Kg	per
11	Ceiling Plastering with cm 1:3 mix 10mm thick	0.10/3 x 1440	48.00	10Sqm
12	Plastering 12 mm thick with			
	Cm 1:2 mix	0.14/2 x 1440	100.80	10 Sqm
	Cm 1.3 mix	0.14/3 x 1440	67.20	10 Sqm
	Cm 1:4 mix	0.14/4 x 1440	50.40	10 Sqm
	Cm 1:5 mix	0.14/5 x 1440	40.32	10 Sqm
	Cm 1:6 mix	0.14/6 x 1440	33.60	10 Sqm
13	Plastering 20 mm thick with			
	Cm 1:2 mix	0.22/2 x 1440	158.40	10 Sqm
	Cm 1.3 mix	0.22/3 x 1440	105.60	10 Sqm
	Cm 1:4 mix	0.22/4 x 1440	79.20	10 Sqm
	Cm 1:5 mix	0.22/5 x 1440	63.36	10 Sqm
	Cm 1:6 mix	0.22/6 x 1440	52.80	10 Sqm
14	Cut Stone Masonry with			
	Cm 1:4 mix	0.16/4 x 1440	57.60	Cum
	Cm 1.5 mix	0.16/5 x 1440	46.08	Cum
15	Random Rubble Masonry with			
	Cm 1:3 mix	0.34/3 x 1440	163.20	Cum
	Cm 1:4 mix	0.34/4 x 1440	122.40	Cum
	Cm 1:5 mix	0.34/5 x 1440	97.92	Cum
16	Course Rubble Masonry (First sort) with			
	Cm 1:4 mix	0.26/4 x 1440	100.80	Cum
	Cm 1.5 mix	0.26/5 x 1440	80.64	Cum
17	Damp Proof Course with cm 1:3, 20mm thick	0.21/3 x 1440	100.80	10Sqm
18	Ellis pattern flooring in cc 1:3 using stone cuttings			
	¾ " thick		117.00	10 Sqm
	1" thick		146.25	10 Sqm

Sl No.	Description	Calculation	Cement in Kg	per
19	Mosaic flooring and Mosaic Dadooing with tiles			
	Coloured			
	For Cm 1:3 mix	0.21/3 x 1440	22 kg	10Sqm
	Pointing with cm 1:3 mix	0.04/3 x 1440	100.80	10Sqm
			19.20	10Sqm
20	Flush pointing for Brick work etc.			
	Cm 1:3 mix	0.06/3 x 1440	28.80	10 Sqm
	Cm 1:4 mix	0.06/4 x 1440	21.60	10 Sqm
	Cm 1:5 mix	0.06/5 x 1440	17.28	10 Sqm
	Cm 1:6 mix	0.06/6 x 1440	14.40	10 Sqm
21	Flush pointing for RR Masonry etc.			
	Cm 1:3 mix	0.09/3 x 1440	43.20	10 Sqm
	Cm 1:4 mix	0.09/4 x 1440	32.40	10 Sqm
	Cm 1:5 mix	0.09/5 x 1440	25.92	10 Sqm
	Cm 1:6 mix	0.09/6 x 1440	21.60	10 Sqm
22	Laying of pressed tiles in cm 1:3 mix.			
	Cm 1:3 mix base	0.12/3 x 1440	57.60	10 Sqm
	Pointing with Cm 1:3 mix	0.04/3 x 1440	19.20	10 Sqm
			76.80	10 Sqm
23	Laying of Flat tiles 2 course in cm 1:3 mix.			
	Cm 1:3 mix base	0.27/3 x 1440	129.60	10 Sqm
	Pointing with Cm 1:3 mix	0.04/3 x 1440	19.20	10 Sqm
			148.80	10 Sqm

12.4.3 Average Weight of Soils, Materials and Masonry in Kg/m3

Sl. No	Description of Item	Unit weight in Kg/m3
1.	Earth dry to wet	1600 – 2400
2	Sand dry to wet	1450 – 2000
3	Sand and Clay	2000
4	Gravel	1450
5	Gravel and Sand	1750
6	Silt dry to wet	1600 – 1750
7	Brick Masonry	1920
8	Reinforced Cement Concrete 1% Steel	2370
9	Reinforced Cement Concrete 2% Steel	2420
10	Reinforced Cement Concrete 3% Steel	2580
11	Stone Masonry	2080
12	Cement Concrete	2080 – 2400
13	Lime Concrete	1800
14	Water	1000
15	Tar	1010
16	Diesel	1840

Note: 1 Kg/m3 = 0.028 Kg/ft3

12.4.4 Live Loads on Floors in Kg/m2 (Based on IS:875)

Sl. No	Floor	Minimum Live load for floor area (Kg/m2)
1	Dwelling Houses, Hospitals, Wards, bed rooms, dormitories	200
2	Office floor other than entrance hall, light working rooms	250-400
3	Reading room, office entrance	300
4	Shops, floors for display, class room assembly of fixed seating, restaurants	400
5	Warehouse, workshop, factories	500-700
6	Stairs, landings, Corridors	300-500
7	Balconies (not liable to overcrowding)	300
8	Balconies liable for overcrowding and assembly halls without fixed seating.	500

12.4.5 Live Loads on Roofs in Kg/m2 (IS 875)

Sl No	Type of Roof	Live load measured on Plan in Kg/m2	Minimum live load measured on Plan
1	Flat, sloping or curved roof with slopes up to and including 10^0 Access provided	150	375 kg uniformly distributed over any span of one meter width of the roof slab and 900kg. uniformly distributed over the span in case of all beams.
	Access not provided except for maintenance	75	190 Kg uniformly distributed over any span of one meter width of the roof slab and 450 kg uniformly distributed over the span in the case of beams.
2	Sloping roof with slope greater than 10^0	Less one kg/m2 for every degree increase in slope over 10^0 up to and including 20^0 and 2 kg/m2 for every degree increase in slope 20^0	Subject to a min of 40kg/m2
3	Curved roofs with slope at springing	(75-345r2)kg/m where, r=h/l, h=the height of the highest point of the structure measured from its springing, l=chord width of the roof if singly curved and shorter of the two sides, if doubly curved.	Subject to min. of 40kg/m2

Note: For special types of roofs with highly permeable and absorbent material, the contingency of roof material increasing in weight due to absorption of moisture shall be provided for.

12.4.6 Coefficient for painting measurement (Equivalent Plain areas at uneven surface)

Sl.No.	Description of work	Multiplying Co-efficient
Wood works – Doors & Windows etc.		
1	Paneled or framed and braced doors, windows etc.	1.30 (for each side)
2	Ledged and battened or ledged, battened and braced doors, windows etc.	1.30(for each side)
3	Flush doors etc.	1.20(for each side)
4	Part panalled and part glassed or gauged doors, windows, etc.	1.00(for each side)
5	Fully glassed or gauged doors, windows etc.	0.80(for each side)
6	Fully Venetioned or louvered doors, windows etc.	1.80(for each side)
7	Trellies (or Jaffri) work one way or two way	2.00(for painting all over)
8	Carved or enriched work	2.00 (for each side)
9	Weather boarding	1.20 (for each side)
10	Wood shingle roofing	1.10 (for each side)
11	Boarding with cover fillets and match boarding	1.05 (for each side)
12	Tile and state battening	0.80 (for painting overall)
13	Plain sheeted steel doors or windows	1.10 (for each side)
14	Fully glazed or gauged steel doors and windows	0.50 (for each side)
15	Partly paneled or Partly glazed or gauged steel doors and windows	0.80 (for each side)
16	Corrugated sheeted steel doors or windows	1.25 (for each side)
17	Collapsible gates	1.50 (for each side)
18	Rolling shutters of interlocked laths	1.50 (for painting overall)
General Works		
19	Expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings in guard bars, balustrades, railings and partitions	1 (for painting all over)
20	Open Palisade fencing and gates including standards, braces, rails stays etc. in timber or steel.	1 (for painting all over)
21	Corrugated iron sheeting in roofs, side cladding etc.	1.14 (for each side)
22	A.C Corrugated sheeting in roofs, side cladding etc.	1.20 (for each side)
23	A.C semi Corrugated sheeting in roofs, side cladding etc.(or Nainital pattern using plain sheets)	1.10 (for each side)
24	Wire gauge shutters including painting of wire gauge	1 (for each side)

Note: The height shall be taken from the bottom of the lowest rail, if the palisades do not go below it (or from the lower end of palisades, if they project below the lowest rail) up to the top of palisades but not up to the top of standards if they are higher than the palisades.

12.5. Sectional Properties of Square and Round Bars

Sl No.	Dia or width (mm)	Weight per metre in Kg		Sectional Area		Perimeter	
		Square	Round	Square	Round	Square	Round
1	5.0	0.20	0.15	0.25	0.20	2.00	1.57
2	5.50	0.24	0.19	0.30	0.24	2.20	1.73
3	6.00	0.28	0.22	0.36	0.28	2.40	1.88
4	7.00	0.38	0.30	0.49	0.38	2.80	2.20
5	8.00	0.50	0.39	0.64	0.50	3.20	3.51
6	9.00	0.64	0.50	0.81	0.64	3.60	2.83
7	10.00	0.78	0.62	1.00	0.79	4.00	3.14
8	11.00	0.95	0.75	1.21	0.95	4.40	3.46
9	12.00	1.13	0.89	1.44	1.13	4.80	3.77
10	14.00	1.54	1.21	1.96	1.54	5.60	4.40
11	16.00	2.01	1.58	2.56	2.01	6.40	5.03
12	18.00	2.54	2.00	3.24	2.54	7.20	5.65
13	20.00	3.14	2.47	4.00	3.14	8.00	6.28
14	22.00	3.80	2.98	4.84	3.80	8.80	6.91
15	25.00	4.91	3.85	6.25	4.91	10.00	7.85
17	28.00	6.15	4.83	7.84	6.16	11.20	8.80
18	32.00	8.04	6.31	10.24	8.04	12.80	10.05
19	36.00	10.17	7.99	12.96	10.18	14.40	11.31
20	40.00	12.56	9.86	16.00	12.57	16.00	12.57
21	45.00	15.90	12.49	20.25	15.90	18.00	14.14
22	50.00	19.62	15.41	25.00	19.64	20.00	15.71
23	56.00	24.62	19.34	31.36	24.63	22.40	17.59
24	63.00	31.16	24.47	39.69	31.17	25.20	19.79
25	71.00	39.57	31.08	50.41	39.59	28.40	22.31

12.6. USUAL RANGE OF SAFE BEARING CAPACITY VALUES

Sl No.	Types of Rocks / Soils	Safe Bearing Capcity Kg / CM2
(a)	**Rocks**	
i	Rocks hard without lamination and defects, eg. Granite and dionite	33.0
ii	Laminated rocks - eg. Sandstone and lime stone	16.5
iii	Residual deposits of shattered and broken bedrock	9.0
iv	Soft Rock	4.5
(b)	**Non-Cohesive Soils**	
i	Gravel, sand offering high resistance to penetration when excavated by tools	4.5
ii	Coarse sand, compact and dry	4.5
iii	Medium sand, compact and dry	4.5
iv	Fine sand, silt	2.5
v	Loose gravel or sand gravel mixture dry	1.0
vi	Fine sand, loose and dry	1.0
(c)	**Cohesive Soils**	
i	Soft shale, hard clay in deep bed dry	4.6
ii	Medium clay, readily indented with a thumb nail	2.5
iii	Moist clay and sand clay mixture with strong thumb pressure	1.5
iv	Soft dry with moderate thumb pressure	1.0
v	Very soft clay which can be penetrated	0.5
vi	Black cotton soil or expensive clay in dry condition	No Generalized Value
vii	Peat	No Generalized Value
viii	Fills or made up ground	No Generalized Value

12.7 . Dimensions and Properties of Rolled Steel Equal Angles

Sl No.	Size A x B x t (in mm)	Sectional area (cm^2)	Weight per metre w kg	Centre of Gravity Cxx= Cyy cm	Moment of Inertia		Radii of Gyration		Sections Modulus CM^3
					Ixx cm4	Iyy cm4	rxx cm	ryy cm	
1	20 x 20 x 3	1.12	0.90	0.59	0.40	0.20	0.58	0.87	0.30
2	20 x 20 x 3	1.45	1.10	0.63	0.50	0.20	0.58	0.87	0.40
3	25 x 25 x 3	1.41	1.10	0.71	0.80	0.30	0.73	0.47	0.40
5	25 x 25 x 4	1.84	1.40	0.75	1.00	0.40	0.73	0.47	0.60
6	25 x 25 x 5	2.25	1.80	0.79	1.20	0.50	0.72	0.47	0.70
7	30 x 30 x 3	1.73	1.40	0.83	1.40	0.60	0.89	0.57	0.60
8	30 x 30 x 4	2.26	1.80	0.87	1.80	0.70	0.89	0.57	0.80
9	30 x 30 x 5	2.77	2.20	0.92	2.10	0.90	0.88	0.57	1.00
10	35 x 35 x 3	2.03	1.60	0.95	2.30	0.90	1.05	0.67	0.90
11	35 x 35 x 4	2.66	2.10	1.00	2.90	1.20	1.05	0.67	1.20
12	35 x 35 x 5	3.27	2.60	1.04	3.50	1.50	1.04	0.67	1.40
13	35 x 35 x 6	3.86	3.00	1.08	4.10	1.70	1.03	0.67	1.70
14	40 x 40 x 3	2.34	1.80	1.08	3.40	1.40	1.21	0.77	1.20
15	40 x 40 x 4	3.07	2.40	1.12	4.50	1.80	1.21	0.77	1.60
16	40 x 40 x 5	3.78	3.0	1.16	5.40	2.20	1.20	0.77	1.90
17	40 x 40 x 6	4.47	3.50	1.20	6.30	2.60	1.19	0.77	2.30
18	45 x 45 x 3	2.64	2.10	1.20	5.00	2.00	1.38	0.87	1.50
19	45 x 45 x 4	3.47	2.70	1.25	6.50	2.60	1.37	0.87	2.00
20	45 x 45 x 5	4.28	3.40	1.29	7.90	3.20	1.36	0.87	2.50
21	45 x 45 x 6	5.07	4.00	1.33	9.20	3.80	1.35	0.87	2.90
22	50 x 50 x 3	2.95	2.30	1.32	6.90	2.80	1.53	0.97	1.90
23	50 x 50 x 4	3.88	3.00	1.37	9.10	3.60	1.53	0.97	2.50
24	50 x 50 x5	4.74	3.80	1.41	11.0	4.50	1.52	0.97	3.10
25	50 x 50 x 6	5.68	4.50	1.45	12.9	5.3	1.51	0.96	3.60
26	55 x 55 x 5	5.27	4.10	1.53	14.7	5.90	1.67	1.06	3.70
27	55 x 55 x 6	6.26	4.90	1.57	17.3	7.00	1.66	1.06	4.40

28	55 x 55 x 8	8.18	6.40	1.65	22.0	9.1	1.64	1.06	5.70
29	55x55 x 10	10.02	7.90	1.72	26.3	11.2	1.62	1.06	7.00
30	60 x 60 x 5	5.75	4.50	1.65	19.2	7.70	1.82	1.16	4.40
31	60 x 60 x 6	6.84	5.40	1.69	22.6	9.10	1.82	1.15	5.20
32	60 x 60 x 8	8.96	7.00	1.77	29.0	11.9	1.80	1.15	6.80
33	60x60x10	11.00	8.60	1.85	34.8	14.6	1.78	1.15	8.40
34	65 x 65 x 5	6.25	4.90	1.77	24.7	9.90	1.99	1.26	5.20
35	65 x 65 x6	7.44	5.80	1.81	29.1	11.7	1.98	1.26	6.20
36	65 x 65 x 8	9.76	7.70	1.89	37.4	15.3	1.96	1.25	8.10
37	65x 65 x10	12.0	9.40	1.97	45.0	18.8	1.94	1.25	9.90

12.8. Weight of MS Plate (Plain)

Thickness in mm	5	6	8	10	12	14	16
Weight in Kg/m2	39.25	47.10	62.80	78.50	94.20	100.90	125.60

Thickness in mm	18	20	22	25
Weight in Kg/m2	141.30	157.00	172.70	196.25

12.9. Weight of Mild Steel Flats

Weight of Mild Steel Flats(Kg/m)													
Width in mm	**Thickness (in mm)**												
	3	4	5	6	8	10	12	16	18	20	25	32	40
10	0.2	0.3	0.5	-	-	-	-	-	-	-	-	-	-
20	0.5	0.6	0.8	0.9	1.3	1.6	-	-	-	-	-	-	-
25	0.6	0.8	1.0	1.2	1.6	2.0	2.4	-	-	-	-	-	-
30	0.7	0.9	1.2	1.4	1.9	2.2	2.8	3.8	-	-	-	-	-
35	0.8	1.1	1.4	1.6	2.4	2.8	3.3	4.4	5.0	5.5	-	-	-
40	0.9	1.3	1.6	1.9	2.5	3.1	3.8	5.0	5.6	6.3	-	-	-
45	1.1	1.4	1.8	2.1	2.8	3.5	4.2	5.6	6.4	7.1	-	-	-
50	1.2	1.6	2.0	2.4	3.1	3.9	4.7	6.3	7.1	7.8	9.8	-	
75	-	-	-	3.5	3.7	5.9	7.1	9.4	10.6	11.8	14.7	18.8	23.6
100	-	-	-	4.7	6.3	7.8	9.4	12.6	14.1	15.7	19.6	25.1	31.4

12.10. Basic Technical Information

12.10.1 Basic Conversions

1 metre	=	1000mm	1 mile	=	1.609 km
1 metre	=	100 cm	1 kilogram	=	1000 gram
1 metre	=	3.28084 feet	1 Tonne	=	1000 kilogram
1 metre	=	39.3701 inch	1 Hectare	=	104 Sq. metres
1 cm	=	0.3937 inch		=	0.01 Sq Km
1 inch	=	2.54 cm		=	2.471 acres
1 feet	=	30.48 cm		=	0.00386 sq. mile
1 feet	=	0.3048 m			
1 kilometre	=	1000 m			
1 kilometre	=	0.6214 miles			

1 Litre = 1000 cubic centimeters = 1000 millimetres = 1000 grams = 0.264 gallons (US), 0.220 = gallons(British) = 0.0353 Cubic feet = 61.02 Cubic iches = 0.001308 Cubic yard	1 Horse power = 746 Watts, = 0.746 Kilowatts
1 Litre per second = 2.12 cubic feet per minute = 0.308 gallon per minute (British) = 0.474 gallon per minute (US)	Kg per Sq mm = 0.685 tonne per sq. inch Kg per Sq cm = 14.223 pounds per sq. inch = 0.9124 tonne per sq.foot Kg per Sqm = 0.205 pounds per sq feet
1 Cubic foot = 0.0283 cubic metre28.32 litres = 1.728 cubic inches = 62.32 pounds of water = 1000 ounces of water (approx)	1 Cubic inch = 16.39 cubic centimeter 1 Cubic metre = 1000 litres = 1 kilolitre = 35.315 cubic feet = 1.308 cubic yards = 0.00081 acre foot

1 Cubic Yard	= 0.7646 cubic metre	= 27 cubic feet
1 Cumec	= 35.345 cusecs	= 0.0283 Cumecs
1 Cumec per day	= 0.0864 million cubic metre	= 8.64 hectare metre
1 Cubic centimeter	= 1 milli litre	= 1/1000 litre
		= 0.061 cubic inch

12.10.2. Paper sizes:

Sl No.	Paper Size	mm	Inches
1	A0	841 x 1189	33.1 x 46.8
2	A1	594 x 841	23.4 x 33.1
3	A2	420 x 594	16.5 x 23.4
4	A3	297 x 420	11.7 x 16.5
5	A4	210 x 297	8.3 x 11.70
6	A5	148 x 210	5.8 x 8.3
7	A6	105 x 148	4.1 x 5.8
8	A7	74 x 105	2.9 x 4.10

Gauge Conversion

Gauge No	Inches	mm	Gauge No	Inches	mm
0000	0.400	10.160	24	0.022	0.559
000	0.372	9.0449	25	0.020	0.508
00	0.348	8.839	26	0.018	0.457
0	0.324	8.230	27	0.0164	0.4166
1	0.300	7.620	28	0.0148	0.3759
2	0.276	7.010	29	0.0136	0.3454
3	0.252	6.401	30	0.0124	0.315
4	0.232	5.893	31	0.0116	0.2946
5	0.212	5.385	32	0.0108	0.2743
6	0.196	4.877	33	0.010	0.254
7	0.176	4.470	34	0.0092	0.2337
8	0.160	4.064	35	0.0084	0.2134
9	0.144	3.658	36	0.0076	0.193
10	0.128	3.251	37	0.0068	0.1727
11	0.116	2.946	38	0.006	0.1524
12	0.104	2.642	39	0.0052	0.1312
13	0.092	2.337	40	0.0048	0.1219
14	0.080	2.032	41	0.0044	0.1118
15	0.072	1.829	42	0.004	0.1016
16	0.064	1.626	43	0.0026	0.0914
17	0.056	1.422	44	0.0032	0.0813
18	0.048	1.219	45	0.0028	0.0711
19	0.040	1.016	46	0.0024	0.061
20	0.036	0.914	47	0.002	0.0508
21	0.032	0.813	48	0.0016	0.0408
22	0.028	0.711	49	0.0012	0.0305
23	0.024	0.610	50	0.001	0.0254

12.11. LIST OF INDIAN STANDARDS RELATED TO BUILDING CONSTRUCTION, MANAGEMENT AND QUALITY CONTROL

SP 7 : 1983	National building code of India 1983
SP 10: 1975	Nomograms for Thickness of Masonry Walls
SP 16: 1980	Design Aids for Reinforced Concrete to IS 456 : 1978
SP 20 (S and T) : 1991	Handbook on Masonry Design and Construction
SP 21 (S and T) : 1983	Summaries of Indian Standards for Building Materials
SP 22 : 1982	Explanatory Handbook on Codes for Earthquake Engineering
SP 23 : 1982	Handbook on Concrete Mixes
SP 24 (S and T) : 1983 Reinforced	Explanatory Handbook on Indian Standard Code of Practice for Plain and Concrete
SP 25 : 1984	Handbook on Causes and Prevention of Cracks in Buildings
SP 27 : 1987	Handbook on method of measurement of buildings works
SP 30 : 1985	Special Publication - National Electrical Code
SP 32 : 1986 Ventilation)	Handbook on Functional Requirements of Industrial Buildings (Lighting and
SP 34 : 1987	Handbook on Concrete Reinforcement and Detailing
SP 35 : 1987	Handbook on Water Supply and Drainage (with Special Emphasis on Plumbing)
SP 36 : Part 1 : 1987	Compendium of Indian standards on soil engineering: Part 1 Laboratory testing of soils for civil engineering purposes
SP 36 : Part 2 : 1988	Compendium of Indian standards on soil engineering: Part 2 Field testing
SP 38 (S and T) : 1987	Handbook of Typified Designs for Structures with Steel Roof Trusses (with and without Cranes) (Based on is Codes)
SP 41 (S and T) : 1987	Handbook on Functional Requirements of Buildings (Other than Industrial Buildings)
SP 43 (S and T) : 1987	Handbook on Structures with Reinforced Concrete Portal Frames (Without Cranes)
SP 46 : 2003	Engineering Drawing Practice for Schools and Colleges
SP 57 (QAWSM) : 1993	Handbook on Pipes and Fittings for Drinking Water Supply
SP 58 : 1995	Handbook on Pumps for Drinking Water Supply
SP 60 : 1993	Guidelines for Competence, Acceptance and Accreditation of Laboratories, Inspection Bodies, Certification Bodies and Systems of Certification
SP 62 (S and T) : 1997	Handbook on Building Construction Practices (Excluding Electrical Work)
SP 63 : 1997	Explanatory guide for the application of quality system standards (IS/ISO 9001, 9002 and 9003)

SP 64 (S & T) : 2001	Explanatory Handbook on Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures
SP 70 : 2001	Handbook on Construction Safety Practices
SP 1650 : 1993	Standard colours for building and decorative finishes
IS 5 : 1994	Colours for ready mixed paints and enamels
IS 195 : 1991	Fireclay Mortar for Laying Fireclay Refractory Bricks - Specification
IS 269 : 1989	Specification for 33 grade ordinary Portland cement
IS 383 : 1970	Specification for coarse and fine aggregates from natural sources for concrete
IS 456 : 2000	Plain and Reinforced Concrete - Code of Practice
IS 457 : 1957	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures
IS 516 : 1959	Method of test for‘strength of concrete
IS 650 : 1991	Specification for standard sand for testing of cement
IS 732 : 1989	Code of Practice for Electrical Wiring Installations
IS 772 : 1973	Specification for general requirements for enamelled cast iron sanitary appliances
IS 783 : 1985	Code of practice for laying of concrete pipes
IS 784 : 2001	Prestressed Concrete Pipes (Including Fittings) - Specification
IS 875 : Part 1 : 1987	Code of practice for design loads (other than earthquake)for buildings and structures Part 1 Dead loads - Unit weights of building material and stored materials (Incorporating IS:1911-1967)
IS 875 : Part 2 : 1987	Code of practice for design loads (other than earthquake) for buildings and structures: Part 2 Imposed loads
IS 875 : Part 3 : 1987	Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures - Part 3 : Wind Loads
IS 875 : Part 4 : 1987	Code of practice for design loads (other than earthquake) for buildings and structures Part 4 Snow loads
IS 875 : Part 5 : 1987	Code of practice for design loads (other than earthquake) for buildings and structures Part 5 Special loads and load combinations
IS 962 : 1989	Code of practice for architectural and building drawings
IS 1038 : 1983	Specification for steel doors, windows and ventilators
IS 1077 : 1992	Common Burnt Clay Building Bricks - Specification
IS 1080 : 1985	Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)
IS 1121 : Part 1 : 1974	Methods of test for determination of strength properties of natural building stones: Part I Compressive strength

IS 1121 : Part II : 1974	Methods of Test for Determination of Strength Properties of Natural Building Stones - Part II : Transverse Strength
IS 1121 : Part III : 1974	Methods of Test for Determination of Strength Properties of Natural Building Stones - Part III : Tensile Strength
IS 1121 : Part 4 : 1974	Methods of test for determination of strength properties of natural building stones: Part IV Shear strength
IS 1122 : 1974	Method of test for determination of true specific gravity of natural building stones
IS 1123 : 1975	Method of identification of natural building stones
IS 1124 : 1974	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS 1127 : 1970	Recommendations for dimensions and workmanship of natural building stones for masonry work
IS 1172 : 1993	Code of Basic Requirements for Water Supply, Drainage and Sanitation
IS 1195 : 2002	Bitumen-Mastic for Flooring - Specification
IS 1199 : 1959	Methods of sampling and analysis of concrete
IS 1200 : Part 1 : 1992	Methods of measurement of building and civil engineering works: Part 1 Earthwork
IS 1200 : Part 2 : 1974	Method of measurement of building and engineering works: Part 2 concrete works
IS 1200 : Part III : 1976	Method of Measurement of Building and Civil Engineering Works - Part III : Brickwork
IS 1200 : Part 4 : 1976	Method of measurement of building and civil engineering works: Part 4 stone masonry
IS 1200 : Part 5 : 1982	Method of measurement of building and civil engineering works: part 5 form work
IS 1200 : Part 6 : 1974	Method of measurement of building and civil engineering works: Part 6 refractory work
IS 1200 : Part 7 : 1972	Method of measurement of building and civil engineering works: Part 7 hardware
IS 1200 : Part 8 : 1993	Method of measurement of building and civil engineering work: Part 8 steel work and iron work
IS 1200 : Part 9 : 1973	Method of measurement of building and civil engineering work: Part 9 roof covering (including cladding)
IS 1200 : Part 10 : 1973	Method of measurement of building and civil engineering works: part 10 ceiling and linings
IS 1200 : Part 11 : 1977	Method of measurement of building and civil engineering work: Part11 paving, floor finishes dado and skirting
IS 1200 : Part XII : 1976	Method of Measurement of Building and Civil Engineering Works - Part XII : Plastering and Pointing
IS 1200 : Part 13 : 1994	Method of measurement of building and civil engineering works: Part 13 Whitewashing, colour washing, distempering and painting of building surfaces
IS 1200 : Part 14 : 1984	Method of measurement of building and civil engineering works: Part 14 glazing
IS 1200 : Part 15 : 1987	Method of measurement of building and civil engineering works: Part 15 painting, polishing, varnishing etc

IS 1200 : Part 16 : 1979	Method of measurement of building and civil engineering works: Part 16 laying of water and sewer lines including appurtenant items
IS 1200 : Part 17 : 1985	Method of measurement of building and civil engineering works: Part 17 road work including air field pavements
IS 1200 : Part 18 : 1974	Method of measurement of building and civil engineering works: Part 18 demolition and dismantling
IS 1200 : Part XIX : 1981	Method of Measurement of Building and Civil Engineering Works - Part XIX : Water Supply, Plumbing and Drains
IS 1200 : Part 20 : 1981	Method of measurement of building and civil engineering works: Part 20 laying of gas and oil pipelines
IS 1200 : Part 22 : 1982	Method of measurement of building and civil engineering works: Part 22 materials
IS 1200 : Part 23 : 1988	Method of measurement of building and civil engineering works: Part 23 piling
IS 1200 : Part 24 : 1983	Method of measurement of building and civil engineering works: Part 24 well foundations
IS 1200 : Part 27 : 1992	Method of measurement of building and civil engineering works: Part 27 Earthwork done by mechanical appliances
IS 1200 : Part 28 : 1992	Methods of measurement of building and civil engineering works: Part 28 Sound insulation works
IS 1237 : 1980	Specification for Cement Concrete Flooring Tiles
IS 1332 : 1986	Specification for precast reinforced concrete street lighting poles
IS 1343 : 1980	Code of Practice for Prestressed Concrete
IS 1346 : 1991	Code of Practice for Waterproofing of Roofs with Bitumen Felts
IS 1443 : 1972	Code of practice for laying and finishing of cement concrete flooring tiles
IS 1481 : 1970	Specification for Metric Steel Scales for Engineers
IS 1498 : 1970	Classification and identification of soils for general engineering purposes
IS 1553 : 1989	Design of Library Buildings - Recommendations Relating to its Primary Elements
IS 1597 : Part 1 : 1992	Construction of Stone Masonry - Code of Practice - Part 1 : Rubble Stone Masonry
IS 1597 : Part 2 : 1992	Code of practice for construction of stone masonry: Part 2 Ashlar masonry
IS 1630 : 1984	Specification for mason's tools for plaster work and pointing work
IS 1642 : 1989	Code of practice for fire safety of buildings (general): Details of construction
IS 1646 : 1997	Code of practice for fire safety of buildings (general): Electrical installations
SP 1650 : 1973	Standard colours for building and decorative finishes (with supplement)
IS 1706 : 1972	Method for determination of resistance to wear by abrasion of natural building stones
IS 1791 : 1985	General Requirements for Batch Type Concrete Mixers
IS 1892 : 1979	Code of practice for subsurface investigations for foundations
IS 1893 : 1984	Criteria for earthquake resistant design of structures

IS 1893 : Part 1 : 2002	Criteria for Earthquake Resistant Design of Structures - Part 1 : General Provisions and Buildings
IS 1904 : 1986	Code of practice for design and construction of foundations in soils: general requirements
IS 2064 : 1993	Code of practice for selection, installation and maintenance of sanitary appliances
IS 2065 : 1983	Code of practice for water supply in buildings
IS 2185 : Part I : 1979	Specification for Concrete Masonry Units - Part I : Hollow and Solid Concrete Blocks
IS 2185 : Part 2 : 1983	Specification for concrete masonry units: Part 2 Hollow and solid light weight concrete blocks (superseding IS:3590)
IS 2185 : Part 3 : 1984	Specification for concrete masonry units Part 3 Autoclaved cellular Aerated concrete blocks (Superseding IS:5482)
IS 2212 : 1991	Code of practice for brickwork
IS 2386 : Part I : 1963	Methods of Test for Aggregates for Concrete - Part I : Particle Size and Shape
IS 2386 : Part 2 : 1963	Methods of test for aggreegates for concrete Part 2 Estimation of deleterious materials and organic impurities
IS 2386 : Part 3 : 1963	Methods of test for aggregates for concrete Part 3 Specific gravity, density, voids, absorption and bulking
IS 2386 : Part 4 : 1963	Methods of test for aggregates for concrete Part 4 Mechanical properties
IS 2386 : Part V : 1963	Methods of Test for Aggregates for Concrete - Part V : Soundness
IS 2386 : Part 6 : 1963	Methods of test for aggregates for concrete : Part 6 Measuring mortar making properties of fine aggregates
IS 2386 : Part VII : 1963	Methods of Test for Aggregates for Concrete - Part VII : Alkali Aggregate Reactivity
IS 2386 : Part VIII : 1963	Methods of Test for Aggregates for Concrete - Part VIII : Petrographic Examination
IS 2395 : Part 1 : 1994	Painting of Concrete, Masonry and Plaster Surfaces - Code of Practice - Part 1 : Operations and Workmanship
IS 2395 : Part 2 : 1994	Code of practice for painting concrete, masonry and plaster surfaces: Part 2 Schedule
IS 2430 : 1986	Methods for Sampling of Aggregates for Concrete
IS 2470 : Part 1 : 1985	Code of practice for installation of septic tanks: Part I design, criteria and construction
IS 2470 : Part 2 : 1985	Code of practice for installation of septic tanks: Part II Secondary treatment and disposal of septic tank effluent
IS 2502 : 1963	Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS 2720 : Part 1 : 1983	Methods of Test for Soils - Part 1 : Preparation of Dry Soil Samples for Various Tests
IS 2720 : Part 2 : 1973	Methods of test for soils: Part 2 Determination of water content
IS 2720 : Part 3 : Sec 1 : 1980	Methods of test for soils: Part 3 Determination of specific gravity Section 1 fine grained soils
IS 2720 : Part III : Sec 2 : 1980	Test for Soils - Part III : Determination of Specific Gravity - Section 2 : Fine, Medium and Coarse Grained Soils

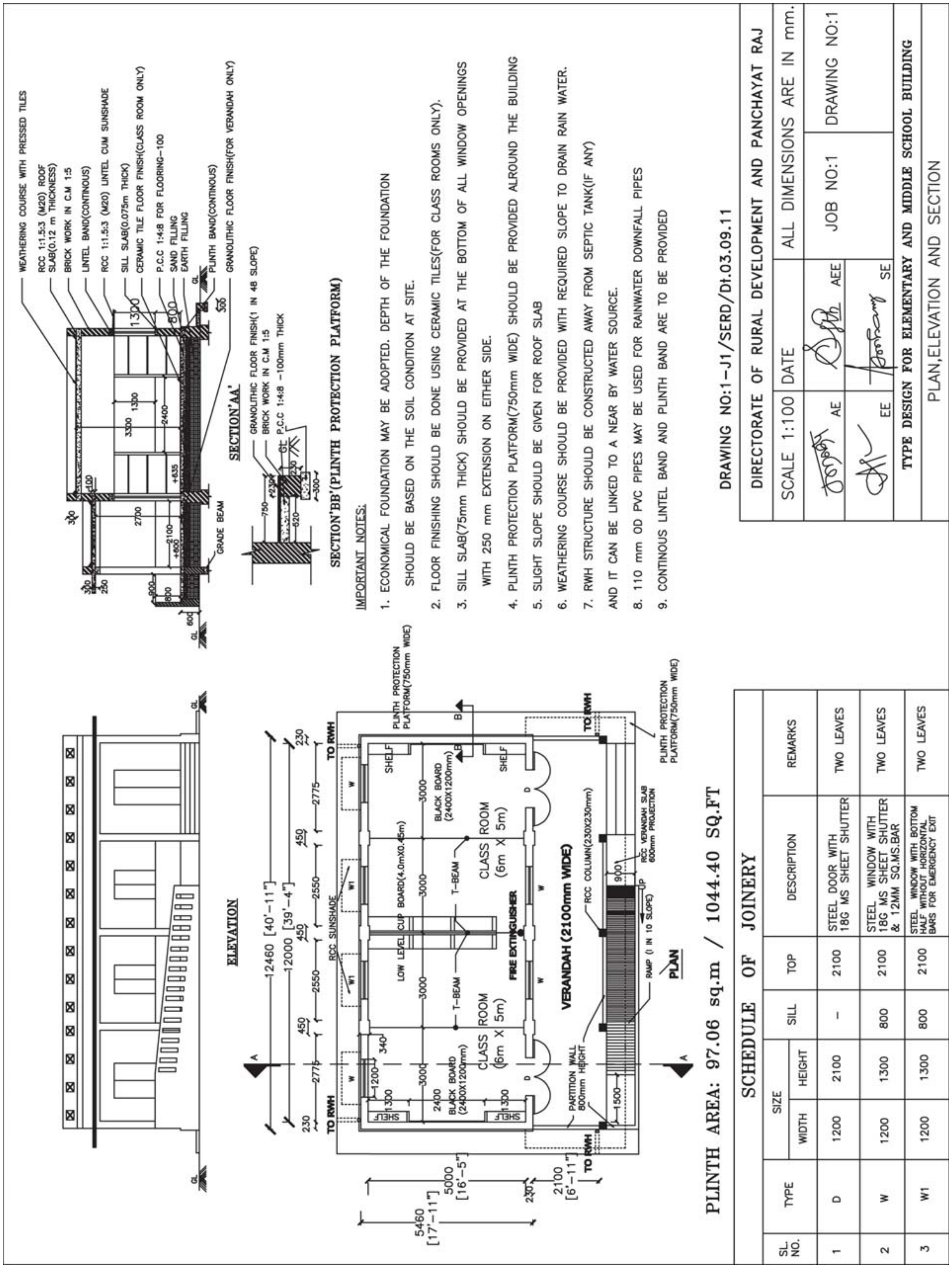
IS 2720 : Part 4 : 1985	Methods of Test for Soils - Part 4 : Grain Size Analysis
IS 2720 : Part 5 : 1985	Method of Test for Soils - Part 5 : Determination of Liquid and Plastic Limit
IS 2720 : Part 6 : 1972	Methods of test for soils: Part 6 Determination of shrinkage factors
IS 2720 : Part VII : 1980	Methods of Test for Soils - Part VII : Determination of Water Content-Dry Density Relation Using Light Compaction
IS 2720 : Part 8 : 1983	Methods of Test for Soils - Part 8 : Determination of Water Content-Dry Density Relation Using Heavy Compaction
IS 2720 : Part 9 : 1992	Methods of test for soils: Part 9 Determination of dry density- moisture content relation by constant weight of soil method
IS 2720 : Part 10 : 1991	Methods of test for soils: Part 10 Determination of unconfined compressive strength
IS 2720 : Part 11 : 1993	Methods of test for soils: Part 11 Determination of the Shear Strength Parameters of a specimen tested in inconsolidated, indrained triaxial compression without the measurement of pore water pressure
IS 2720 : Part 12 : 1981	Methods of test for soils: Part 12 Determination of shear strength parameters of soil from consolidated undrained triaxial compression test with measurement of pore water pressure
IS 2720 : Part 13 : 1986	Methods of Test for Soils - Part 13 : Direct Shear Test
IS 2720 : Part 14 : 1983	Methods of Test for Soils - Part 14 : Determination of Density Index (Relative Density) of Cohesionless Soils
IS 2720 : Part XV : 1965	Methods of Test for Soils - Part XV : Determination of Consolidation Properties
IS 2720 : Part 16 : 1987	Methods of Test for Soil - Part 16 : Laboratory Determination of CBR
IS 2720 : Part 17 : 1986	Methods of Test for Soils - Part 17 : Laboratory Determination of Permeability
IS 2720 : Part 18 : 1992	Methods of test for Soils - Part 18 : Determination of Field Moisture Equivalent
IS 2720 : Part 19 : 1992	Methods of Test for Soils - Part 19 : Determination of Centrifuge Moisture Equivalent
IS 2720 : Part 20 : 1992	Methods of test for soils: Part 20 Determination of linear shrinkage
IS 2720 : Part XXI : 1977	Methods of Test for Soils - Part XXI : Determination of Total Soluble Solids
IS 2720 : Part 22 : 1972	Methods of test for soils: Part 22 Determination of organic matter
IS 2720 : Part 23 : 1976	Methods of test for soils: Part 23 Determination of calcium carbonate
IS 2720 : Part XXIV : 1976	Methods of Test for Soils - Part XXIV : Determination of Cation Exchange Capacity
IS 2720 : Part 25 : 1982	Methods of test for soils: Part 25 Determination silica sesquioxide ratio
IS 2720 : Part 26 : 1987	Method of Test for Soils - Part 26 : Determination of pH Value
IS 2720 : Part 27 : 1977	Methods of test for soils: Part 27 Determination of total soluble sulphates
IS 2720 : Part 28 : 1974	Methods of test for soils: Part 28 Determination of dry density of soils inplace, by the sand replacement method
IS 2858 : 1984 Code of practice for roofing with mangalore tiles	

IS 3583 : 1988	Specification for burnt clay paving bricks
IS 3589 : 2001	Steel Pipes for Water and Sewage (168.3 to 2 540 mm Outside Diameter) - Specification
IS 4648 : 1968	Guide for Electrical Layout in Residential Buildings
IS 4925 : 1968	Specification for concrete batching and mixing plant
IS 4926 : 2003	Ready-Mixed Concrete - Code of Practice
IS 5410 : 1992	Cement Paint - Specification
IS 5411 : Part I : 1974	Specification for Plastic Emulsion Paint - Part I : For Interior Use
IS 5411 : Part II : 1972	Specification for Plastic Emulsion Paint - Part II : For Exterior Use
IS 5491 : 1969	Code of practice for laying of in-situ granolithic concrete flooring topping
IS 6042 : 1969	Code of practice for construction of lightweight concrete block masonry
IS 7245 : 1974	Specification for concrete pavers
IS 7251 : 1974	Specification for concrete finishers
IS 7634 : Part 3 : 2003 Practice - Part 3 :	Plastics Pipes Selection, Handling, Storage and Installation for Potable Water Supplies - Code of Laying and Jointing of UPVC Pipes
IS 7662 : Part 1 : 1974	Recommendations for orientation of buildings: Part 1 Non-industrial buildings
IS 7784 : Part 1 : 1993	Code of practice for design of cross drainage works: Part 1 General features
IS 7784 : Part 2 : Sec 1 : 1995	Code of practice for design of cross drainage works: Part 2 Specific requirements Section I Aqueducts
IS 7784 : Part 2 : Sec 2 : 2000	Code of Practice for Design of Cross Drainage Works - Part 2 : Specific Requirements - Section 2 : Super passages
IS 7784 : Part 2 : Sec 3 : 1996	Code of practice for design of cross drainage works: Part 2 Specific requirements Section 3 Canal siphons
IS 7784 : Part 2 : Sec 4 : 1999	Design of Cross Drainage Works - Code of Practice - Part 2 : Specific Requirements - Section 4 : Level Crossings
IS 7784 : Part 2 : Sec 5 : 2000	Code of Practice for Design of Cross Drainage Works - Part 2 : Specific Requirements - Section 5 : Siphon Aqueducts
IS 10262 : 1982	Recommended guidelines for concrete mix design
IS 14215 : 1994	Design and Construction of Floors and Roofs with Precast Reinforced Concrete Channel Units - Code of Practice
IS 14961 : 2001	Guidelines for Rain Water Harvesting in Hilly Areas by Roof Water Collection System
IS 14978 : 2002	New Seven Tools for Quality Management

13. TYPE DESIGN DRAWINGS

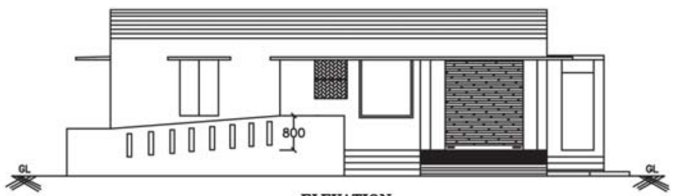
13. TYPE DESIGN DRAWINGS

Type Design for Elementary and Middle School Building

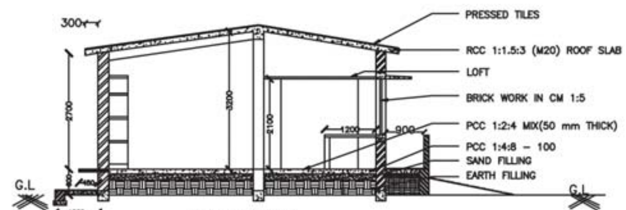


SL. NO.	TYPE	SIZE WIDTH	SIZE HEIGHT	SILL	TOP	DESCRIPTION	REMARKS
1	D	1200	2100	-	2100	STEEL DOOR WITH 18G MS SHEET SHUTTER	TWO LEAVES
2	W	1200	1300	800	2100	STEEL WINDOW WITH 18G MS SHEET SHUTTER & 12MM SQ.MS.BAR	TWO LEAVES
3	W1	1200	1300	800	2100	STEEL WINDOW WITH BOTTOM HALF WITHOUT HORIZONTAL BARS FOR EMERGENCY EXIT	TWO LEAVES

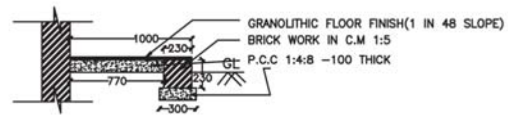
Type Design for Public Distribution Shop (Sloped Roof)



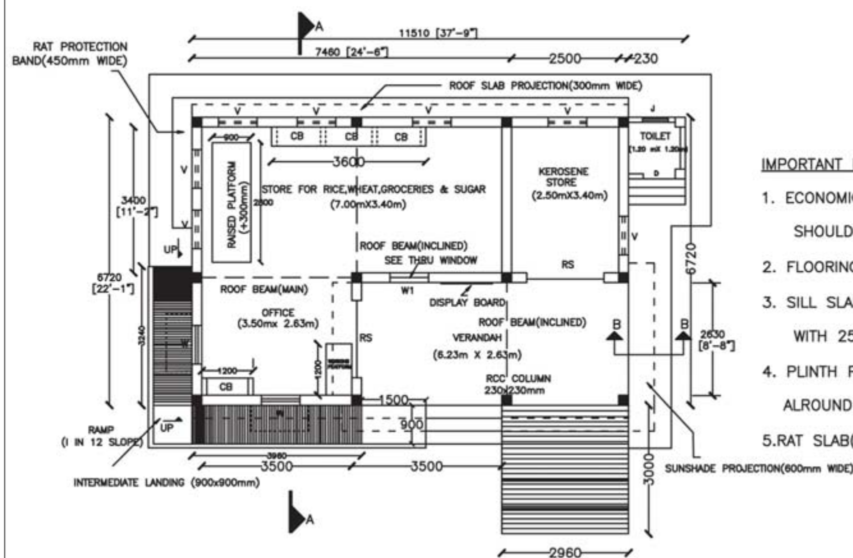
ELEVATION



SECTION'AA'



SECTION'BB'(PLINTH PROTECTION PLATFORM)



IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF THE FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE DONE USING PCC 1:2:4 MIX CONCRETE(50mm THICK).
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED AT THE BOTTOM OF ALL WINDOW OPENINGS WITH 250mm EXTENSION ON EITHER SIDE.
4. PLINTH PROTECTION PLATFORM(1000mm WIDE) SHOULD BE PROVIDED ALROUND THE BUILDING
5. RAT SLAB(50mm THICK) SHOULD BE PROVIDED AT BASEMENT LEVEL

SCHEDULE OF JOINERY

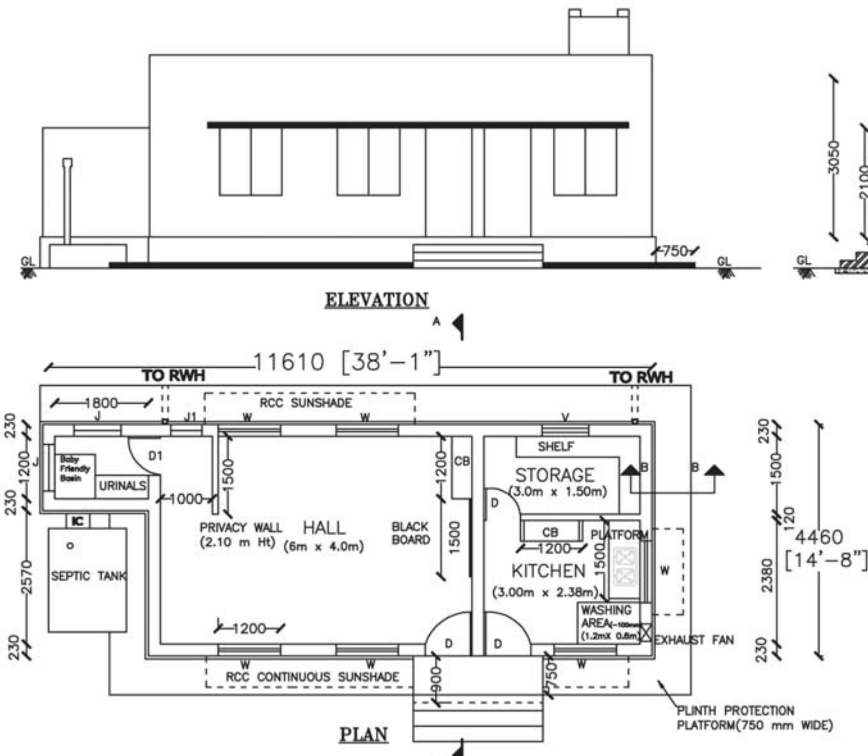
SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	RS	1800	2100	–	2100	ROLLING SHUTTER	----
2	D	750	1800	–	1800	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF
3	W	900	1300	800	2100	STEEL WINDOW WITH 18GMS SHEET SHUTTER 12MM SQ.MS.BAR	TWO LEAVES
4	W1	750	900	1200	2100	SEE THRU WINDOW WITH GRILLS AND FIXED GLASS(INSIDE)	----
5	V	900	600	2100	2700	STEEL GLAZED VENTILATOR WITH 12MM SQ.MS.BAR	N-TYPE
6	J	600	450	1650	2100	RCC JOLLY	----

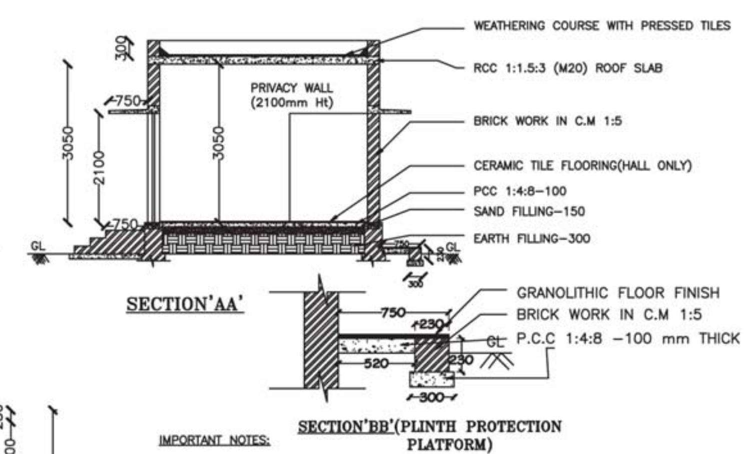
PLINTH AREA :70.38 sq.m / 757.29 sq.ft

DRAWING NO:1–J2/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATE	ALL DIMENSIONS ARE IN mm	
AE	AEE	JOB NO:2	DRAWING NO:1
EE	SE		
TYPE DESIGN FOR PUBLIC DISTRIBUTION SHOP(SLOPED ROOF)			
PLAN,ELEVATION AND SECTION			

Type Design for Noon Meal Centre / Anganwadi





PLINTH AREA :46.59 sq.m / 501.30 sq.ft

IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE DONE USING CERAMIC TILES(FOR HALL ONLY).
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED AT BOTTOM OF ALL WINDOW OPENINGS WITH 250 mm EXTENSION ON EITHER SIDE.
4. PLINTH PROTECTION PLATFORM(750mm WIDTH) SHOULD BE PROVIDED ALROUND THE BUILDING
5. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
6. WEATHERING COURSE SHOULD BE PROVIDED WITH REQUIRED SLOPE TO DRAIN RAIN WATER.
7. RWH STRUCTURE SHOULD BE CONSTRUCTED AWAY FROM SEPTIC TANK(IF ANY) AND IT CAN BE LINKED TO A NEAR BY WATER SOURCE.
8. 110 mm OD PVC PIPES MAY BE USED FOR RAINWATER DOWNFALL PIPES.
9. WASHING AREA SHOULD BE 100mm LOWER THAN FLOOR LEVEL.
10. CARTOONS SHOULD BE DRAWN INSIDE THE HALL AND TOILET ONLY.
11. PVC TANK OF 500 LITRES CAPACITY SHOULD BE PROVIDED.
12. CONTINOUS LINTEL SHOULD BE PROVIDED.

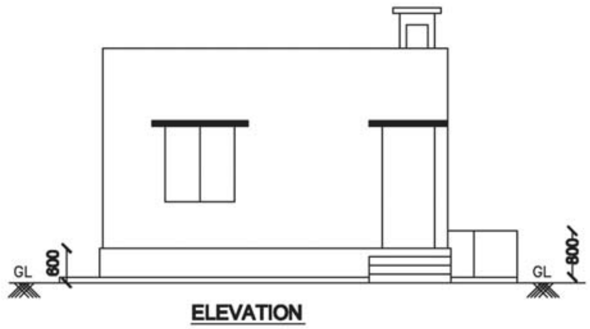
SCHEDULE OF JOINERY

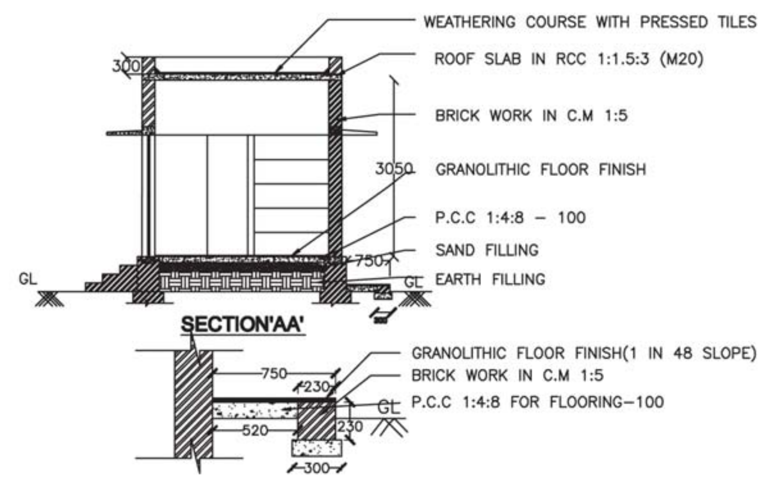
SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	D	900	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF
2	D1	750	1200	–	–	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF
3	W	1200	1300	800	2100	STEEL WINDOW WITH 18GMS SHEET SHUTTER& 12MM SQ.MS.BARS	TWO LEAF
4	V	900	450	1650	2100	STEEL GLAZED VENTILATOR WITH 12MM SQ.MS.BAR	N–TYPE
5	J	900	450	1650	2100	R.C.C JOLLY	–
6	J1	600	1300	800	2100	R.C.C JOLLY	–

DRAWING NO:1–J3/SERD/Dt.03.09.11

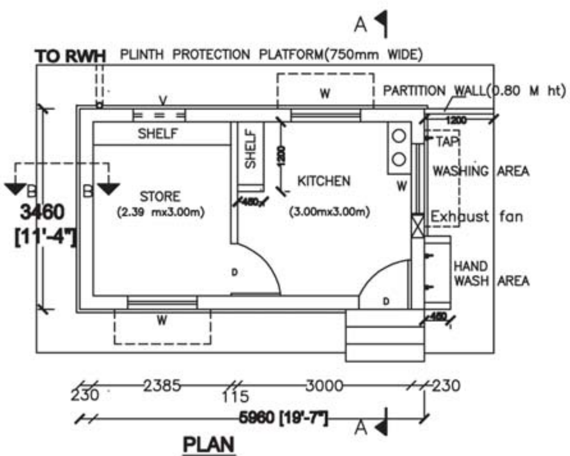
DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATE:	ALL DIMENSION ARE IN mm.	
AE / EE	AEE / BE	JOB NO:3	DRAWING NO:1
TYPE DESIGN FOR NOON MEAL CENTRE/ANGANWADI			
PLAN, ELEVATION AND SECTION			

Type Design for Kitchen Shed (Elementrary School)





SECTION'BB'(PLINTH PROTECTION PLATFORM)



PLINTH AREA : 20.62 SQM/221.87 SFT.

SCHEDULE OF JOINERY

SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	D	900	2100	–	2100	STEEL DOOR WITH 18 GMS SHEET SHUTTER	SINGLE LEAF
2	W	1200	1300	800	2100	STEEL WINDOW WITH 18GMS SHEET SHUTTER &12MM SQ.M.S.BARS	TWO LEAVES
3	V	900	450	2600	3050	STEEL GLAZED VENTILATOR WITH 12 GMS SQ. M.S. BARS	N–TYPE

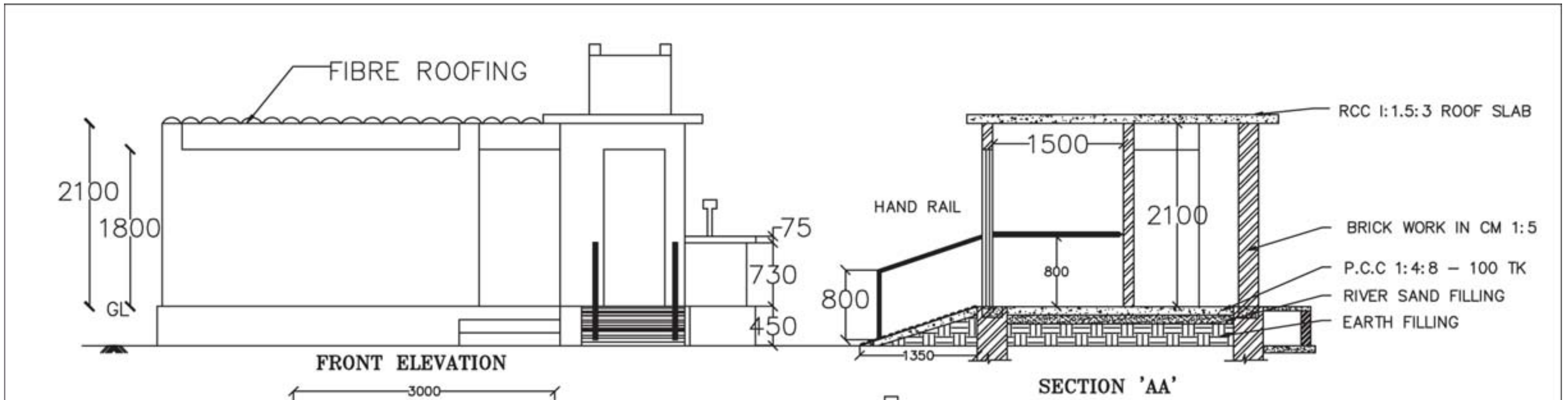
IMPORTANT NOTES:

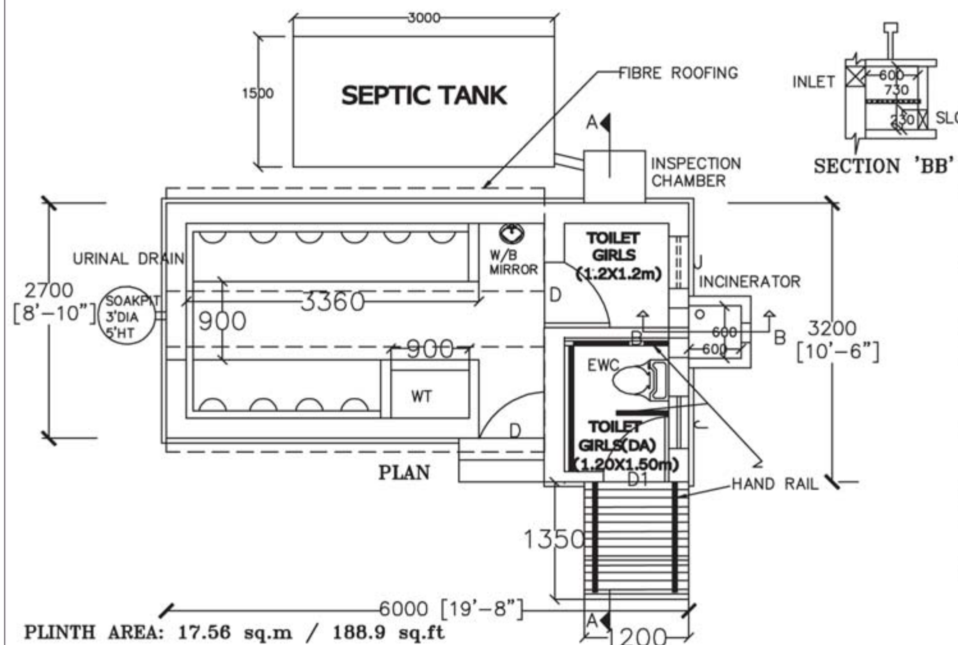
1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE OF GRANOLITHIC TYPE.
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED AT BOTTOM OF ALL WINDOW OPENINGS WITH 250 mm EXTENSION ON EITHER SIDE.
4. PLINTH PROTECTION PLATFORM(750mm WIDTH) SHOULD BE PROVIDED ALROUND THE BUILDING
5. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
6. WEATHERING COURSE SHOULD BE PROVIDED WITH REQUIRED SLOPE TO DRAIN RAIN WATER.
7. RWH STRUCTURE SHOULD BE CONSTRUCTED AWAY FROM SEPTIC TANK(IF ANY) AND IT CAN BE LINKED TO A NEAR BY WATER SOURCE.
8. 110 mm OD PVC PIPES MAY BE USED FOR RAIN WATER DOWNFALL PIPES.
9. 35 mm CLEAR COVER IN THE ROOF SLAB MAY BE PROVIDED.
10. CONTINOUS LINTEL SHOULD BE PROVIDED.

DRAWING NO:1–J4/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:50	DATE:	ALL DIMENSIONS ARE IN mm.	
AE / EE	AEE / SE	JOB NO:4	DRAWING NO:1
TYPE DESIGN FOR KITCHEN SHED (ELEMENTARY SCHOOL)			
PLAN, ELEVATION AND SECTION.			

Type Design for School Toilet (Girls)





IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE DONE USING ANTI SKID TILES FOR TOILETS ONLY.
3. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
4. HANDRAILS SHOULD BE PROVIDED INSIDE THE TOILET AND AT THE RAMP PORTION FOR DIFFERENTLY ABLED STUDENTS.
5. FIBRE ROOFING HAS TO BE PROVIDED ONLY IF THERE IS ANY BUILDING NEAR BY.
6. SURFACE OF THE RAMP SHOULD BE GROOVED.
7. PVC TANK WITH 500 LITRES CAPACITY SHOULD BE PROVIDED.
8. DOOR (FOR DA TOILET) SHOULD BE PROVIDED WITH HANDRAIL.

PLINTH AREA: 17.56 sq.m / 188.9 sq.ft

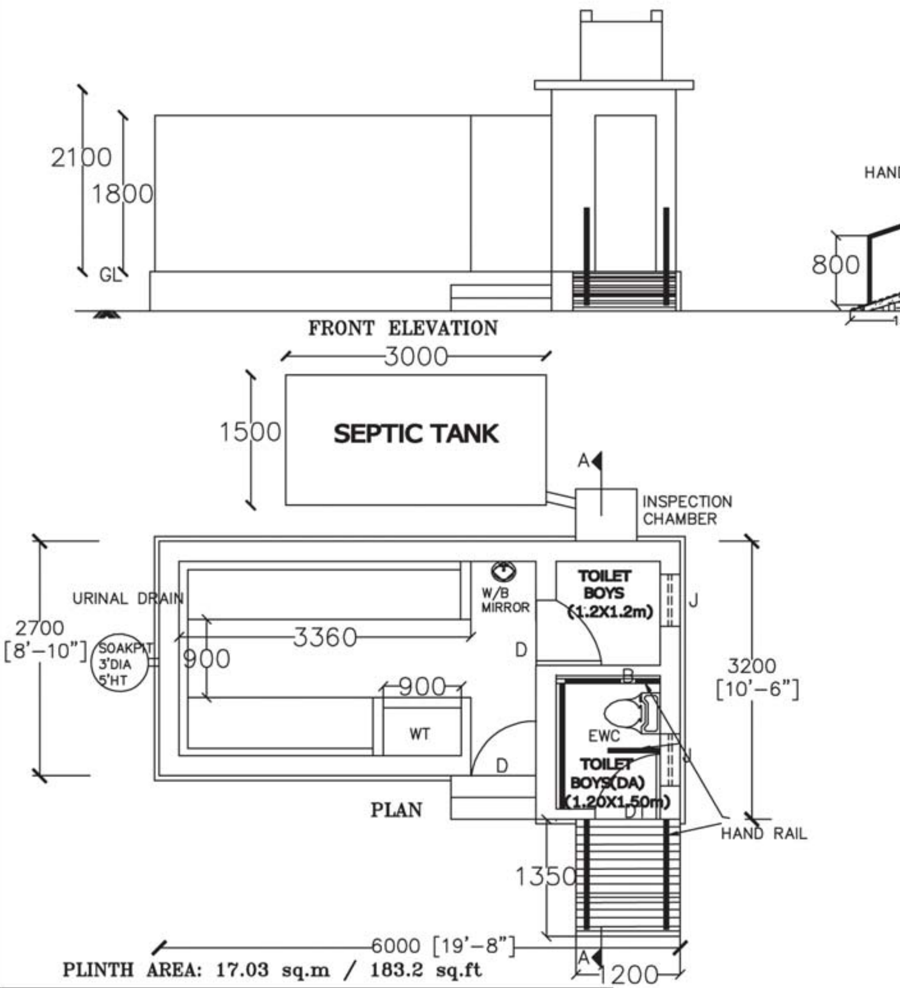
SCHEDULE OF JOINERY

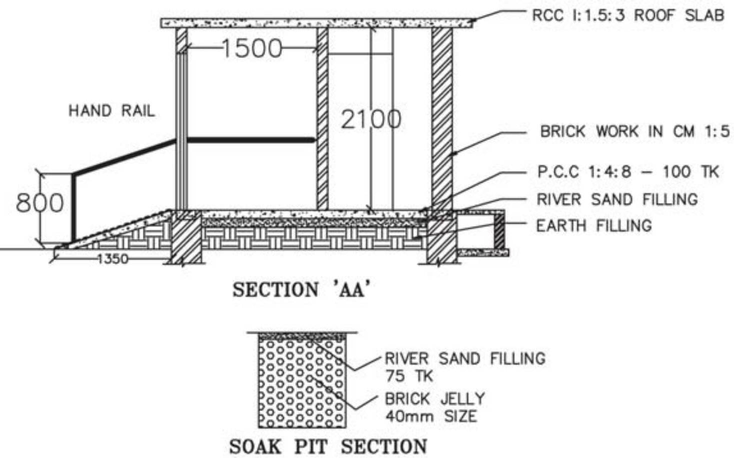
SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	D	750	1800	–	1800	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE
2	D1	750	1800	–	1800	STEEL DOOR WITH 18GMS SHEET SHUTTER WITH HANDRAIL	SINGLE
	J	600	300	1500	1800	RCC JOLLY	—

DRAWING NO:1–J5/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ		
SCALE 1:100	DATE;	ALL DIMENSIONS ARE IN mm.
AE / AEE	JOB NO:5	DRAWING NO:1
EE / SE		
TYPE DESIGN FOR SCHOOL TOILET (GIRLS)		
PLAN,ELEVATION AND SECTION		

Type Design for School Toilet (Boys)





IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE DONE USING ANTI SKID TILES FOR TOILETS ONLY.
3. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
4. HANDRAILS SHOULD BE PROVIDED INSIDE THE TOILET AND AT THE RAMP PORTION FOR DIFFERENTLY ABLED STUDENTS.
5. SURFACE OF THE RAMP SHOULD BE GROOVED.
6. DOOR (FOR DA TOILET) SHOULD BE PROVIDED WITH HANDRAIL.

PLINTH AREA: 17.03 sq.m / 183.2 sq.ft

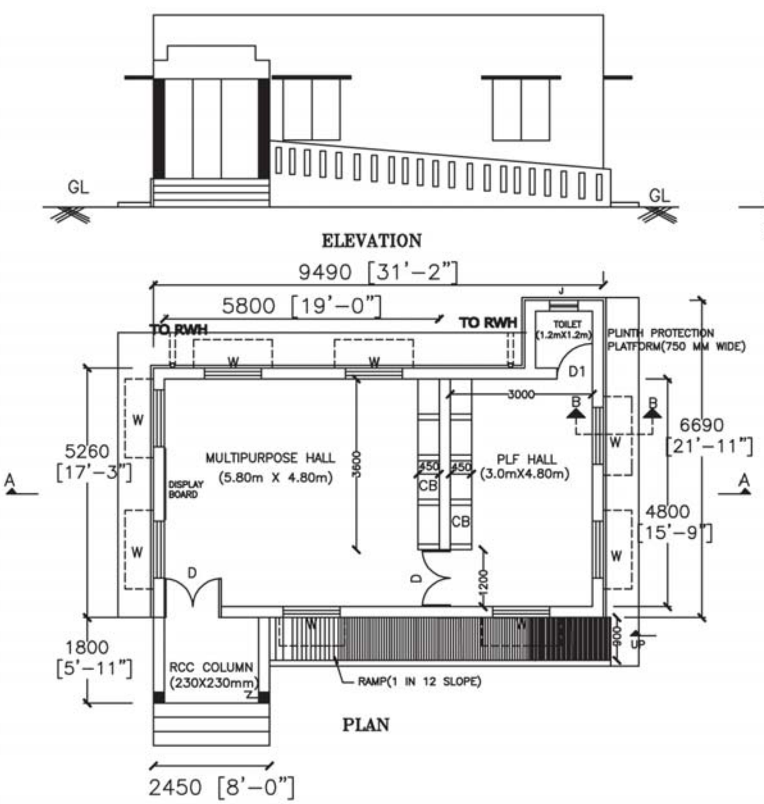
SCHEDULE OF JOINERY

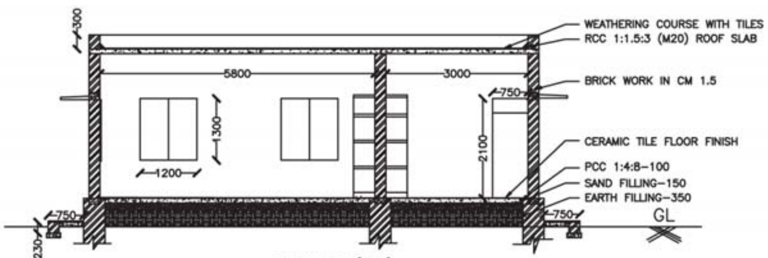
TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
	WIDTH	HEIGHT				
D	750	1800	–	1800	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE
D1	750	1800	–	1800	STEEL DOOR WITH 18GMS SHEET SHUTTER WITH HANDRAIL	SINGLE
J	600	300	1500	1800	RCC JOLLY	—

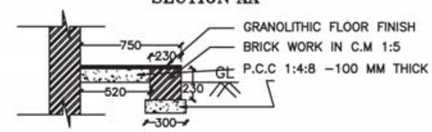
DRAWING NO:1–J6/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATE	ALL DIMENSIONS ARE IN mm.	
AE	AEE	JOB NO:6	DRAWING NO:1
EE	SE		
TYPE DESIGN FOR SCHOOL TOILET (BOYS)			
PLAN,ELEVATION AND SECTION			

Type Design for Combined SHG and PLF Building







SECTION'BB'(PLINTH PROTECTION PLATFORM)

IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE DONE USING CERAMIC TILES
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED AT BOTTOM OF ALL WINDOW OPENINGS WITH 250 mm EXTENSION ON EITHER SIDE.
4. PLINTH PROTECTION PLATFORM(750mm WIDTH) SHOULD BE PROVIDED ALROUND THE BUILDING
5. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
6. WEATHERING COURSE SHOULD BE PROVIDED WITH REQUIRED SLOPE TO DRAIN RAIN WATER.
7. RWH STRUCTURE SHOULD BE CONSTRUCTED AWAY FROM SEPTIC TANK(IF ANY) AND IT CAN BE LINKED TO A NEAR BY WATER SOURCE.
8. 110 mm OD PVC PIPES MAY BE USED FOR RAINWATER DOWNFALL PIPE.
9. CONTINOUS LINTEL SHOULD BE PROVIDED.

PLINTH AREA: 56.67 sq.m / 609.8 SQ.FT

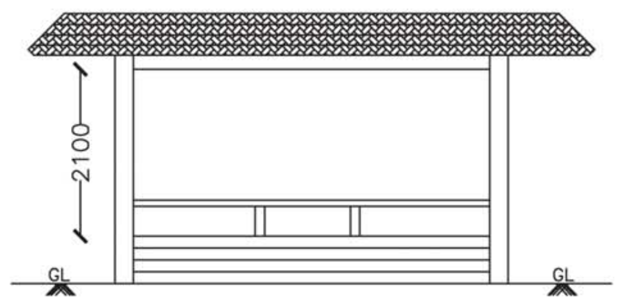
DRAWING NO:1–J7/SERD/Dt.03.09.11

SCHEDULE OF JOINERY

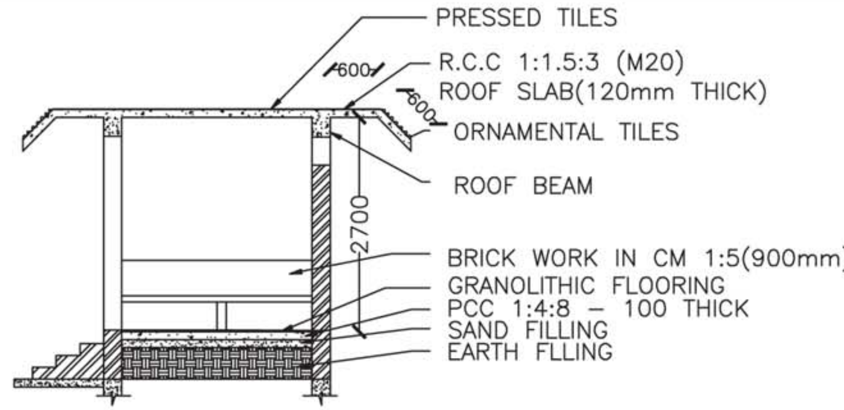
SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	D	1200	2100	—	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	TWO LEAVES
2	D1	750	1800	—	1800	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF
3	W	1200	1300	800	2100	STEEL WINDOW WITH 18GMS SHEET SHUTTER & 12MM SQ. MS. BARS	TWO LEAVES
4	J	600	450	1650	2100	RCC JOLLY	—

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATE	ALL DIMENSIONS ARE IN mm.	
AE	AEE	JOB NO:7	DRAWING NO:1
EE	SE		
TYPE DESIGN FOR COMBINED SHG AND PLF BUILDING			
PLAN, ELEVATION AND SECTION			

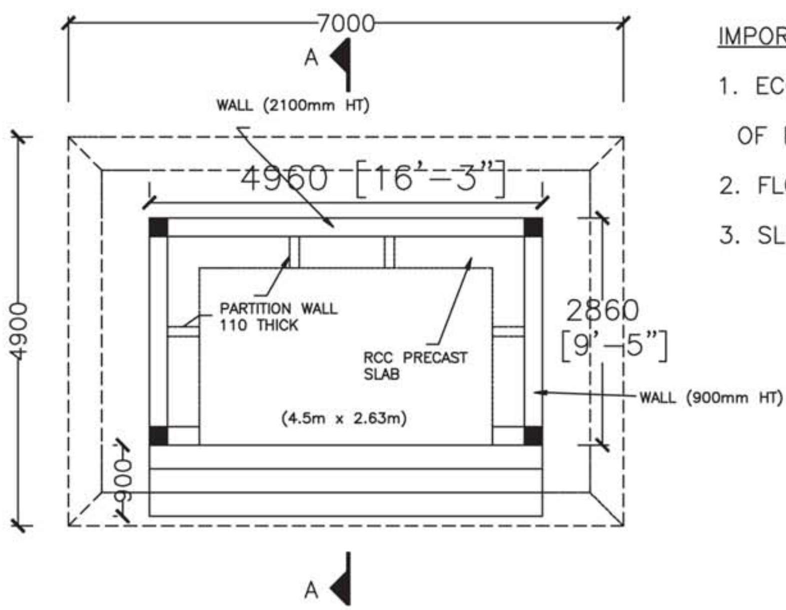
Type Design for Passenger Shelter



ELEVATION



SECTION'AA'



PLAN

IMPORTANT NOTES:

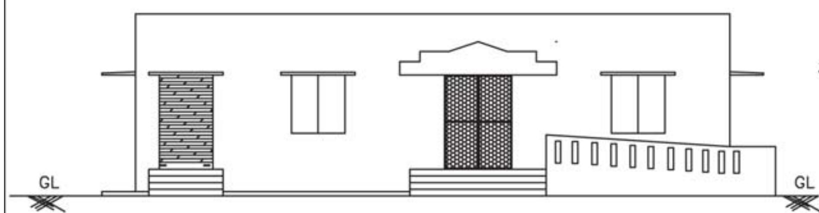
1. ECONOMICAL FOUNDATION ONLY TO BE ADOPTED AND DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE OF GRANOLITHIC TYPE
3. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB

PLINTH AREA ; 14.19 sq.m / 152.64 sq.ft

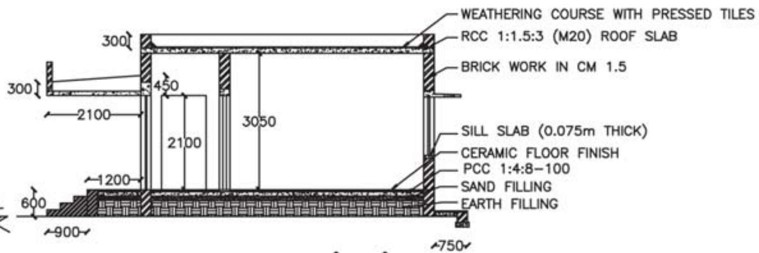
DRAWING NO:1–J8/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATE:	ALL DIMENSIONS ARE IN mm	
AE	AEE	JOB NO:8	DRAWING NO:1
EE	SE		
TYPE DESIGN FOR PASSENGER SHELTER			
PLAN,ELEVATION AND SECTION			

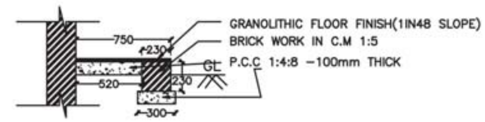
Type Design for Panchayat Office Building

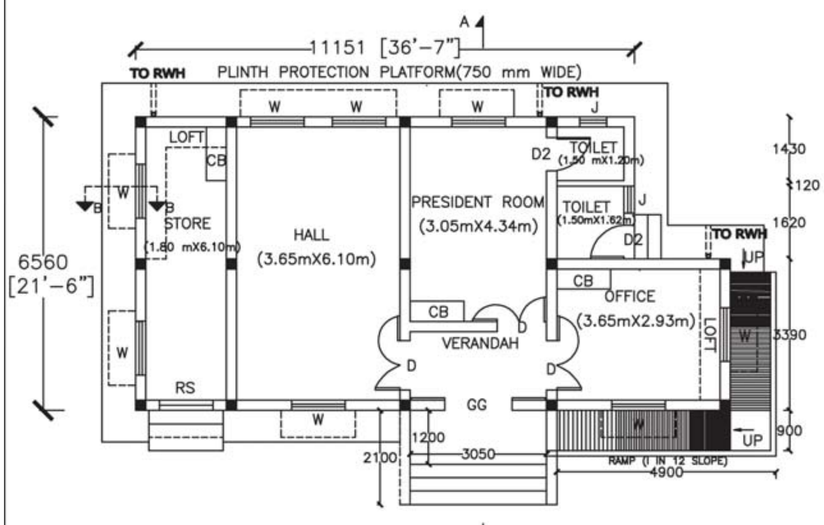


ELEVATION



SECTION'AA'





PLAN

PLINTH AREA: 87.81 sq.m / 944.84 sq.ft

SCHEDULE OF JOINERY

SL. NO.	TYPE	SIZE WIDTH	SIZE HEIGHT	SILL	TOP	DESCRIPTION	REMARKS
1	D	1100	2100	—	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	TWO LEAVES
2	D2	750	2100	—	2100	PVC DOOR	SINGLE LEAF
3	RS	1200	2100	—	2100	ROLLING SHUTTER	-----
4	GG	1500	2100	—	2100	GRILL GATE USING FLATS AND BARS	
5	W	1200	1300	800	2100	STEEL WINDOW WITH 18GMS SHEET SHUTTER & 12MM SQ. MS. BARS	TWO LEAVES
6	J	600	450	1650	2100	JOLLY	—

IMPORTANT NOTES: SECTION'BB'(PLINTH PROTECTION PLATFORM)

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOOR FINISHING SHOULD BE DONE USING CERAMIC TILES
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED AT THE BOTTOM OF ALL WINDOW OPENINGS WITH 250 mm EXTENSION ON EITHER SIDE.
4. PLINTH PROTECTION PLATFORM(750mm WIDE) SHOULD BE PROVIDED ALROUND THE BUILDING
5. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
6. WEATHERING COURSE SHOULD BE PROVIDED WITH REQUIRED SLOPE TO DRAIN RAIN WATER.
7. RWH STRUCTURE SHOULD BE CONSTRUCTED AWAY FROM SEPTIC TANK(IF ANY) AND IT CAN BE LINKED TO A NEAR BY WATER SOURCE.
8. 110 mm OD PVC PIPES MAY BE USED FOR RAIN WATER DOWNFALL PIPES
9. CONTINOUS LINTEL SHOULD BE PROVIDED.

DRAWING NO:1–J9/SERD/Dt.03.09.11

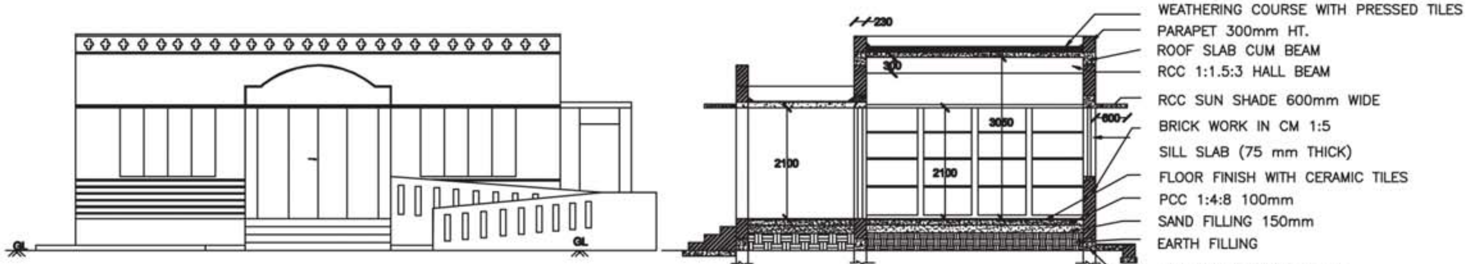
DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ

SCALE 1:100	DATE	ALL DIMENSIONS ARE IN mm.	
AE	AEE	JOB NO:9	DRAWING NO:1
EE	SE		

TYPE DESIGN FOR PANCHAYAT OFFICE BUILDING

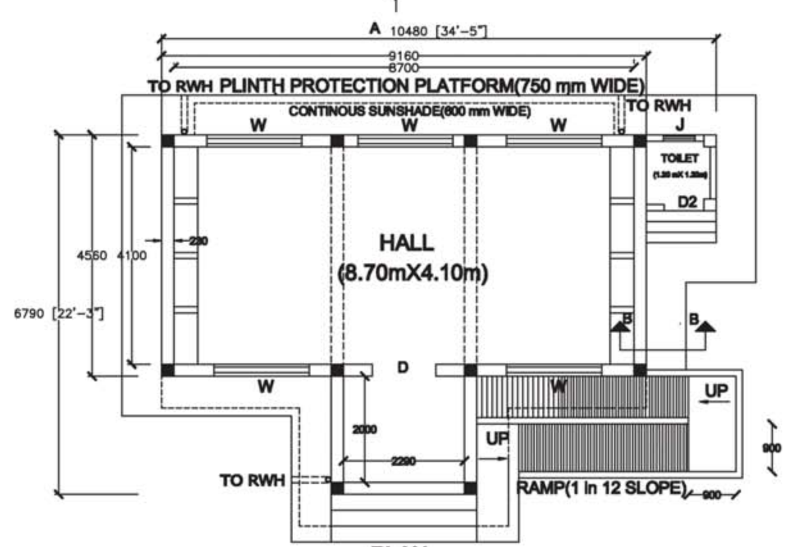
PLAN, ELEVATION AND SECTION

Type Design for Rural Library Building

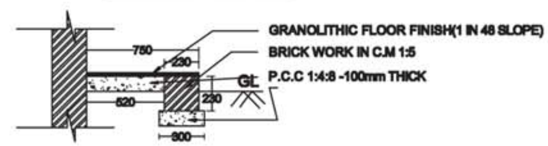


ELEVATION

SECTION ON 'AA'



PLAN



SECTION'BB'(PLINTH PROTECTION PLATFORM)

IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE DONE USING CERAMIC TILES
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED AT THE BOTTOM OF ALL WINDOW OPENINGS WITH 250 mm EXTENSION ON EITHER SIDE.
4. PLINTH PROTECTION PLATFORM(750mm WIDE) SHOULD BE PROVIDED ALROUND THE BUILDING
5. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
6. WEATHERING COURSE SHOULD BE PROVIDED WITH REQUIRED SLOPE TO DRAIN RAIN WATER.
7. RWH STRUCTURE SHOULD BE CONSTRUCTED AWAY FROM SEPTIC TANK(IF ANY) AND IT CAN BE LINKED TO A NEAR BY WATER SOURCE.
8. 110 mm OD PVC PIPES MAY BE USED FOR RAINWATER DOWNFALL PIPES.
9. CONTINOUS LINTEL SHOULD BE PROVIDED.

PLINTH AREA: 49.80 sq.m / 536 sq.ft

DRAWING NO:1–J10/SERD/Dt.03.09.11

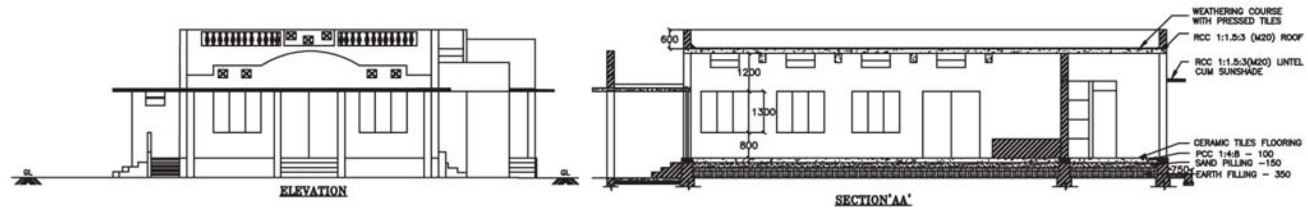
SCHEDULE OF JOINERY

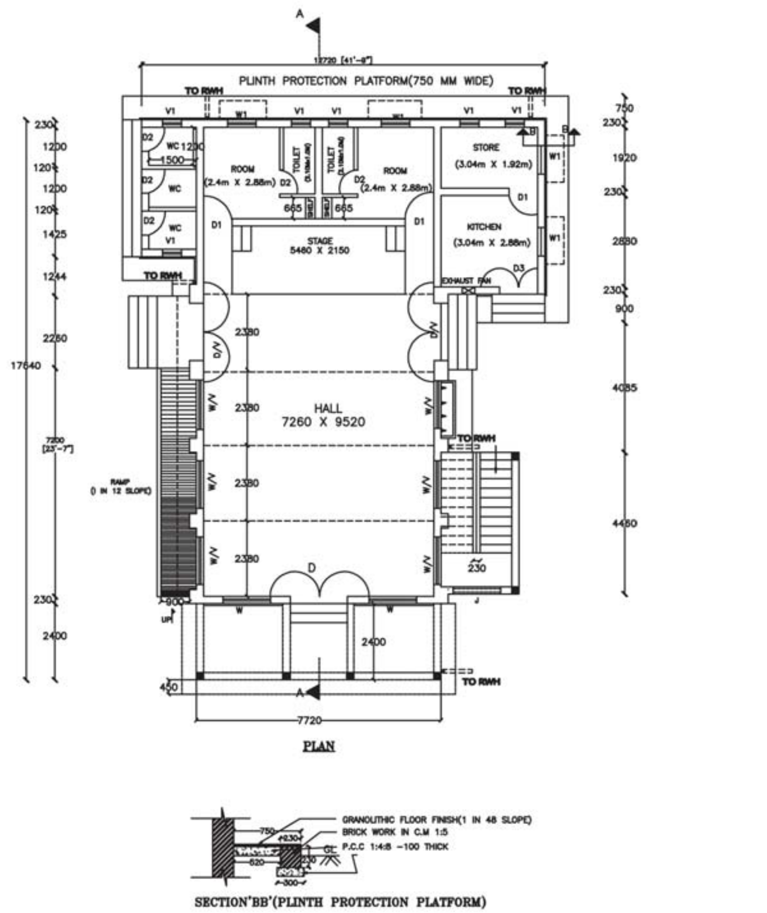
SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	D	1200	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	TWO LEAVES
2	D2	750	2100	–	2100	PVC DOOR	SINGLE LEAF
3	W	1800	1300	800	2100	STEEL WINDOW WITH 18GMS SHEET SHUTTER & 12MM SQ. MS. BARS	TWO LEAVES
4	J	600	450	1650	2100	JOLLY	—

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ

SCALE=1:100	DATE:	ALL DIMENSIONS ARE IN mm	
AE	AEE	JOB NO:10	DRAWING NO:1
EE	SE		
TYPE DESIGN FOR RURAL LIBRARY BUILDING			
PLAN,ELEVATION,AND SECTION			

Community Hall Type Design No.1





IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOOR FINISHING SHOULD BE DONE USING CERAMIC TILES
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED AT BOTTOM OF ALL WINDOW OPENINGS WITH 250 mm EXTENSION ON EITHER SIDE.
4. PLINTH PROTECTION PLATFORM(750mm WIDTH) SHOULD BE PROVIDED ALROUND THE BUILDING
5. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
6. WEATHERING COURSE SHOULD BE PROVIDED WITH REQUIRED SLOPE TO DRAIN RAIN WATER.
7. RWH STRUCTURE SHOULD BE CONSTRUCTED AWAY FROM SEPTIC TANK(IF ANY) AND IT CAN BE LINKED TO A NEAR BY WATER SOURCE.
8. 110 mm OD PVC PIPES MAY BE USED FOR RAINWATER DOWNFALL PIPES.
9. CONTINOUS LINTEL SHOULD BE PROVIDED.

PLINTH AREA: 162.96 sq.m / 1753.4 sq.ft

SCHEDULE OF JOINERY

SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	D	1800	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	TWO LEAVES
2	D1	900	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF
3	D2	750	2100	–	2100	PVC DOOR	SINGLE LEAF
4	D3	1200	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	DOUBLE LEAF
5	W	1500	1300	800	2100	STEEL WINDOW WITH GLAZED SHUTTER & 12MM SQ.MS BARS	THREE LEAVES
6	W1	900	1300	800	2100	STEEL WINDOW WITH GLAZED SHUTTER & 12MM SQ.MS BARS	TWO LEAVES
7	V	900	450	1650	2100	STEEL GLAZED VENTILATOR WITH 12MM SQ.MS.BARS	N-TYPE
8	V1	600	450	1650	2100	STEEL GLAZED VENTILATOR WITH 12MM SQ.MS.BARS	N-TYPE

DRAWING NO:1–J11/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ

SCALE 1:100 | DATE; | ALL DIMENSIONS ARE IN mm.

AE | AEE | JOB NO:11 | DRAWING NO:1

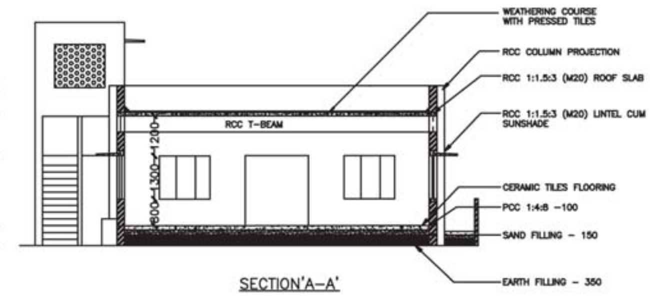
EE | SE

COMMUNITY HALL – TYPE DESIGN NO.1

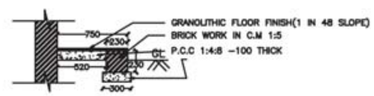
PLAN,ELEVATION AND SECTION

Community Hall Type Design No.2

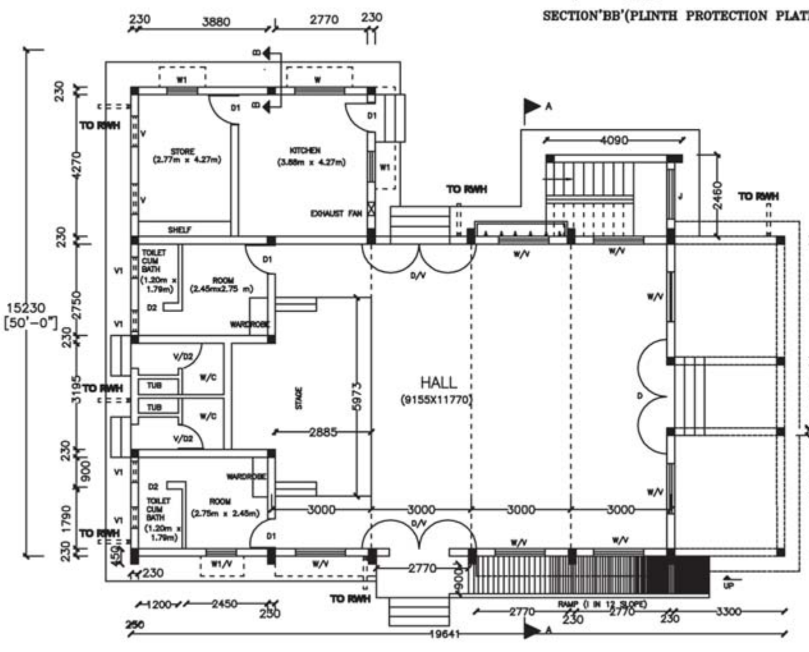
ELEVATION



SECTION'A–A'



SECTION'BB'(PLINTH PROTECTION PLATFORM)



PLAN

IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOOR FINISHING SHOULD BE DONE USING CERAMIC TILES
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED AT THE BOTTOM OF ALL WINDOW OPENINGS WITH 250 mm EXTENSION ON EITHER SIDE.
4. PLINTH PROTECTION PLATFORM(750mm WIDE) SHOULD BE PROVIDED ALROUND THE BUILDING
5. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
6. WEATHERING COURSE SHOULD BE PROVIDED WITH REQUIRED SLOPE TO DRAIN RAIN WATER.
7. RWH STRUCTURE SHOULD BE CONSTRUCTED AWAY FROM SEPTIC TANK(IF ANY) AND IT CAN BE LINKED TO A NEAR BY WATER SOURCE.
8. 110 mm OD PVC PIPES MAY BE USED FOR RAINWATER DOWNFALL PIPES

PLINTH AREA : 222.35 sq.m / 2392.5 SQ.FT

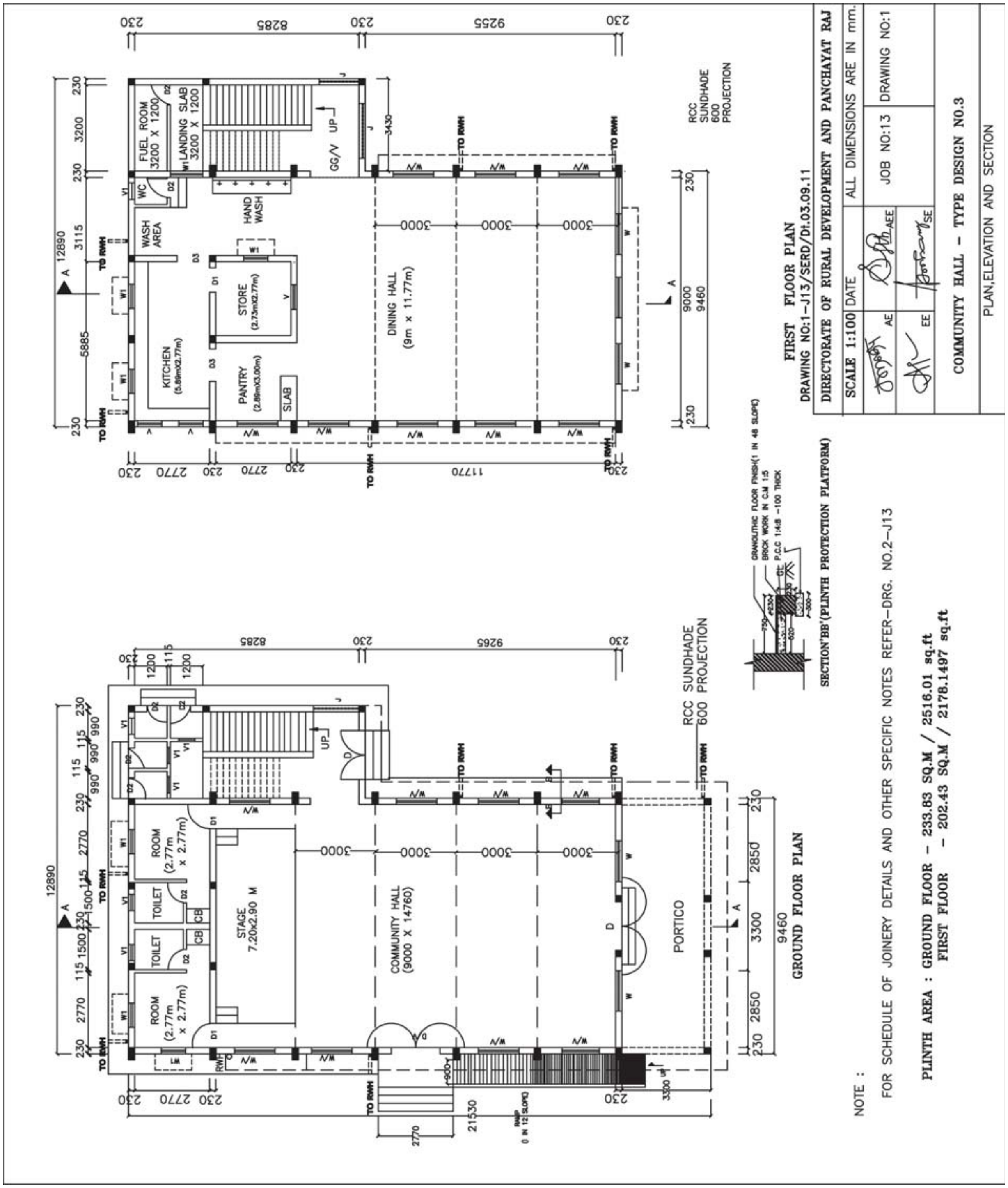
SCHDULE OF JOINERY

SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	D	1800	2100	–	2100	STEEL DOOR WITH 18 GMS SHEET SHUTTER	TWO LEAVES
2	D1	900	2100	–	2100	STEEL DOOR WITH 18 GMS SHEET SHUTTER	SINGLE LEAF
3	D2	750	2100	–	2100	PVC DOOR	SINGLE LEAF
4	W	1500	1300	800	2100	STEEL WINDOW WITH GLAZED SHUTTER & 12MM SQ. M.S. BARS	THREE LEAVES
5	W1	900	1300	800	2100	STEEL WINDOW WITH GLAZED SHUTTER & 12MM SQ. M.S. BARS	TWO LEAVES
6	V	900	450	2850	3300	STEEL GLAZED VENTILATOR WITH 12MM SQ. M.S. BARS	N–TYPE
7	V1	600	450	1650	2100	STEEL GLAZED VENTILATOR WITH 12MM SQ. M.S. BARS	N–TYPE
8	J	1500	1300	2200	3500	RCC JOLLY	FIXED

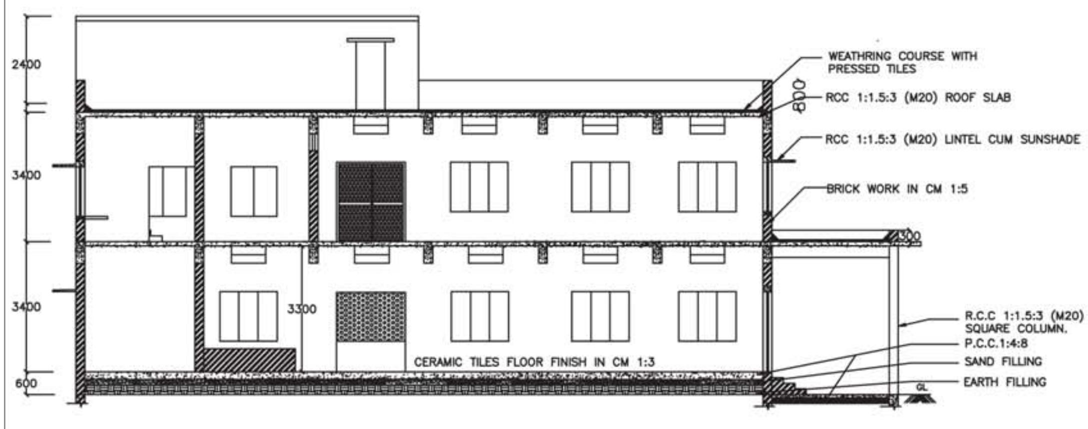
DRAWING NO:1–J12/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATA :	ALL DIMENTIONS ARE IN mm	
AE	AEE	JOB NO:12	DRAWING NO: 1
EE	SE		
CUMMUNITY HALL– TYPE DESIGN NO:2			
PLAN, ELEVATION AND SECTION			

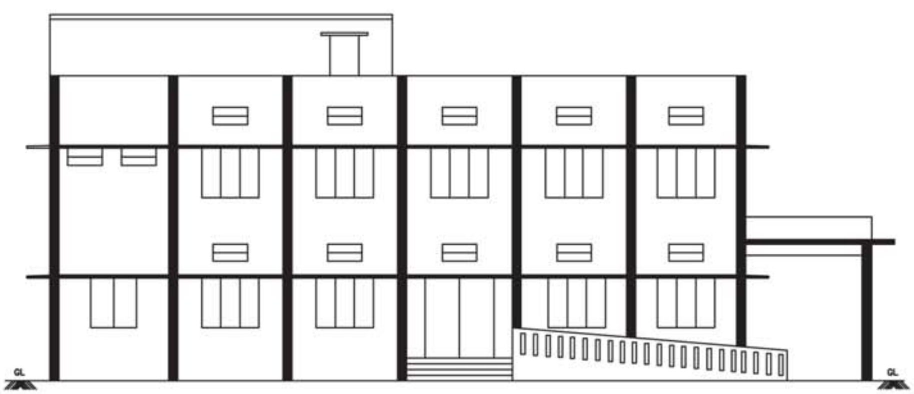
Community Hall Type Design No.3



Community Hall Type Design No.3



SECTION 'AA'



SIDE ELEVATION

IMPORTANT NOTE :

1. FLOORING SHOULD BE DONE USING CERAMIC TILES
2. THE SIZE OF THE R.CC.COLUMNS AND BEAMS SHOULD BE AS PER DETAILED R.C.C DESIGN.
3. WEATHERING COURSE SHUOLD BE PROVIDED WITH REQUIRED SLOPE TO DRAIN RAIN WATER
4. PLINTH PROTECTION PLATFORM SHOULD BE PROVIDED ALROUND THE BUILDING
5. RWH STRUCTURE SHOULD BE CONSTRUCTED FAR AWAY FROM SEPITIC TANK AND IT CAN BE LINKED TO A NEAR BY WATER SOURSE.

SCHEDULE OF JOINERY

SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	D	1800	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	TWO LEAVES
2	D1	900	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF
3	D2	750	2100	–	2100	PVC DOOR	SINGLE LEAF
4	W	1500	1300	800	2100	STEEL WINDOW WITH GLAZED SHUTTER & 12MM SQ.MS BARS	THREE LEAVES
5	W1	1200	1300	800	2100	STEEL WINDOW WITH GLAZED SHUTTER & 12MM SQ.MS BARS	TWO LEAVES
6	V	900	450	2850	3300	STEEL GLAZED VENTILATORS 12MM SQM M.S.BARS	N–TYPE
7	V1	600	450	1650	2100	STEEL GLAZED VENTILATOR WITH 12MM SQ.MS.BARS	N–TYPE
8	J	1800	1300	800	2100	RCC JOLLY	–
9	GG	1800	1300	800	2100	GRILL GATE	–
10	D3	1200	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	DOUBLE LEAF

DRAWING NO:2–J13/SERD/Dt.03.09.11

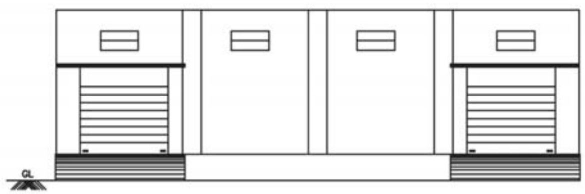
DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ

SCALE 1:100	DATE	ALL DIMENSIONS ARE IN mm.	
AE	AEE	JOB NO:13	DRAWING NO:2
EE	SE		

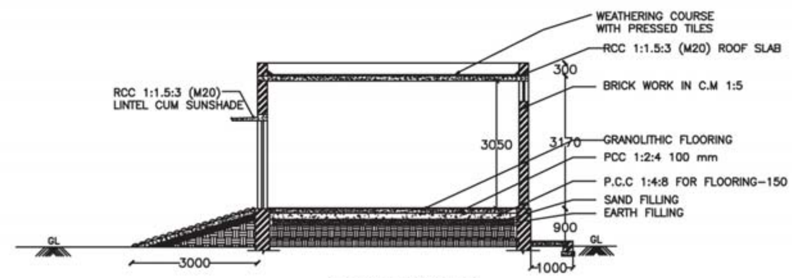
COMMUNITY HALL – TYPE DESIGN NO.3

SIDE ELEVATION AND SECTION

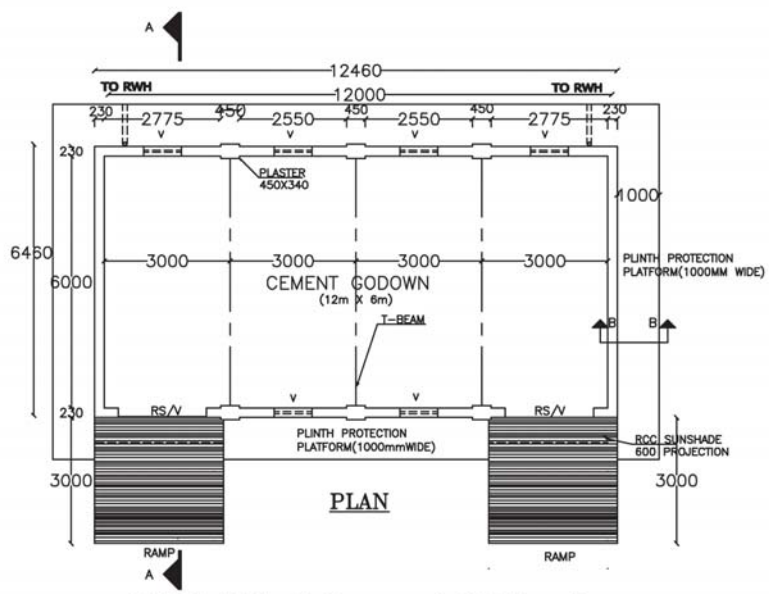
Type Design for Cement Godown



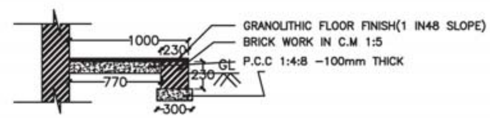
ELEVATION



SECTION'AA'



PLAN



SECTION'BB'(PLINTH PROTECTION PLATFORM)

IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE OF GRANOLITHIC TYPE.
3. PLINTH PROTECTION PLATFORM(1000mm WIDTH)SHOULD BE PROVIDED ALROUND THE BUILDING
4. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB.
5. WEATHERING COURSE SHOULD BE PROVIDED WITH REQUIRED SLOPE FOR DRAINING OFF RAIN WATER
6. RWH STRUCTURE SHOULD BE CONSTRUCTED AWAY FROM SEPTIC TANK AND IT CAN BE LINKED TO A NEAR BY WATER SOURCE.
7. SURFACE OF THE RAMP SHOULD BE GROOVED.

PLINTH AREA: 80.49 sq.m / 866.07 sq.ft

DRAWING NO:1-J14/SERD/Dt.03.09.11

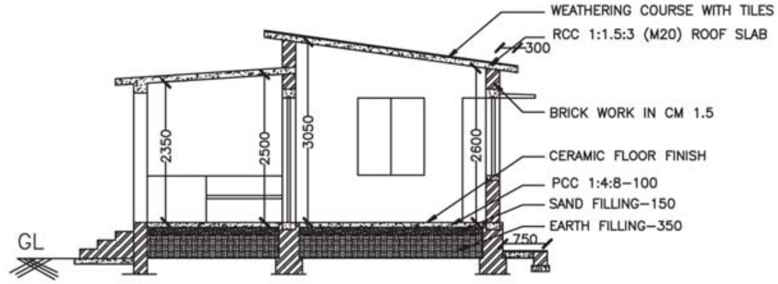
SCHEDULE OF JOINERY

SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	RS	2100	2100	–	2100	ROLLING SHUTTER	SINGLE
2	V	900	450	2600	3050	STEEL GLAZED VENTILATOR WITH 12MM SQ.MS.BAR	N-TYPE

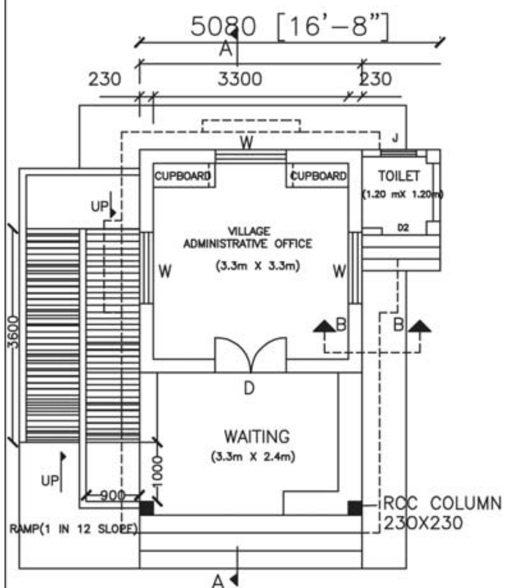
DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATE	ALL DIMENSIONS ARE IN mm.	
AE	AEE	JOB NO:14	DRAWING NO:1
EE	SE		
TYPE DESIGN FOR CEMENT GODOWN			
PLAN,ELEVATION AND SECTION			

Type Design for Village Administrative Office

ELEVATION



SECTION'AA'



PLAN

PLINTH AREA: 25.06 sq.m / 269.65 SQ.FT

SECTION'BB'(PLINTH PROTECTION PLATFORM)

IMPORTANT NOTES:

1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE DONE USING CERAMIC TILES(OFFICE ONLY)
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED BELOW ALL WINDOW OPENINGS WITH 250 mm EXTENSION ON EITHER SIDE OF WINDOW OPENING.
4. PLINTH PROTECTION PLATFORM(750mm WIDTH) SHOULD BE PROVIDED ALROUND THE BUILDING
5.CONTINOUS LINTEL SHOULD BE PROVIDED.

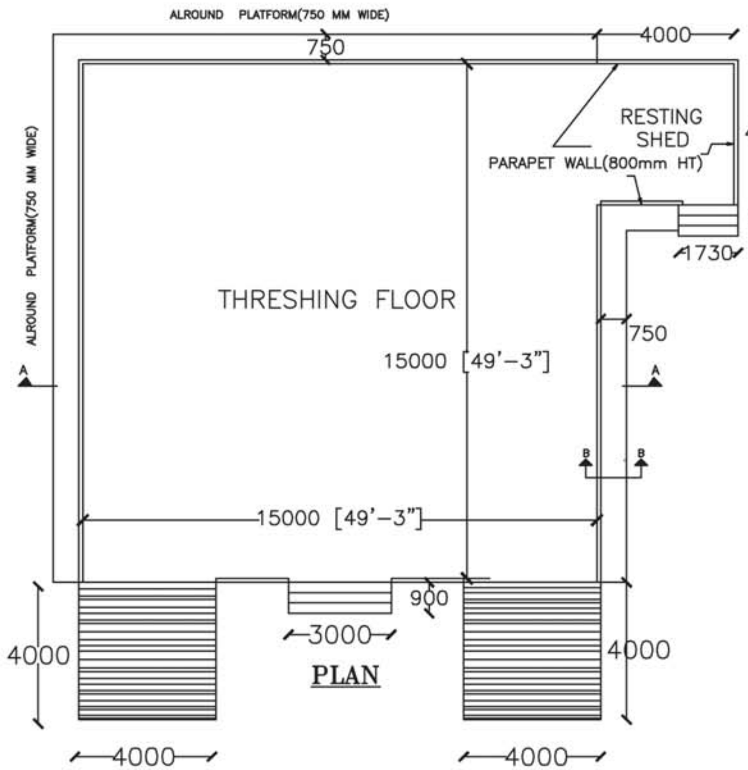
SCHEDULE OF JOINERY

SL. NO.	TYPE	SIZE WIDTH	SIZE HEIGHT	SILL	TOP	DESCRIPTION	REMARKS
1	D	1200	2000	—	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	TWO LEAVES
2	W	1200	1300	800	2100	STEEL WINDOW WITH 18GMS SHEET SHUTTER & 12MM SQ. MS. BARS	TWO LEAVES
3	D1	750	1800	—	1800	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF

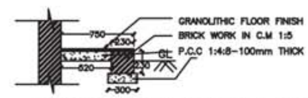
DRAWING NO:1–J15/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATE	ALL DIMENSIONS ARE IN mm.	
AE	AEE	JOB NO:15	DRAWING NO:1
EE	SE		
TYPE DESIGN FOR VILLAGE ADMINISTRATIVE OFFICE			
PLAN, ELEVATION AND SECTION			

Type Design for Threshing Floor



PLAN



SECTION'BB'(PLINTH PROTECTION PLATFORM)

IMPORTANT NOTES:

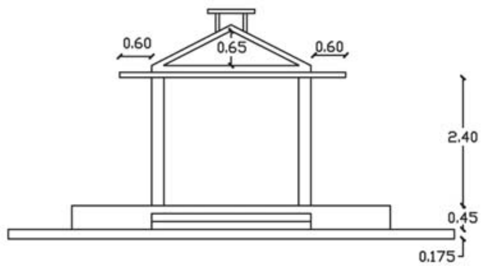
1. ECONOMICAL FOUNDATION MAY BE ADOPTED.DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. THE INNER DIMENSIONS CAN BE ALTERED AS PER THE AVAILABILITY OF AREA.
3. POSITION OF RAMP CAN BE DECIDED BASED ON THE SITE CONDITIONS
4. BASEMENT HEIGHT CAN BE INCREASED IN THE LOW LYING AREAS

PLINTH AREA: 248.85 sq.m / 2677.63 sq.ft

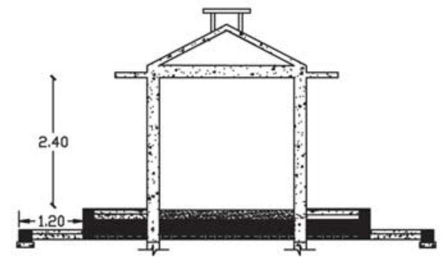
DRAWING NO:1–J16/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE : 1:100	DATE	ALL DIMENSIONS ARE IN mm.	
AE	AEE	JOB NO:16	DRAWING NO:1
EE	SE		
TYPE DESIGN FOR THRESHING FLOOR			
PLAN,ELEVATION AND SECTION			

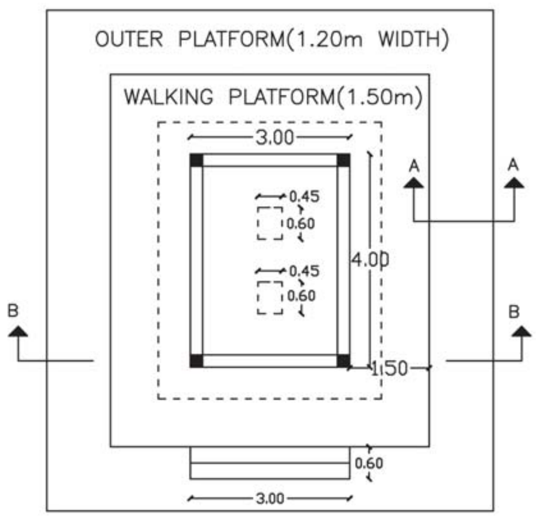
Type Design for Cremation Shed



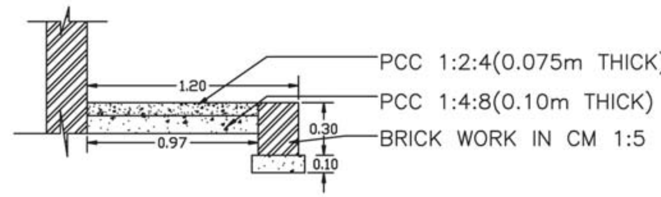
ELEVATION



SECTION BB



PLAN



SECTION AA

IMPORTANT NOTES:

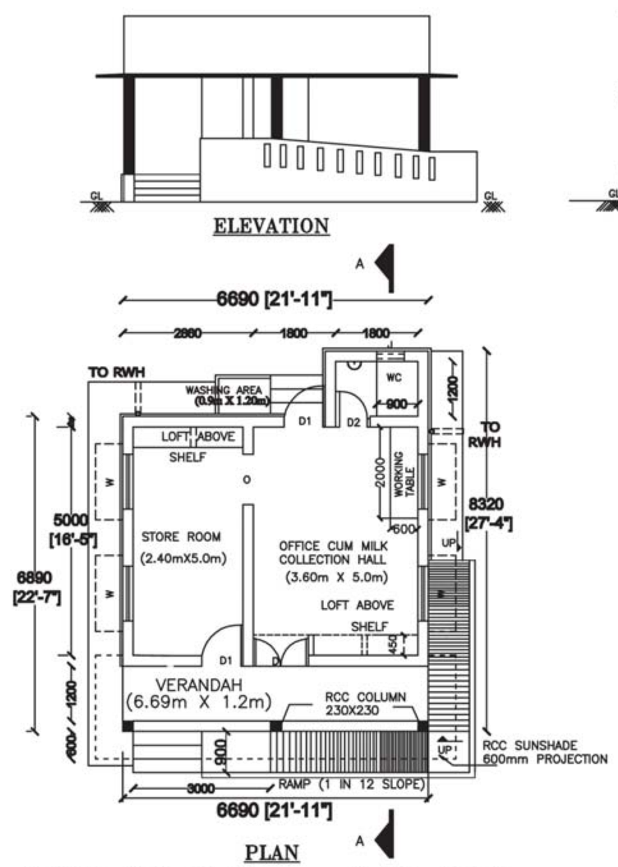
1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. BASEMENT HEIGHT CAN BE CHANGED ACCORDING TO THE SITE CONDITIONS.
3. WALKING PLATFORM SHOULD BE PROVIDED ALROUND THE SHED.
4. A COVER OF 35 mm SHOULD BE PROVIDED FOR THE ROOF SLAB.

PLINTH AREA 60 sq.m/645.6 sq.ft

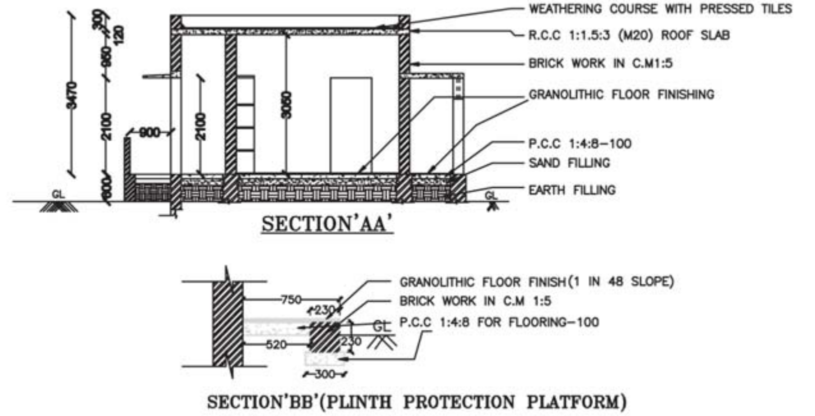
DRAWING NO: 1-J17/SERD/Dt.03.09.11

DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATE	ALL DIMENSIONS ARE IN m.	
AE	AEE	JOB NO:17	DRAWING NO:1
EE	SE		
TYPE DESIGN FOR CREMATION SHED			
PLAN,ELEVATION AND SECTION			

Type Design for Milk Producer's Cooperative Society Building



PLINTH AREA:49.33 sq.m / 531 SQ.FT



IMPORTANT NOTES:

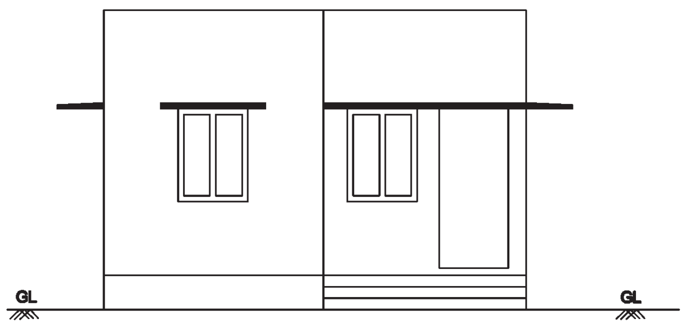
1. ECONOMICAL FOUNDATION MAY BE ADOPTED. DEPTH OF FOUNDATION SHOULD BE BASED ON THE SOIL CONDITION AT SITE.
2. FLOORING SHOULD BE DONE USING CERAMIC TILES
3. SILL SLAB(75mm THICK) SHOULD BE PROVIDED BELOW ALL WINDOW OPENINGS WITH 250 mm EXTENSION ON EITHER SIDE OF WINDOW OPENING.
4. PLINTH PROTECTION PLATFORM(750mm WIDE) SHOULD BE PROVIDED ALL-ROUND THE BUILDING
5. SLIGHT SLOPE SHOULD BE GIVEN FOR ROOF SLAB
6. WEATHERING COURSE SHOULD BE PROVIDED WITH REQUIRED SLOPE TO DRAIN RAIN WATER.
7. RWH STRUCTURE SHOULD BE CONSTRUCTED AWAY FROM SEPTIC TANK(IF ANY) AND IT CAN BE LINKED TO A NEAR BY WATER SOURCE.
8. 110 mm OD PVC PIPES MAY BE USED FOR RAINWATER DOWNFALL PIPES

SCHEDULE OF JOINERY

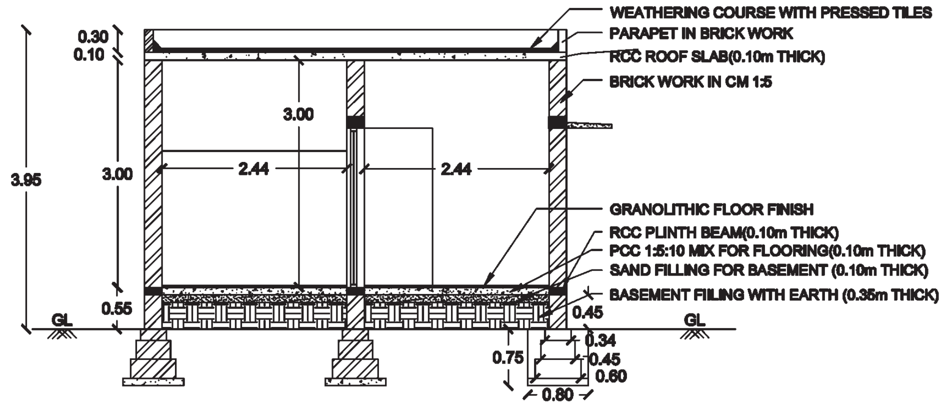
SL. NO.	TYPE	SIZE WIDTH	SIZE HEIGHT	SILL	TOP	DESCRIPTION	REMARKS
1	D	1200	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	TWO LEAVES
2	D1	900	2100	–	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF
3	D2	750	2100	–	2100	PVC DOOR	SINGLE LEAF
4	W	1200	1300	800	2100	STEEL WINDOW WITH 18 GMS SHEET SHUTTERS & 12MM SQ. M.S. BARS	TWO LEAVES
5	J	600	450	1650	2100	R.C.C JOLLY	-
6	O	900	2000	–	2100	OPENING	-

DRAWING NO:1–J18/SERD/Dt.03.09.11

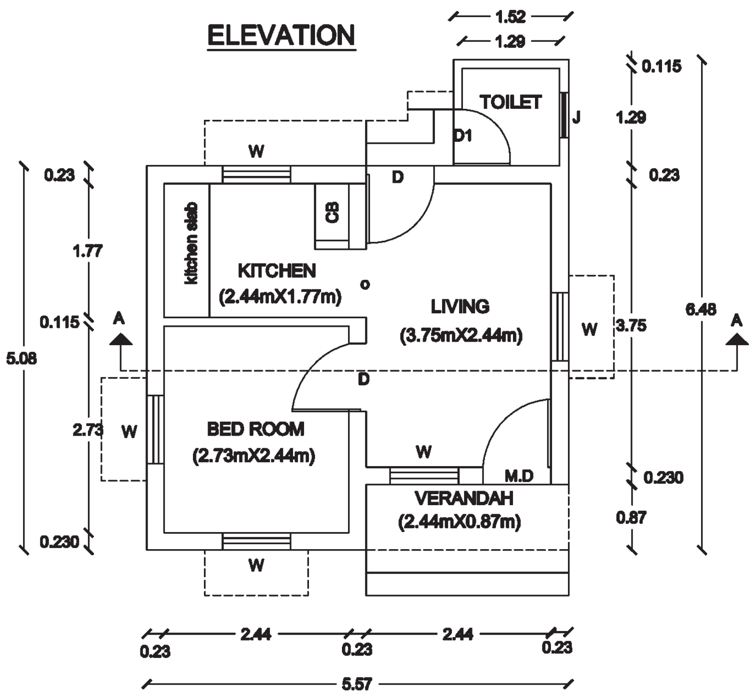
DIRECTORATE OF RURAL DEVELOPMENT AND PANCHAYAT RAJ			
SCALE 1:100	DATE	ALL DIMENTIONS ARE IN mm.	
AE / EE	AEE / SE	JOB NO:18	DRAWING NO:1
TYPE DESIGN FOR MILK PRODUCER'S COOPERATIVE SOCIETY BUILDING			
PLAN, ELEVATION AND SECTION			



ELEVATION



SECTION ON A - A



PLAN

PLINTH AREA :28.00 sq.m / 300 sq.ft

SCHEDULE OF JOINERY

SL. NO.	TYPE	SIZE		SILL	TOP	DESCRIPTION	REMARKS
		WIDTH	HEIGHT				
1	MD	900	2100	-	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF
2	D	900	2100	-	2100	STEEL DOOR WITH 18GMS SHEET SHUTTER	SINGLE LEAF
3	D1	750	1800	-	1800	PVC DOOR	SINGLE LEAF
4	W	900	1200	900	2100	STEEL WINDOW WITH 18GMS SHEET SHUTTER & 12MM SQ.MS.BARS	TWO LEAF
5	J	600	450	1650	2100	PRECAST JOLLY	-

DIRECTORATE OF RURAL DEVELOPMENT

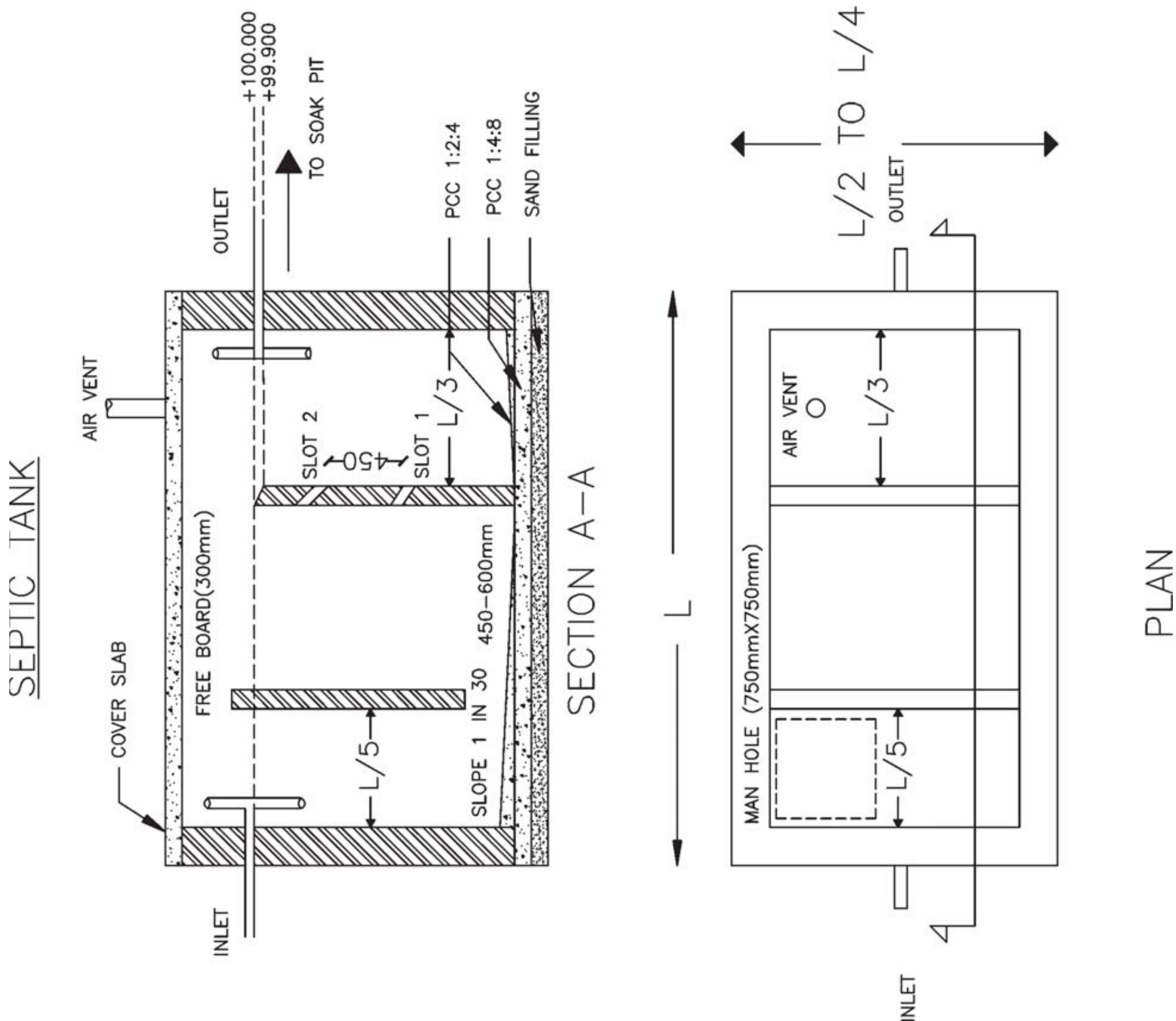
SCALE 1:75	DATE:	ALL DIMENSION ARE IN M.	
AE	AEE	JOB NO:	DRAWING NO:
EE	SE		

TYPE DESIGN FOR PASUMAI VEEDU

PLAN, ELEVATION AND SECTION

IMPORTANT NOTES:

1. TYPE OF FOUNDATION, ITS WIDTH & DEPTH ETC TO BE DECIDED BASED ON THE SOIL SAFE BEARING CAPACITY.
2. THICKNESS OF R.C.C MEMBERS WILL BE BASED ON THE DESIGN.


SEPTIC TANK
COVER SLAB
AIR VENT
OUTLET
INLET
+100.000
+99.900
TO SOAK PIT
FREE BOARD(300mm)
SLOT 2
450
SLOT 1
L/3
L/5
SLOPE 1 IN 30
450–600mm
PCC 1:2:4
PCC 1:4:8
SAND FILLING
SECTION A–A
L
L/2 TO L/4
MAN HOLE (750mmX750mm)
AIR VENT
OUTLET
L/3
L/5
INLET
PLAN