HAND BOOK
ON
WORKS AUDIT – BUILDINGS

Office of the
Principal Accountant General (Civil Audit)
Tamil Nadu and Puducherry,
Chennai – 18.

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<u>For Internal Circulation and Use only</u> **The information given in this Hand Book has been gathered from various sources. For reporting the originals have to be referred and not provisions of this Hand Book. This Hand Book is only to educate the officials engaged in Works Audit.**	**CONTRIBUTORS** **1. Shri. C. Sreedharan, Sr. A.O.,** **2. Smt. Chandra Seetharaman, A.A.O.,** **3. Smt. Sree Lakshmi Sridhar, A.A.O.,**

HAND BOOK ON WORKS AUDIT - BUILDINGS

CONTENTS

1. ADMINISTRATION OF BUILDINGS

A Building – is any structure for whatsoever purpose and of whatsoever materials constructed and every part thereof whether used as human habitation or not and includes foundation, plinth, walls, floors, roofs, chimneys, plumbing and building services, fixed platforms, verandah, balcony, projection, part of a building or anything affixed thereto or any wall enclosing or intended to enclose any land or space and signs and outdoor display structures.

Buildings shall be classified as Residential, Educational, Institutional, Assembly, Business, Mercantile, Industrial, Storage and Hazardous groups. The National Building Code of India further sub-classifies building and various related provisions thereof with respect to administration of Development Control Rules and general building requirements, building materials, fire and life safety, structural design, constructional practices and safety, plumbing services, landscaping, etc and prescribes guidelines to be followed for judicious implementation.

Allocation of Works:

- The PWD is responsible for execution of all works of Government wherein the State has not specially allotted to other Departments.

  (Para 98 of TNPWD code Art.150 to 155 of TNFC Vol.1)

- The Electrical Division of the Public Works Department looks after all the electrical works, repairs or original, irrespective of their cost and their maintenance.

- The improvement works to the existing buildings and also those that find a place in the Register of Public Buildings and appurtenant works such as enlarging of the existing structure, water supply, sewerage works, compound wall etc., irrespective of the estimated cost of construction and the execution of original works within the upper financial limit of Rs.30 lakhs shall be carried out by the Construction and Maintenance Division.

- Original (capital) works costing Rs.30 Lakh and more shall continue to be entrusted with the Construction divisions and Circles as being done hitherto.

(C.E.(B)'s No. AEE/T10(s)24475/2002 dt.9.5.2002)

Original Works and Repairs

- Original works include all new constructions whether entirely new works or additions and alterations to existing works, except as hereinafter provided and also all repairs to newly purchased or previously abandoned buildings required to render them usable.

  (Para 89 of TNPWD Code)

- The term repairs or maintenance includes all operations required to maintain the building in proper condition or to replace the wear and tear of buildings and works in ordinary use.

  (Para 91 of TNPWD Code)

- There are certain operations of the P.W.D. which fall under both the categories of original works and repairs i.e., operations which are of the nature of both substitution of terrace for tiled roofing, substitution of steel beams for damaged teak beams, dismantling and extending a verandah etc.

(Para 92 of TNPWD Code)

- Repairs may be ordinary or special repair.

- Ordinary repairs include those works carried out periodically and such as painting or white washing a building etc., and other occasional petty repairs, which are necessary from time to time and carried out periodically. Special repairs are other than ordinary repairs i.e. they are repairs, which are not periodical or frequent (e.g.) re-roofing a building, replacing of beams, renewal of flooring etc.

(Para 133 & 134(i) of TNPWD Code)

Lapse of Sanction:

- An ordinary repairs estimate lapses on the last day of the financial year in the case of roads and buildings. If, however, if there is any delay in carrying out the repair work the expenditure incurred after the due date is being treated as expenditure against a fresh repairs estimate for the next working year.

(Para 136 to 137 of TNPWD Code)

Approval for Repair works:

- No administrative approval is required for ordinary or special repairs.

(Para 142 of TNPWD Code)

- Provision for the payment of municipal or other taxes on public buildings should be made in the annual repair estimates in the cases indicated in Article 120 of T.N. Financial Code volume I.

(Para 146 of TNPWD Code)

Execution of Ordinary Repairs and Special Repairs in a compound wall:

i. All works relating to ordinary repairs in each compound shall be treated as one unit and the value of works done per year will be fixed not exceeding the norm.

ii. Special repair estimate in huge compounds shall be prepared separately and grouped together for tender call.

iii. For huge compounds, buildings shall be grouped in such a way so as to limit the estimate value of ordinary repairs to Rs.1.00 lakh and for each group separate contract shall be decided.

(Para 144 of TNPWD. Code as amended in G.O.Ms.No.1691 PWD dt.3.10.85)

Public Buildings:

The buildings owned by the Government are called "Public Buildings".

- **Register of Public Buildings**
  - All the Government Departments including P.W.D., should maintain "Register of Immovable Property". PWD is the main agency for construction and maintenance of Government buildings and is the custodian of all such buildings by bringing them in the "Register of Public Buildings"(RPB) (PWD Form 136). Each Superintending Engineer will keep a register of all buildings under the charge of the Department, within his Circle and each Executive Engineer, should also maintain a similar register of all buildings within his Division.

    (Para 261 of TNPWD Code)

  - When the officer of PWD prepares plans and estimates for administrative approval, they should invariably include therein, information as to whether the buildings are borne on the PWD Register of Buildings or on the Departmental Register.

    (Note 3 Under Para 100 of TNPWD Code).

  - The expenditure on construction of buildings of P.W.D. should invariably be debited to the P.W.D., budget and such buildings, entered in the PWD, Register of Buildings, irrespective of whether these buildings are in the occupation of PWD or any other Department of State Government or other agencies permitted by Government.

    (Note I under Para 100 of T.N.P.W.D. Code)

  - In the case of buildings and works borne on the register of PWD, the detailed plans of the buildings should be annexed to the Register of Public Building (RPB) and the Executive Engineer is responsible for correction of plans on completion of any alterations.

    (Para 262 & 263 of T.N.P.W.D code)

  - As soon as a building either residential or non-residential is constructed by P.W.D., it should be brought to the Register of Public Buildings for future maintenance.

Vacant Building:

Whenever a Public building, which is not borne on the R.P.B. of PWD; falls vacant, it should be handed over to the custody of Revenue Department by the occupying department. Public building borne on the R.P.B. of PWD should be handed over to the respective Department, when vacated.

(Para 249 of T.N.P.W.D. Code)

Allotment of Vacant Buildings:

The Superintending Engineers are empowered to sanction in consultation with the District Collector and the Heads of Departments concerned, the occupation as an office by one department of Government after another Department for which it was originally constructed or provided vacates it. But orders of Government should be obtained for allotment to Local bodies / Central Government / private bodies or when two departments ask for the same building.

(Para 239 of T.N.P.W.D. Code)

Disposal of Temporary Buildings:

Temporary Buildings erected during construction of a work may, under, the sanction of Executive Engineer be sold or dismantled on the completion of work or when the purpose for which they were erected has been served. It is the duty of Executive Engineer to report when in his opinion, any other building or property of Government in his charge, ought to be sold or dismantled.

(Para 236 of T.N.P.W.D. Code)

Disposal of Buildings/Survey Report:

When a building has become unserviceable and beyond repairs, then it has to be disposed off or demolished by obtaining a survey report and the actual loss would be written off by the competent authority.

(Para 235 of T.N.P.W.D. Code)

Sale and Dismantlement of Buildings:

Buildings in charge of P.W.D., Chief Engineer, Superintending Engineer and Executive Engineer have powers to sanction the sale of dismantlement of State Government building in charge of P.W.D., when the book value of building does not exceed Rs.50, 000/-, Rs.25,000/- and Rs.5,000/- respectively. However they have no power to sell land. The sale and dismantlement of building are subject to following further condition.

(i) No building should be sold without ascertaining that it is not required by any department of Government and also without prior the approval of the Collector.

(ii) No building should be demolished unless it is in a dangerous condition or beyond repairs.

(iii) The power will not extend to the sale or dismantlement of several individual buildings situated in a compound.

(iv) When it is proposed to sell or dismantle a portion of the building, the value of the entire building and not of the portion shall be taken for the purpose of determining the authority competent to sanction it.

(Para 235 of T.N.P.W.D. Code)

In case of buildings in the charge of Revenue Department, it should be ascertained that building is not required for the use of any department of Government and the Executive Engineer concerned should have certified that building proposed to be demolished is dangerous or beyond repairs.

(*Para 236 of T.N.P.W.D Code****)***

Taxes:

- Municipal taxes for non-residential buildings should be paid by the user department / occupying departments. Taxes for Residential buildings maintained by P.W.D. have to be paid by Public Works Department.

(Article 120 of T.N.F. code and Para 245 and 250 of TNPWD Code)

- The Executive Engineer should intimate the local bodies within fifteen days from the date of completion or occupation of a building, whichever is earlier for assessment of tax in case of building (residential or non-residential) for which P.W.D., will have to pay the tax, and in other cases, the Head of Office who will have to pay the tax shall give the information furnishing valuation details for fixation of property tax.

(Para 253 of TNPWD Code)

Vacancy-Remission of Tax:

- If a building whether residential or non-residential, is vacant for more than 30 days consecutively, the Panchayat or municipal taxes thereof, can be got reduced proportionately. Hence, the occupant or occupying department or the Head of Office concerned is required to notify the vacancy immediately direct to the local body under intimation to the Executive Engineer concerned to enable him to claim remission. The Executive Engineer should immediately apply to the local body for remission of tax.

- In the case of vacant buildings under the control of P.W.D., it is the duty of the Section Officer concerned to give the vacancy notice direct to the local body under intimation to the Executive Engineer.

- When a building or portion of it is destroyed or demolished, the Executive Engineer concerned should give the requisite notice and claim remission of tax.

(Para 252 of T.N.P.W.D. Code)

Inspection of Public Buildings:

- Every Public building borne on PWD Registers should be inspected annually by the officers according to the delegated powers noted below.

Officer	Cost of Construction	
	Prior to 1.1.1946	**After 1.1.1946**
i) Section Officer	Rs.5,000/-	Rs.10,000/-
ii) Sub Divisional Officer	Rs.5,000/- to Rs.25.000/-	Rs.10,000/- to Rs.50.000/-
iii) Executive Engineer	Rs.25,000/- to Rs.2 lakhs	Rs.50,000/- to Rs. 5 lakhs
iv) Superintending Engineer	Above Rs.2.00 lakhs	Above Rs.5.00 lakhs

Executive Engineer, Assistant Engineer and Divisional Engineer/Junior Engineer should maintain separate registers for their inspections. The Superintending Engineer shall see them during annual inspection. The Executive Engineer should inspect as often as possible, buildings which show cracks or definite signs of deterioration and take early steps to effect necessary improvements.

(Para 260 of T.N.P.W.D. Code)

The officers of Electrical Wing should also take prompt action to inspect the electrical installations including wiring, fittings, fixtures etc,. To facilitate a foolproof system of annual inspection of electrical installations, the Chief Engineer (Buildings) has also prescribed a Checklist for adherence by the Officers of the Electrical wing.

(CE (B) Circular Memo No HDO (A)/33029/2002 Dated 14.6.2002)

Special Rule to Electrical Works:

The Executive Engineer concerned shall be incharge of the electrical installations in all Government buildings either borne on the Register of Public Building or not (except those maintained by Electrical Engineer, PWD., Jails, Borstel School, certified schools) and shall carry out the repairs and small extensions, thereto with the help of electricians or wireman employed under them. The expenditure should be met from funds provided in P.W.D., budget.

(Note 1 under Para 256 of T.N.P.W.D., Code)

Maintenance of Buildings:

- The responsibility of maintaining Government buildings is vested with the P.W.D., though different departments may be occupying the buildings.

- The occupying department is responsible for the "house keeping" only.

- The construction of petty buildings and execution of ordinary repairs to all civil buildings upto a limit of Rs.10, 000/- shall ordinarily be undertaken by the department using or requiring them, out of the funds placed at their disposal in the civil budget.

  (Para 97(1) of TNPWD Code)

- Such works requiring structural alterations and additions will require prior concurrence of P.W.D. The Department has got the discretion either to permit such works to be executed by the user department with professional supervision or not.

  (Para 97(1) and Note 3(ii) (2) of TNPWD Code)

Some important provisions from Tamil Nadu Public Works Department Code and Tamil Nadu Treasury Rules:

Time Barred Cheque:

If the currency of a cheque has expired owing to its not being presented at the Treasury or payment is not been made within three months after the month of issue and the cheque is returned to the Drawing Officer, he shall destroy it and may draw a new cheque in place of it and the fact recorded in the counterfoil of the old cheque.

(SR 49 under Treasury Rules 16)

Lost Cheques:

The fact should be reported to the Treasury Officer and request him to stop payment of the cheque. Non payment Certificate is to be obtained. The party requesting for a fresh cheque in lieu of the lost one should execute an indemnity bond in Form 46A. The fact of loss should be recorded in the counterfoil.

(*SR 50 under Treasury Rules 16)*

Cancelled Cheque:

The Drawing Officer shall cancel the cheques which has remained unpaid for three months after the month of issue. When a cheque is cancelled for any reason the fact shall be recorded on its counterfoil and if it is in the possession of the Drawing Officer it shall be destroyed. If the cheque is not in his possession and payment has not already been made, a request has to be made to the Treasury Officer to stop payment of the cheque and should also obtain a Non Payment Certificate.

(SR 51 under Treasury Rules 16)

Powers to draw cheque by Sub Divisional Officer

A Divisional Officer may authorize any Sub Divisional Officer working under him to draw cheques against his own account with a District Treasury including sub - treasuries under it.No separate account shall be opened for a Sub Divisional Officer who is so authorized. The cheques drawn shall be charged to his account as if drawn by the Divisional Officer. The Divisional Officer will allocate to them under Letter of Credit to the SDO and in turn the Treasury Officers will communicate the allocation to the Sub Treasury Officers. Drawal of cheques by the SDO shall be regulated with reference to the allotment made by the Treasury Officers.

(SR 55 (a) under Treasury Rules 16)

Special Provisions for Public Works Department

The Accountant General will ordinarily place each Divisional Officer in account with one or more District Treasuries within his jurisdiction for the purpose of drawing cheques. The Superintending Engineer may resume and allocate funds among the division under their charge from the amount placed with them for the month subject to the monetary limits.

Drawing from the account will be covered by Letter of Credit system. Letter of Credit for each drawing officer stipulating the amount that can be drawn during the year will be issued by the Finance Department of the Government. The Government will issue instructions to the Treasury Officers indicating monthly as well as annual allocation for various Drawing Officers. The Treasury Officer will communicate the allocation to the Sub Treasury. Cheques drawn will be honored only up to the amount of allocation communicated. Balance of allocation in a month can be carried over to the subsequent month subject to over all provision for the financial year. The balance outstanding at the close of the financial years shall lapse. But LOC for the month of March shall be kept open up to June. The cheques issued during the last quarter of financial year shall be counted against the LOC for the month and paid till the balance exhausted. These carry over payments should not under any account be counted against the LOC for the month from April to June for which separate account shall be opened.

(SR 54 under TR 16)

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Starting of Works

No work shall be started without a properly sanctioned detailed design and estimate, allotment of funds and orders to begin the work issued by competent authority. No liability may also be incurred and no officer may accept a contract for any work until an assurance has been received from the competent authority to provide funds and that such funds will be allotted before the liability matures.

(Para 173 of TNPWD Code)

Scope of Sanction

Any anticipated or actual savings on sanctioned estimates for a definite work should not be applied to carry out additional works not contemplated in the original project or fairly contingent on its actual execution without special authority.

(Para 182 of TNPWD Code)

The amount of the detailed estimate must not exceed the amount included in the administrative approval by more than 10 percent.

(182(2) of TNPWD Code)

The approval or sanction of an estimate for any public works other than annual repairs will unless, such work has been commenced cease to operate after a period of five years from the date upon which it was accorded.

(Para 186 of TNPWD Code)

Where important structural alternatives are contemplated though not necessarily involving an increased outlay, orders of the original sanctioning authority should be obtained. A revised estimate should be submitted for technical sanction where the alterations involve any substantial change in the cost of the work.

(Para 187 of TNPWD Code)

A revised estimate must be submitted when the sanctioned estimate is likely to be exceeded by more than 5 percent and necessitated revised administrative approval.

(Para 214 of TNPWD Code)

Deposit Works:

Contributions should be realized before any liability is incurred on account of the work. No interest will be allowed on the contribution.

Deposits on account of one work cannot under any circumstances be utilized for any other works.

(Para 205 of TNPWD Code)

Investigation before preparation of estimates:

No estimate should be prepared for any work except on the basis of a detailed investigation on the site.

(Para 100 of TNPWD Code)

Audit Approaches:

1. ***Register of building is the Asset Register required to be maintained by SE / EE as per Para 261 of TN PWD code. Cases of not bringing out all the buildings of Government and also not updating the Register may be scrutinized to ascertain cases of building omitted to be included in the Register. This would lead to unauthorized occupation of Government building and non-recovery of lease rent.***

2. ***Para 239, 249 and 236 of TNPWD code stipulate the procedure for disposal of vacant building. Cases of buildings remaining vacant for long period may be identified by verifying the Register of building and other records and comments made on loss due to delay in disposal of vacant building and also expenditure incurred on maintenance of vacant building.***

3. ***Para 252 and 253 of TNPWD code provide for remission of property tax (Municipal tax) for the period of vacancy. Cases where property tax was paid to local bodies during the period of vacancy may be examined and suitable comment made on the failure.***

4. ***Para 235 and 236 of TNPWD code indicate the procedure for disposal of dismantled materials of the building. Cases of non-adherence of that provision may be examined and commented.***

2. PLANNING MANAGEMENT

(Part 7 of National Building Code of India 2005)

Planning Aspects (*Clause 2.1):*

Construction planning aspects aim to identify and develop various stages of project execution on site, which should be consistent with the management considerations. Planning aspects evolve out of the objectives of the project and requirements of the completed facilities. These objectives could relate to the final constraints, cost considerations, quality standards, safety standards, environmental considerations and health considerations. Construction practices would, then have to satisfy these objectives during construction phase of the project.

Having established objectives of the construction phase, planning determines processes, resources (including materials, equipments, human and environmental) and monitoring system to ensure that the practices are appropriately aligned. Adequate knowledge about pre-construction phase, evolution of project, especially related to consumer's requirements, is an essential prerequisite for construction planning.

Preconstruction Phase *(Clause 2.1.1):*

- Besides the design aspects, preconstruction phase should also address all the issues related to the implementation of the design at the site through suitable construction strategy. During the design stage, the site conditions should be fully understood with anticipated difficulties and avoids the risk of subsequent delays and changes after the construction has started.

- The selection of construction methods, building systems and materials, components, manpower and equipments and techniques are best done in the preconstruction phase. Such selection is influenced by the local conditions like terrain, climate, vulnerability for disasters etc.,

- Construction in busy localities of cities need special considerations and meticulous planning due to restricted space, adjoining structures, underground utilities, traffic restrictions, noise and other environmental pollution and other specific site constraints.

- The construction aspects of the proposed construction methods need to be carefully evaluated at the planning stage to ensure ease of construction besides optimizing the construction schedule and achieving quality, reliability and maintainability of the constructed facilities.

- Constructional practices in hilly regions need to take into consideration the problem of landslides, slope stability, drainage etc., besides ensuring that there is no adverse impact on the fragile environmental conditions.

- Durability of constructions in corrosive atmospheric conditions like coastal regions and aggressive ground situations with high chlorides and sulphates should also be taken care of with appropriate constructional practices.

- Constructional practices in disaster prone areas need specific planning. The type of construction, use of materials, construction techniques require special consideration in such areas.

- Adverse weather conditions have strong bearing on construction phase. Situations wherein constructions are to be carried out in adverse weather conditions, such as heavy and continuous rainfall, extreme hot or cold weather, dust storms etc., the practices have to address the relevant aspects. Accordingly, suitable design and field operations should be adopted or redefined in anticipation of these aspects.

Resource planning *(Clause 2.1.2):*

- Resource planning aims to identify requirement availability and regulatory/control processes related to resources.

- In construction phases, the resources could be categorized as materials, manufactured products, equipments for construction, installation and fabrication, human resources, as a part of overall organization, information resources, such as, reference standards, environmental standards, other practice documents, environmental conditions for work on site and infrastructure facilities. Therefore, the resource planning encompasses identification, estimation, scheduling and allocation of resources. Resource planning needs to establish a control system for controlling consumption monitoring, corrective action and resource re-appropriation in the event of favourable deviation. Organizational capability, commitment to the project requirements and other constraints such as time and cost, need to be considered as inputs while planning resources. Techniques of management and planning, such as, Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM) may be used.

- Non – availability of basic building materials (brick, stone, aggregate etc.,) within reasonable lead would influence the constructional practice by alternative materials. The constructional practices also get decided by the local skills of the manpower for constructional activities. The equipment selection would also be governed by the site constraints. Therefore, the resource planning is critical to the project viability itself, the inputs to the resource planning need to be validated appropriately and established for such management. Resource planning should establish for such management. Resource planning should establish a proper system of data collection so as to facilitate effective resources control mechanism. Resource planning responsibility has to be specifically defined in the overall organizational setup.

Construction phase *(Clause 2.1.3):*

- The site management should be carried out through suitable site organization structure with roles and responsibilities assigned to the construction personnel for various constructions related functions. Safety management is one of the important components of site management.

- The layout of the construction site should be carefully planned keeping in view the various requirements to construction activities and the specific constraints in terms of its size, shape, topography, traffic and other restrictions in public interest. A well-planned site layout would enable safe smooth and efficient construction operations.

- Access for fire fighting equipment shall be provided to the construction site at the start of construction and maintained until all construction work is completed.

- In all buildings over two storeys high, at least one stairway shall be provided in usable condition at all times.

Construction strategy and construction sequence (*Clause 2.1.3.5*):

Construction strategy and construction methods are to be evolved at the planning and design stage specific to the conditions and constraints of the project site and implemented by the site management personnel to ensure ease of construction and smooth flow of construction activities. Sites of high water table conditions with aggressive chemical contents of subsoil need special design consideration. Building with basement in site of high water table should be planned with dewatering scheme with appropriate construction sequence. Duration of dewatering should continue till sufficient dead load are achieved to stabilize the buoyancy loads with adequate factor of safety.

Scope management *(Clause 2.1.4)*:

As a part of overall project scope management functions, the processes of scope planning, scope definition and scope verification are associated with the preconstruction phase of the project. The scope monitoring and the change control are critical to the construction phase leading to serious implications on the time and cost aspects. In this respect, consolidated brief of the project established at the end of the design completion is an essential reference for scope baseline.

Construction management *(Clause 2.2)*:

Construction phase of the project transfer the project conceived on paper in the form of plans and designs, into reality by use of resources like materials, machines and men through one or more construction agencies. To fulfill the construction scope with quality, in time and under safe conditions within a reasonable cost, it is desired that the project is planned for managing construction for amalgamation of above resources for their optimum use and its continuous monitoring. Agencies managing the supervision and or construction are desired to plan and document a management system with clear cut responsibilities and for managing various parameters like scope, time, quality, health, safety and environment and cost for implementation, monitoring and control for their effectiveness. This may be preferably inline with proven National/International documentation system covering all aspects of monitoring and controls. Various parameters to be managed during construction are as follows

a) Time management *(Clause 2.2.1):*

The project is to be completed in the defined time schedule to get its fruitful benefits. Hence time management is essential .The system should include a periodic review of a project with all parameters as well as catch up plans in case of delay identified for controls and reporting from time to time. The system planned should preferably be computer friendly and simple to follow for implementation, monitoring and controls and for reporting from time-to-time.

b) Quality management *(Clause 2.2.2):*

Quality of a project should be planned for all activities from inception to completion. It is desirable that the system planned gives adequate assurance and controls that it shall meet project quality objectives. The system shall cover review of existing requirements, sub-contracting, materials, processes and controls during process, auditing, training of personnel, final inspection and acceptance. All activities shall be planned and controlled. Quality system approach may be referred for planning, suitable to a particular project for implementation.

c) Health, Safety Environment *(Clause 2.2.3):*

Each project affects the safety and health of the workmen and surroundings during construction. Various activities having impact on health, safety and environment need to be identified with their likely effect and proposed preventive corrective actions, together with the concerned statutory obligations.

d) Cost Management *(Clause 2.2.4):*

To keep the project under viable proposition, it is desired that cost of the project during construction are monitored and controlled through a documentation system. The various parameters, which may affect the basic cost, escalations, cost due to variation in scope and quantities, etc., need to be monitored at a defined frequency. The system planned may be in line with a proven cost control method or similar in nature and cost incurred vis-à-vis cost sanctioned and cost anticipated to be reported and controlled from time to time.

Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM) (Annexure A Clause 2.1.2):

PERT and CPM are modern management tools or devices, which have made it possible to achieve considerable savings in cost and time of construction. They can be used with advantage for demolition, constructional safety and fire protection measures, by including them in the list of activities (also called events) along side with other 'events' of the project

Advance planning:

PERT and CPM enable us to achieve judicious employment and utilisation of resources, such as labour materials and equipment by pre-determining the various stage, listing out the various activities and drawing out ' Arrow Network Diagram'.

Synchronization of Sub-Project:

Another extremely important advantage of CPM is that various factors influencing completion of a project can be scientifically planned to be coordinated such that the completion of various sub-projects and services, such as furniture, sewage, electricity and water supply synchronises.

Preparation of CPM Chart:

The most important step in preparation of CPM network is to list out the activities involved to the minutest details. For example, a few activities in case of building projects are given below:

a) Planning and designing of building by architect, engineer and approval of plans by the Authority.

b) Making the land available.

c) Outlining detailed specifications.

d) Procurement of materials, such as sand, cement, stone and timber; and plants such as concrete mixer, vibrator, water pump for curing.

e) Soil explorations and trial pits

f) Excavation in foundations, including demolition, if needed.

g) Construction safety aspects especially in case of pile foundations.

h) Blasting if required (for deep foundations)

i) Fire protection measures.

Time Needed for Each Activity:

An assessment is to be made to find out the time needed for each activity and then to list out those activities, which can be executed concurrently (or simultaneously) with each other. For example, while designing the building in hand, correspondence for land purchase can also go on side by side; or while work in foundations is in progress, order for ‘ joinery’ can be placed.

Critical Activity:

It should then be seen as to which of the activities are critical, that is which item are such that a single day’s delay will mean overall delay on the project. Contrary to this, it will be seen from CPM Network that certain activities can be delayed to a certain extent without delaying the completion of the project. This is very useful and valuable information for the ‘project manager’. That is where resources scheduling becomes easier and economical and a time saver. It eliminates chances of idle labour and higher expenses, which are results of haphazard planning.

Updating:

In Implementing the CPM, there could be gaps between the planned CPM and actual progress. This could be checked periodically – weekly, fortnightly, or monthly depending on nature and size of the project.

General:

Incase of projects being executed by contractors for the owners, or departments, it is recommended that it should be an essential condition of the contract to submit a CPM Chart along with the quoted tenders. This will ensure that the construction work will be according to a systematic, engineer like and well-knit plan of execution.

Guidelines for Avoidance of Delay on Execution of Building Works:

(Memorandum No.H.D.O (A) / 24179 / 2002-1, dated 22.4.2002 and No. AEE / T.10 / 29031 / 2002-1 dated 22.5.2002 of Chief Engineer (Buildings)

To avoid the delay in execution on a building works and also to keep the image of this department intact, the following guidelines are issued for strict adherence:-

- **Administrative Sanction:**

As soon as an order on administrative or financial sanction for a work is received (and availability of site is ensured) action should be taken to address the Government Architect, with relevant details for furnishing detailed (conceptual) drawings. The Executive Engineer concerned should send correct Layout Plan of the site, indicating all adjoining roads with levels, buildings, service lines, position of electrical lines, land, etc., with reference to the main road, In case, the road is secondary or subsidiary the level with reference to Main Road should be indicated. The Chief Architect should also mark an Index Plan (in the plans prepared by him with details). Then action should be taken to prepare detailed estimates and drawing. Whenever or wherever the design requires specialization, it may be referred to the Superintending Engineer, Planning and Designs circle without any loss of time. Further, the designs for works costing more than 30.00 lakh should invariably be sent to the Superintending Engineer, Planning and Designs Circle for scrutiny. In normal cases the period of preparation of drawings, sanction of detailed designs and estimates should not exceed one month.

- **Planning Stage:**

As soon as Government-sanction for the work is received, delay in getting the site from the District Heads shall be avoided. Persistent and periodical correspondence as well as face-to-face contacts with those departmental heads is desirable. If any bottleneck in taking over the site is anticipated, the facts may be reported to the relevant Head of User Department concerned without any loss of time and sustained efforts taken till the site is taken over.

- **Preparation of Estimates:**

Immediately on taking over charge of the site, the nature of foundation that ought to be adopted shall be assessed without any loss of time, by conducting soil exploration and suggestions could be made to the Field Officers for preparation of detailed estimates. If any guidance or assistance is needed in this regard, the Superintending Engineer of Planning and Designs Circle and Executive Engineer of Buildings Research Station, Taramani shall be approached who will readily do the needful.

The lump sum provisions to be incorporated in the estimate shall be assessed on requirement as precisely as possible, according to the nature of construction, type of structure and conditions of site. These exercises shall be done by the Executive Engineers themselves and the Superintending Engineers shall guide and direct them properly on this score. Obtaining the countersignature of the Head of the user department in the estimates is a must to avoid any criticism of boosting the cost of the construction.

- **Invitation for Tenders:**

According to G.O, Ms. No. 222, PW (G2) Department dated 08.04.1999 and Rule 20 of the Tamil Nadu Transparency in Tenders Rules,2000, the minimum period between the date of publication of the Notification in the relevant Tender Bulletin or in the Newspapers (whichever is later) and the last date for submission of Tender should be

a. 15 days for Tenders upto Rs.2.00 crore in value.

b. 30 days for Tenders, the value of which exceed Rs.2.00 crore.

This should be followed scrupulously and no further extension should be allowed without reason and without specific orders of Chief Engineer (Buildings).

- **Deciding of Tenders: -**

As per G.O. Ms.No.873, Public Works Department, dated 04.05.1982 read with G.O.Ms.No. 490 Finance (Salaries) Department, dated 11.9.1998, the following time limit should be followed while processing tenders.

1. The Superintending Engineer, PWD concerned should scrutinize and examine the tenders carefully and if necessary, after negotiating with the contractors, submit the tender proposals to the Chief Engineer, within 15 days (fifteen days) from the date of receipt of the tenders.

2. The Chief Engineer should also scrutinize the tenders, which require Government sanction, and submit them to the Government along with his specific recommendations within 7 days (seven days) from the date of receipt of the proposals from the Superintending Engineers.

3. The Government in the Public Works Department, which receives the tender proposals, should place it before the Tender Committee to take

decision and finalise them after obtaining orders in circulation within a period of one month.
(Instead of Government, now the Tender Award Committee shall finalise the tenders costing more than Rs.1.00 crore and others, where the tender percentage exceeds 10% over the estimated value)

- **Agreement:**

As soon as tenders are decided, the prospective agency shall be requested at once, to execute the agreement within 15 days from the date of work orders as prescribed in G.O.Ms.No. 490 Finance (Salaries) dated 11.9.1998 and to take over the site for the earliest commencement of work. The Superintending Engineer shall monitor the activity in order to avoid delay in handing over the site to the contracting agency and thereby ward off the consequential delay in commencing the work.

- **Execution:**

All works shall be executed as per preset programmes. In the event of any contingency, the sequencing of the phases or the scheduling may be updated as and when warranted to figure out the actual date of completion at any point of time.

The Superintending Engineers shall periodically monitor the execution, preferably once in a fortnight in case of prestigious and high-utility buildings and report their observation to the Chief Engineer (Buildings) for review and issue of instructions on follow up action. Soon on starting the work, the Executive Engineers shall arrange to decide the agencies for all the subsidiary works (Including Rain water harvesting, laying of approach roads within the compound, etc.) to ensure simultaneous execution and completion of all these components of works in parallel to the main project, as the time factor is quite crucial.

- **Time limit for execution of works:**

For important and prestigious works costing Rs.30.00 lakh and above, the Superintending Engineer should see that PERT / CPM / BAR charts are prepared with a realistic time-frame for completion of project and this should be furnished along with the estimate. The time schedule for execution of work shall be incorporated in the Tender documents, Agreements etc., in accordance with the time frame worked out in PERT/CPM/BAR charts. And such time limits should not be exceeded. However, the period of execution of works as furnished below can also be taken as guidelines: -

Sl. No	**Type of Buildings**	**Construction Period (in months) for Total Plinth Area of buildings**		
		Upto 500 Sq.m	501 sq.m to 1000 sq.m	1001 sq.m to 2500 Sq.m
1	Single-storeyed, load bearing structures	4	7	10
2	Single-storeyed, framed structures	5	9	12

Extra for every additional storey (for both types) - 1.5. Months

During the execution of works, the monthly progress of each and every work shall be critically reviewed at circle-level with reference to PERT / CPM / BAR charts. The time limits can be modified and updated due to unforeseen contingencies but with the approval of higher authorities only. For the buildings where the plinth area exceeds 2500 sq.m (special type of buildings) the time limit can be fixed with the approval of the Chief Engineer (Buildings).

- **Change in Design, Entrustment of Additional Items / Quantities:**

On and after countersigning the conceptual plans drawn by the Chief Architect, approved by the Chief Engineer (Buildings) or any other empowered authority of PWD and counter-signed by the User Departmental Head, there shall not be any deviation, in general and the user departmental authorities may be convinced of this, duly pointing out that any deviation would definitely contribute to the delayed completion of the project apart from creating the necessity to get the approval from the higher authorities.

Similarly, deviations and departures from the (technically) sanctioned estimates in general and particularly in respect of projects funded by the World Bank or any foreign oriented funding agency including central governmental organizations who are empowered to meet out the cost of projects, without obtaining the prior approval of the authority who technically sanctioned the estimate of the Government should be totally avoided.

- **Interaction:**

Interaction at frequent intervals with the User Departmental Officials would harmonise the relations and quicken the pace. The Executive Engineers / Superintending Engineers shall convince the User Departmental authorities that the delay in countersigning the plan would contribute to delayed completion of works. Similarly, the Head of district administration / the District Collector shall be informed of the stages of various projects periodically and greater amount of interaction with him to sort out bottle-necks and any anticipated problems will yield better results.

- **Completion Report and Plan:**

On satisfactory completion of the project including the electrical component of the works besides ensuring the municipal service connections for electricity, potable water and sewer, the building or structure shall be handed over to the user department for their effective use. There should be a simple process of handing over between the executing department (PWD) and the user department. For this, the Executive Engineers and Superintending Engineers shall periodically interact with the officials of the user department and assess their actual requirements for which the building was planned and try to avoid any criticism from the user department.

The completion report shall contain the following documents.

- The Government order sanctioning the work.
- The Report accompanying the estimate for the work. Abstract of the estimates.

- The details of overall deviations duly quoting the sanction of appropriate authority (Order number and date).
- History of the building while in execution. In this, the Executive Engineers shall record their observations on the history from the date of taking over the site from the User Department to the date of completion of the building including the handing over date.
- A completion plan as per actual construction shall be drawn. This document shall be bound and kept as a Library Book with proper documentation. It shall be made available to the Executive Engineer and other Higher Officers whenever required.
-

Closing of Accounts:

Now that the MAS and 7F Accounts have become things of the past and the contracting agencies are being permitted to use their own material, of course, under strict guarantee of quality control, closing of accounts should not be delayed unduly.

Conclusion:

Summing up, all the Superintending Engineers and Executive Engineers are requested to assume the role of Nodal Officers of the Department at their respective jurisdictional and functional areas and play an active and more effective role in the implementation of all the constructional and maintenance activities to keep up the reputation of the Department.

Audit Approach:

1. G.O.Ms.No. 2143 RDLA dated 7.10.1974, G.O.Ms.No.1069 Housing and urban development dated 9.12.1981 and Government Letter No.12004/UD/98-26 H & UD dated 10.10.2000 require that construction of buildings should be started in area covered by the town planning scheme only after obtaining prior permission of the respective authority (viz. Municipality /CMDA/Director of town planning etc.,). Cases where construction of building commenced without obtaining planning permit which ultimately lead to stoppage of work due to passing of road, classification of site for other purpose (Park, Children play space, residential etc.,) either by private objection or objection of local bodies or by Court etc., may also be examined and comments included on wasteful expenditure to the value of the work done.

2. NBC 2005 stipulates that various factors influencing completion of a project should be scientifically planned and coordinated and various sub projects such as furniture, equipments, sewage, water supply, electricity etc., should be synchronized so that on completion of the building work, the entire project should be put in the optimum intended purpose. The NBC also stipulate to have interaction at frequent interval with the user department to harmonise the process of completion of the work and put in to beneficial use without any delay.

- ***(i) Construction of school without providing furniture, construction of laboratory without any accessories, construction of building without water supply, electricity etc.,***
- ***(ii) Construction of quarters and delay in providing water supply, electricity and sewerage arrangements leading to non occupation of***

quarters which ultimately resulted in blocking of the assets, unnecessary payment of HRA, Rent relief etc.,

(iii) Construction of hospital building without providing water supply, electricity sanitary, laboratory, X ray block without erecting / purchasing necessary equipments.

(iv) Construction of Office building and delay in providing water supply, electricity, sewerage etc., leading to unnecessary payment rent by user agency on occupying private building.

Each case may be identified and suitable comments may be drawn.

3. To avoid delay in execution of the building works the CE (Buildings) had prescribed the guidelines in Memo dated 22.4.2002, 22.5.2002 to be observed by the field officers from the date of administrative sanction to preparation of completion report. The non adherence of the guidelines and the delay in (i) preparation of plan and design (ii) taking over site (iii) preparation of estimates (iv) invitation of tender and finalisation of tender (v) execution of work with in the prescribed time limit (vi) change in design, entrustment of additional items etc., preparation of completion report etc., have to be examined critically and suitable comment made on the delay leading to extra cost.

4. Para 100 of TNPWD code and Government orders stipulate that the estimate should be prepared based on detailed investigation on the site and if the cost as per detailed estimates exceeded the administrative sanction by more then 10%, revised administrative sanction (RAS) should be obtained. There were cases where there was undue delay in obtaining RAS which result in stoppage of work by the contractor for a long period due to non payment to the contractor for the value of work done and the expenditure incurred on the work remain unfruitful.

3. EARTHWORK

(IS 1200 (Part I) – 1974)

The materials to be excavated on earth work shall be classified as follows unless otherwise specified.

a) Soft loose soil
b) Hard Dense soil
c) Mud
d) Soft Disintegrated Rock (Not requiring blasting) – Rock or boulders which may be quarried or split with crowbars. This will also include laterite and hard conglomerate.
e) Hard Rock (Requiring Blasting) – Any rock or boulder for the excavation of which blasting is required.
f) Hard rock (Blasting prohibited)

Lead and Lifts.

Lead:

The distance for removal shall be measured over the shortest practicable route and not necessarily the route actually taken. Distances not exceeding 250m shall be measured in units of 50m. Distance exceeding 250m and not exceeding 500m shall be measured as a separate item. Leads beyond 500m shall be measured in units of 500m upto 5 km. Where the lead exceeds 5km., it will be measured in units of 1 Km. Half km and above will be reckoned as one and less than half kilometer shall be ignored.

The description of items shall include loading and unloading

Lift:

Lift shall be measured from ground level. Excavation upto 1.5m depth below ground level and depositing excavated material on the ground shall be included in the item of earthwork for various kinds of soil. Extra lift shall be measured in units of 1.5m or part thereof. Obvious lifts shall only be measured; that is lifts inherent in the lead due to ground slope shall not be measured except for lead upto 250m

When earth has to be carried over a bank / obstruction and dumped beyond it, the lift shall be the difference in level between the centre of gravity of the earth and the top of the bank.

Planking and strutting:

The planking and strutting required to uphold the face of excavated earth, etc., shall be measured in square meters of face supported and grouped: separately in stages of 1.5m. Planking and strutting for trenches, areas, shafts, wells, cesspits, manholes and the like shall be measured separately.

Where tightly driven close but jointed sheeting is necessary as in the case of running sand, the item shall be measured separately and the packing of cavities behind sheeting with suitable material shall be included in description of the item. Planking and strutting required to be left permanently in position shall be measured separately.

Earthwork:

Earthwork can be done under the Standard Specification (SS) 20A, 20B, 23C, 24, 25, 26A and 26B etc., of Tamil Nadu Building Practice (TNBP) Volume I for various purpose as detailed below:

SS 20 A:

Standard Specification No.20A requires breaking clods, ramming and sectioning of spoil bank and compacting by watering and consolidation in accordance with TNBP.

Sectioning – This work shall comprise the final shaping, trimming, dressing, levelling evenly and ramming of the top surface to bring the section exactly to the dimensions of the working plans. No extra payment will be made for sectioning, which shall be done evenly and true to the working plans. Contract unit rates for earthwork per 10 M^3 shall include:

a) The initial rate for excavating and depositing in layers not exceeding 15cm in thickness, inclusive of the first 50 metres lead and 1.5 metres lift
b) Preparation of bed – (Benching paid separately)
c) Ramming and consolidation, breaking clods and sectioning and watering after temporary stoppage of work.
d) Profile correction etc.,
e) Watering – No extra payment will be made for watering to be done under this standard specification unless a contract rate is approved prior to commencement of the work.

SS 20 B:

This specification will apply to cases of excavation where breaking clods, ramming and sectioning to the spoil bank are not required – such as drain excavation etc., The contract rate for earthwork per 10 cubic metres shall include the initial rate for excavating dressing bed and sides to exact section of working plans, conveyance and depositing to the requirements of this specification, inclusive of 50 metres lead and 1.5 metre lift, providing and forming such profiles as may be considered necessary by the Executive Engineer to guide the contractor in excavating and depositing.

SS No.21

This specification will apply to puddle work (with clay)

SS No.22

This specification will apply to turfing.

SS.No.23

This specification applies to excavating foundation. Excavated material is not to be placed 1m away from the outer edges of the excavation but shall be placed

anywhere within 50 metres, as may be ordered by the Executive Engineer without extra payment.

The contract rate for excavation of foundation shall include the following:

a) Setting out works, profiles etc.,
b) Site clearance, preparation of bed.
c) Forming deadmen or thandoos and their removal after measurements.
d) Forming (or leaving) steps inside of depth excavation and their removal after measurements.
e) Excavation for insertion of planking and strutting
f) Unless otherwise specified, removing slips or falls in excavation.
g) Bailing out water on excavation from rains, sub soil water etc.,
h) Shifting or supporting pipes, electric cables etc., met during excavation

Note: Pumping out water caused by springs, tidal or river seepage, broken water mains or drains, well point pumping and the like shall be measured in kilolitres of water and paid for separately.

i) Unless otherwise specified in the description of relevant schedule items and in addendum specifications, the contractor shall be paid separately for shoring, sheeting, planking, strutting etc., needed for supporting sides of excavation
(ii) Extra rate for work in or under water, in or under foul conditions, under tides and in snow.

When rock is to be excavated by blasting, it will always be specified before work starts. In no case, blasting is to be done before a rate has been agreed on and the approval of the Executive Engineer to such action obtained. Contract rate for any classification of soil assumes that wedges, levers, picks, mamooties and manual tools only are to be used in excavation and in no case will the contractor be allowed to obtain a revision of classification on the ground that blasting is necessary unless such necessity is approved by the Executive Engineer prior to commencement of blasting. In lump sum contracts, the contracts assume the risk of meeting with hard rock, requiring removal without extra compensation unless separate provision for such contingency is specifically entered in the conditions of contract.

Double the relevant rate for standard specification No.20-B will apply to excavation in all soils and rock classification given above for foundation for buildings, abutments piers, wings and return wall of bridges, culverts, sluices regulators and cross masonry works, retaining walls, toe walls, cut off walls and body walls of anicuts, weirs, retaining walls of causeway, bed dams trenches for water supply and drainage works for laying pipes and sewers, pits for avenue trees, trial pits and pits for poles and towers and toe wall for revetment.

An extra 50% over the rate of ordinary excavation in all soil and rock classification given above shall be allowed for drains, channels and canals having bed width 1.25m and below. The extra percentage is applicable only for depth upto 2.00m the depth being measured from the bottom of excavation.

An extra 25% over the rate for ordinary excavation in all the soil and rock classification given above shall be allowed for drains, channels and canals having bed

with 1.25m to 2.00m. The extra percentage is applicable only for depth upto 2.00m, the depth being measured from the bottom of excavation.

(Note under Earthwork of PWD schedule of Rates)

SS 24:

It applies in filling in foundation. All foundation shall be refilled to the original surface of the ground with approved materials, well watered and rammed.

SS 25:

It applies to filling in basement. Materials for filling in basement shall be as defined in the general specification or descriptive specification or shall be brought from a source approved by the Executive Engineer. The surface to receive the filling shall be first cleared from all roots, vegetation or spoil and wetted. Filling upto plinth level is to proceed in layers with the construction of the building so that the earth, filling may be thoroughly consolidated with optimum moisture content and well rammed in layers of 15cm.Where sand filling is specified, the sand shall be clean, free from admixture of foreign material and approved by the Executive Engineer before filling is commenced. Filling in basement shall have optimum moisture content and, well consolidated in layers of 15cm by ramming with iron rammers and butt ends of crowbars.

SS 26 A:

This specification applies to well sinking for foundations. Open excavation shall be carried down to 30cm above sub soil water level, before the well curb is laid. IS 3955/1967 shall apply to sink well foundations in water.

In the case of Lumpsum contracts, the work will be executed for a definite contract amount but completed according to the plans and specification or payment for separate items of works as may be specified in the contract.

SS 26 B:

This specification applies to well sinking for water supply. The work shall be executed to the standard specification for well – sinking for foundations.

Open well Excavation:

(i) Upto 2m diameter of well, 10% excess will be allowed over the basic rates of open well excavation.

(ii) The rates do not include bailing charges. The de-watering is to be done departmentally. 10% of cost of excavation shall be allowed for dewatering for estimate purpose. Actuals (or) 10% whichever is less to be allowed for de-watering charges. For any expenditure above this percentage, prior approval of the Superintending Engineer should be obtained.

Dismantling:

(i) For dismantling 0.75m below Ground level 25% extra over the basic rates.
(ii) The rate of dismantling lime concrete, cement concrete and RC concrete are exclusive of bailing out water charge. The rate is same in all floors.
(iii) Add 25% extra cost for restricted partial dismantling in existing structure where extra care is required for safe guarding the main structure.

Quarrying and Blasting:

(i) The deduction of 40% is to be made for the quantity of voids on stock measurement and payment is for the lesser of the two viz., solid measurement (or) stock measurement minus 40% of stock measurements for voids.
(ii) The rates for extra leads and lifts are on the quantity as per solid measurements or stock measurements less 40% of voids whichever is less. These rates are applicable for head load only.

Audit Approach

1. Cases of providing extra lead and lift for excavation of earth work than that provided in the technically sanctioned estimate have to be scrutinized with reference to IS:1200 (Part-I) 1974 and suitable comment made on extra lead and lift.

2. SS 20 A provides for earth work including sectioning. The item of work under specifications comprise of final shaping, trimming, dressing, leveling etc., . Separate provision, if any given for the above work executed under SS 20A may be examined and suitable comments made on over payments to contractor.

3. When earth work involves quarrying of hard rocks, the hard rock on blasting has to be stocked and compared with the quantity of voids on stock measurements and payments is to be made for lesser than the two for the earth work excavation on hard rock requiring blasting. The blasted material should be disposed of and credited to the work.

4. BUILDING MATERIALS

(Part 5 of National Building Code (NBC) of India 2005)

This Chapter covers the requirement of building materials and components and criteria for accepting new or alternative building materials and components. The Standard Specification (S.S.) No.1 to 15 of Tamil Nadu Building Practice (TNBP) Volume.1 also prescribes the specification for the building materials. The specification indicated both in NBC and TNBP are extract of various Indian Standard Codes published by Bureau of Indian Standards (BIS). A few items of materials commonly issued on building work are given below.

1. Cement:

Cement used shall be any are of the following type. The type of cement selected should be appropriate for the intended use.

i) 33 grade ordinary Portland cement conforming to IS : 269
ii) 43 grade ordinary Portland cement conforming to IS : 8112
iii) 53 grade ordinary Portland cement conforming to IS : 12269
iv) Sulphate resisting Portland cement conforming to IS : 12330

Sulphate resisting Portland cement is being used in work involving construction structure exposing the corrosive nature due to presence of acid, industrial waste, etc.,

Comparative analysis of strength of different grade of cement

Grade	**Compressive strength of cement at 28 days**	**Fineness**	**Setting time**	
33	33 mpa	Not less than 225 M^2 / Kg	Initial setting time not less than 30 minutes	Final setting time not more than 600 minutes
43	43 mpa			
53	53 mpa			

2. Aggregates (IS: 383-1970):

The aggregate used for the work should conform to IS: 383-1970. The aggregates shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or combination thereof. The aggregate is classified as fine aggregate (sand) and coarse aggregate (crushed stone)

a) Graded coarse aggregate:

Graded coarse aggregate may be supplied in the nominal sizes stipulated in clause 4.1 & 4.2 of IS: 383-1970. The grading is based on percentage passing and IS sieve designation. The percentage passing for grade aggregate of nominal size is given below.

40mm	20mm	16mm	12.5mm
100	--	--	--
95 to 100	100	--	--
30 to 70	95 to 100	100	100
10 to 35	25 to 55	30 to 70	40 to 85
0 to 5	0 to 10	0 to 10	0 to 10

b) Fine aggregate:

As per clause 4.3 of IS:383-1970 the sand shall consists of natural sand, crushed stone or crushed gravel sand, or a combination of any of these. The sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain any appreciable amount of clay balls or pallets.

The grading of fine aggregates, when determined as described in IS: 2386-(Part I) 1963 shall be within aggregates, grading zones I, II, III and IV. Where the grading fall outside the limits of any particular grading zone of sieves other than 600 micron I.S sieve by a total amount not exceeding 5 per cent, it shall be regarded as falling within the grading zone.

As per clause 4.3 of IS: 383-1970 the sand shall consists of natural sand, crushed stone or crushed gravel sand, or a combination of any of these. The sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain any appreciable amount of clay balls or pallets.

I.S. sieve designation	Percentage passing for			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

Note:

a) For crushed stone sand, the permissible limit on 150 micron I.S. Sieve is increased to 20 per cent. This does not affect the 5 percent allowance permitted in Clause 4.3 applying to other sieve sizes.

b) Fine aggregate complying with requirements of any grading zone in this table is suitable for concrete but the quality of concrete produced will depend upon a number of factors including proportions.

It is recommended that fine aggregate confirming to grading Zone IV should not be used, in reinforced concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

3) Stone

The building stones are obtained from rock for a good structural stone, the crushing strength should be greater than 100 N/mm^2. The approximate value of crushing strength of some of the stones are given below.

Rock	Stone	Crushing strength in N/mm^2
Igneous	Basalt	150 to 185
	Diorite	90 to 150
	Granite	75 to 127
	Syenite	90 to 150
	Trap	330 to 380
Sedimentary	Laterite	1.80 to 3.10
	Lime stone	54
	Sand stone	64
	Shale	0.20 to 0.60
Metamorphic	Gneiss	206 to 370
	Slate	75 to 207

4.Bricks (IS: 1077-1970):

The bricks used in construction works are burnt bricks and they are classified in four categories. The Indian standard (modular) size of bricks are 19cmx9cmx9cm and 19cmx19cmx4cm. With mortar joints the size of these bricks are respectively 20cmx20cmx10cm and 20cmx20cmx5cm. Now various other size of bricks are available in market.

First class:

These bricks are table moulded wire cut brick of standard shape and they are burnt in kilns. The compressive strength of the brick is between 7.5N/mm^2 and 15 N/mm^2. Buildings or walls, which are pointed and not plastered, may be built of first class brick. Foundation walls may also be built with first class brick.

Second class:

These bricks are ground moulded and burnt in Kiln and they are known as chamber bricks having compressive strength of above 5 N/mm^2 but below 7.5N/mm^2. These bricks are used for Ordinary construction.

Third class:

These bricks are ground moulded and commonly known as country brick having compressive strength between 3.5N/mm^2 and 5 N/mm^2.

Fourth class:

These are over burnt with irregular shape and used as aggregate for concrete foundation, floor etc.,

As per IS 1077:1970 the bricks having crushing or compressive strength of less than 3.50 N/ mm^2 should not be used on masonry work.

5.Reinforcement:

Reinforcement used shall conform to the requirements of IS:432- specification for mild steel and high tensile steel bars. High strength deformed steel bar conforming to IS: 1786-1985 is now commonly used due to technological advances. The strength of deformed steel bar used as reinforcement in concrete have strength of Fe 415, Fe 500 and Fe 550. The reinforcement shall be free from rust, oil and grease or any harmful material. Every bar must be examined before assembling on the work.

6. Timber:

Timber is one of the building materials commonly used for beams, columns and roofings, doors, windows, furniture etc., when a tree is freshly cut, the wood contains considerable quantity of water in the form of sap and moisture and it should be removed before put into any construction. Otherwise, it will crack and strink. Hence the timber shall be seasoned before using on construction. Timber may be seasoned by natural or seasoning method and artificial or kiln seasoning method.

7. Paints & Varnishes:

Timber, steel, cement-plastered wall etc., need a protective coating so as to resist weathering due to atmospheric action etc. Paints are fluids, which are applied as surfaces of timber, steel, plastered wall to protect them against the corrosive action and also to provide decorative colourful finish. Varnishes are practically colourless fluid, which are applied over painted surface or wood works.

Audit Approaches

1. The quantity of materials (Cement Aggregate, brick) used for the work has to be scrutinized based on the test results required to be used on the work should be tested to ensure the appropriate standard. The usage of inferior quality of material should be commented.

2. As per IS: 1077 /1970 the bricks having compressive strength less than 3.5 N/mm^2 should not be used in masonry work. The practice of using kiln burnt country bricks in the rural areas for construction activities is in vogue. The compressive strength of bricks should be tested and ensured that the brick used on work have prescribed compressive strength. The comments on inferior quality of bricks may be included.

5. STRUCTURAL DESIGN – SOIL INVESTIGATION AND FOUNDATION.

(Part 6 – Section 2 of National Building code 2005)

A building has to perform many functions satisfactorily. Amongst these functions are the utility of the building for the intended use and occupancy, structural safety, fire safety and compliance with hygienic sanitation, ventilation and day light standards. The design of the building is dependent upon the minimum requirements prescribed for each of the above functions. The structural safety of this design loads which have to be assumed for dead loads, imposed loads, wind loads, snow loads and other external loads. Consequently selection of suitable site and soil to bear the various loads assumed much important.

Selection of Site (Chapter 2 Basic Civil Engineering by M.S.Palanisamy):

The first and foremost job in construction is to select a suitable site for the building. A properly selected site of the building gives enhanced beauty to the building with out any extra expenditure.

The following points should interalia be considered while selecting the site for any particular building:

a. Soil at the building site should not be of artificially made-up type. Buildings constructed over such soils normally undergo differential settlement and cracks are quite common in such buildings.
b. The site should not be undulating since this leads to increase in cost for leveling the ground.
c. The site should have its general slope, to enable easy drainage.
d. Civic services, such as water supply mains, electric lines, telephone lines, drainage, sewers, should be near the site so that no additional costs incurred.
e. The ground water table in the site should not be high.
f. The selected site should be as far as possible large enough to provide sufficient light and air to the building with drainage facilities and adequate space to accommodate all the essential requirements.
g. The site should possess a good soil at reasonable depth.

Substructure:

A structure essentially consists of two parts, namely the super structure, which is above the plinth level and the substructure, which is below the plinth level. Sub-structure is otherwise known as the foundation and this forms the base for any structure. Generally about 30 per cent of the total construction cost is spent on the foundation. The soil on which the foundation rests is called the "foundation soil" and that plays an important role in the design of foundation.

Site inspection:

The general inspection of the site serves as a good guide for determining the type of foundation to be adopted for the proposed work. The inspection of site helps in getting the data with respect to the following items.

1. Behaviour of ground due to variations in the depth of water table.
2 Disposal of storm water at the site.
3. Nature of soil by means of visual examination.
4. Movement of ground due to earthquake, landslide, etc.

In order to know the quality and thickness of soil underground, trial pits are made up to the foundation level, the soil is excavated and examined. Electrical methods are also adopted to determine the soil quality from the resistance offered by the soil for the passage of current.

Soil

Soil is a material produced by the weathering of the solid rock. The Major categories of soils are gravel, sand silt and clay. They are further grouped into coarse grained (Gravel, sand), fine grained (silt and clay) based on the soil type and size as detailed below.

Soil type	**Size limit**
Gravel	4.75mm to 80mm
Sand	0.075mm to 4.75mm
Silt	0.002mm to 0.075mm
Clay	< 0.002 mm
Organic Soil	Fibrous in nature

As per IS: 1904-1986, the soil is classified into four types a) rocks, b) non-cohesive soils, c) cohesive soils and d) made up ground and fills. Non – cohesive soil are gravel, sand and mixture of sand and gravel, sand and silt and mixed soils. Cohesive soils are hard or stiff clay in dry, medium moisture condition, soft and very soft clay, black cotton or expansive soils.

The soil can be placed in different groups based on the index properties, and the engineering properties such as strength characteristics (shear strength) volume change characteristics or compressibility (settlement) and permeability (rate of settlement). Field test data are essential to know the exact magnitudes of these values. More often laboratory tests are found to be necessary to cross check the values. In some other situations where field-testing is not possible, the laboratory test has a distinct role by itself. Based on the test the ability of a soil mass to support on imposed loading is governed by the shear strength of the soil. As a result, the shearing strength of the soil becomes primarily important in foundation design, highway and airfield design, slope stability problems, and lateral earth pressure problems that deal with the forces exerted on under ground walls, retaining walls, bulk heads, and excavation bracing.

Standard Penetration Test (SPT):

The purpose of this test is to correlate the compactness of granular soil with 'N' value from which angle of shearing resistance, values are estimated. This test is conducted with a standard soil exploration device and a split spoon sampler. The 'N' values corrected for overburden and saturation are used for the estimation of strength parameters viz. angle of shearing resistance, and undrained cohesion. The SPT has

been employed for a number of years as a method of indirect evaluation of subsurface soils. This is highly useful for granular cohesionless soil. SPT is a measure of denseness. 'N' value is the standard penetration value.

Geo-technical Investigation:

Geo-technical investigation is essential for following situations:

a) For new construction
b) For rehabilitation and
c) For analysis of failures

Soil Bearing Capacity (SBC):

Soil bearing capacity is the maximum load per unit area, which the soil resist safely without displacement. By dividing the ultimate bearing powers of soil by a factor of safety, the safe bearing capacity is obtained. In case if SBC is very low, the SBC can be improved by following method.

i) Increasing the depth of foundation
ii) Compacting the soil
iii) Draining the sub soil water
iv) Confining the soil mass
v) Grouting with cement
vi) Chemical treatments like injecting lime, cement etc.,

Allowable Bearing pressure (Clause 7.1.2):

The allowable bearing pressure shall be taken as either of the following whichever is less.

i) The safe bearing capacity on the basis of shear strength characteristics of soils or
ii) The allowable bearing pressure that the soil can take without exceeding the permissible settlement.

Where the engineering properties of the soil are available (ie) cohesion, angle of internal friction, density etc., the bearing capacity of the soil shall be calculated from stability consideration of shear. Factor of safety of 2.5 shall be adopted for safe bearing capacity.

The bearing capacity of soil is affected by wind and seismic forces. Where the bearing pressure due to wind is less than 25 percent of that due to dead and live load it may be neglected for design where this exceeds 25 percent.

The bearing capacity of the soil is also affected by settlement of oil.

The cause of settlement: (Clause 7.1.2):

Settlement is caused due to the following reason.

(i) Elastic compression of the foundation and the underlying soil
(ii) Consolidation including secondary compression
(iii) Ground water lowering
(iv) Seasonal swelling and shrinkage of expansive soil
(v) Ground movement on earth slope
(vi) Other causes

Ground Improvement (Clause 14 of NBC):

The dearth of good construction sites has forced engineers in recent times to use the poor sites by providing deep foundations or by improving the ground. The ground improvement technique is a special method aimed at increasing bearing capacity, reduce compressibility, decrease permeability, modify dynamic response, reduce the risk of liquefaction potential of subsoil and increase the stability of soil in slopes. Ground improvement is generally achieved by one of the following methods:

1. Stone column
2. Lime column
3. Sand drains with preloading
4. Sand compaction piles
5. Sand pads
6. Dynamic compaction
7. Grouting etc.,

Increase in allowable pressure in soils:

As per clause 6.3.5.2. IS:1893- (Part I) 2002, when earthquake forces are included, the allowable bearing pressure in soil shall increase as per table given below depending on the type of the structure and the type of soil.

Percentage of Permissible Increase in Allowable Bearing Pressure of Resistance of Soils

Sl. No	Foundation	Type of Soil Mainly Constituting Foundation		
		Type I – Rock or Hard Soil: Well-graded gravel and sand gravel mixtures with or without clay binder, and clayey sands poorly graded or sand clay mixtures having ' N ' above 30 where N is the standard penetration value	Type II – medium Soils: All soils with N between 10 and 30 and Poorly graded sands with little or no fines with N>15	Type III – soft Soils: All soils with N <10
(1)	**(2)**	**(3)**	**(4)**	**(5)**
i)	Piles passing through any soil but resting on soil type I	50	50	50
ii)	Piles not covered under item (i)	--	25	25
iii)	Raft foundations	50	50	50
iv)	Combined isolated RCC footing with tie beams	50	25	25
v)	Isolated RCC footing without tie beams, or unreinforced strip foundations	50	25	--
vi)	Well foundations	50	25	25

Notes:

1. The allowable bearing pressure shall be determined in accordance with IS: 6403 or IS: 1888.
2. If any increase in bearing pressure has already been permitted for forces other than seismic forces, the total increase in allowable bearing pressure when seismic force is also included shall not exceed the limits specified above.
3. Desirable minimum field values of N- If soils of smaller N-valves are met, compacting may be adopted to achieve these value or deep pile foundations going to stronger strata should be used.
4. The values of N (corrected values) are at the founding level and the allowable bearing pressure shall be determined in accordance with IS 6403 or IS 1888.

Seismic Zone (1)	Depth below Ground Level (in M) (2)	N Values (3)	Remarks (4)
III, IV and V	≤ 5	15	For values of depths between 5m and 10 m linear interpolation is recommended.
	≥ 10	25	
II (for important structures only)	≤ 5	15	
	≥ 10	20	

5. The piles should be designed for lateral loads neglecting lateral resistance of soil layers liable to liquefy.
6. Isolated RCC footing without tie beams, or unreinforced strip foundation shall not be permitted in soft soils with N<10.

(Key clause 6.3.5.2 and Table 1 IS 1893 (Part I) 2002.

7. The erstwhile seismic Zone I has been merged to Zone II as per revised edition of IS 1893 (Part I) 2002.

Seismic zone factor (Clause 6.4.2. and table 2 of IS 1893 (Part I) 2002.

Seismic zone	II	III	IV	V
Seismic intensity	Low	Moderate	Severe	Very severe
Zone factor 'Z'	0.10	0.16	0.24	0.36

Most parts of Tamil Nadu come under zone II and the following towns in Tamilnadu come under zone III. No town/cities of Tamilnadu lies in zone IV and V.

Town	Zone	Zone factor
Chennai	III	0.16
Coimbatore	II	0.10
Cuddalore	III	0.16
Dharmapuri	III	0.16
Kalpakkam	III	0.16
Kancheepuram	III	0.16
Madurai	II	0.10
Pondicherry	II	0.10
Salem	III	0.16
Thanjavur	II	0.10
Thiruchirapalli	II	0.10
Tiruvannamalai	III	0.16
Vellore	III	0.16

(key Annexure 'E' of IS 1893 (Part I :2002)

Loads on Foundations (IS : 875-1987 of Part 6 – section 1 of NBC 2005):

The type of foundation to be used depends upon the loads borne by it. There are various types of loads borne by the foundation – dead load, live load (imposed load), wind load, snow load, seismic load and other external loads.

Dead Load:

This is the self-weight of the various components of a building. The provision for the future construction must also be made in the dead load calculation. In order to calculate the dead load, acknowledge of weight of the common building materials is necessary.

Live Load (imposed load):

This is also known as superimposed load and is the moveable load on the floor. This includes the weight of persons standing on a floor, weight of materials stored temporarily on a floor, weight of snow, etc.

Wind Load and Seismic Load:

In case of tall buildings, the effect due to wind should be considered. The exposed sides and roofs of such buildings are subjected to wind pressure and its effect is to reduce the pressure on the foundation in the windward side and to increase the pressure in the leeward side. Besides seismic force will effect the bearing capacity of the soil.

Snow load:

In area subjected to snow accumulation, snow load on a roof area or any other area above ground is considered for design load.

FOUNDATIONS:

The sub-structure which transmits the loads of superstructure to the soil is termed as foundation. A foundation is provided for the following purposes:

(i) To distribute the total load coming on the structure on a larger area.
(ii) To support the structures.
(iii) To give enough stability to the structures against various disturbing forces, such as wind and rain.
(iv) To prepare a level surface for concreting and masonry work.

The following are the essential requirements of a good foundation:

i) The foundation should be so located that it is able to resist any unexpected future influence, which may adversely affect its performance.
ii) The foundation should be stable or safe against any possible failure.
iii) The foundation should not settle or deflect to such an extent that will impair its usefulness.

Design consideration (Clause 7.1 of Para – 6 Section 2 of NBC 2005):

For the satisfactory design of foundations, the following information is necessary:

a) The type and condition of the soil or rock to which the foundation transfers the loads;
b) The general layout of the columns and load-bearing walls showing the estimated loads, including moments and torques due to various loads (dead load, imposed load, wind load, seismic load) coming on the foundation units;
c) The allowable bearing pressure of the soils;
d) The changes in ground water level, drainage and flooding conditions and also the chemical conditions of the subsoil water, particularly with respect to its sulphate content;
e) The behaviour of the buildings, topography and environment / surroundings adjacent to the site, the type and depths of foundations and the bearing pressure assumed; and
f) Seismic zone of the region.

Depth of Foundations (Clause 7.1.4 ; Part 6 section 2 of NBC 2005):

The depth to which foundations should be carried depends upon the following principal factors:

a) The securing of adequate allowable capacity.
b) In the case of clayey soils, penetration below the zone where shrinkage and swelling due to seasonal weather changes, and due to trees and shrubs are likely to cause appreciable movements.
c) In fine sands and silts, penetration below the zone in which trouble may be expected from frost.
d) The maximum depth of scour, wherever relevant, should also be considered and the weight transmitted from the building to the supporting ground may be important.
e) Other factors such as ground movements and heat transmitted from the building to the supporting ground may be important.

- All foundations shall extend to a depth of at least 500 mm below natural ground level. On rock or such other natural ground, the top soil may be removed and the surface cleaned to provide a suitable bearing and thus prevent slipping or other unwanted movements.
- The foundation in clay soils, black cotton soils etc. should provide adequate load counteracting against swelling pressure of the soil.

Type of foundation: (Clause 6 of Part 6 – Section 2 of NBC 2005):

There are two types of foundations viz-shallow foundation and deep foundation.

Shallow foundation:

When the depth of the foundation is less than or equal to its width, it is designed as a shallow foundation. The main type of shallow foundation are pad or spread and strip foundation, raft foundation and ring and shell foundation. The pad or spread and strip foundation are further classified as isolated footing, strip footing and combined footing.

Isolated footing:

In framed structures where several columns are to be constructed, isolated footing can be adopted. The columns involved can be provided with masonry or concrete footing. If masonry footing is provided, steps are given and the foundation area is thus increased so that the stresses developed at the base is within the limit. Concrete can be moulded to any shape and hence a concrete footing may be a sloping one to provide sufficient spread. In case of masonry footing, the projection of each step must be 1/2 brick thick and each step is made of 1 or 2 brick put together.

Strip footing:

Strip footing is one of the different types of shallow foundation. This is used where soil of good bearing capacity is available at a depth of less than 3m from the ground level. Since the footing throughout the length of the wall is load bearing walls, it is also called as wall footing. Strip footing are classified as follows:

a. Simple footing:

Simple footing are provided in case of walls of very light structures like residential buildings. In simple footing, cement or lime concerte is used in foundation. The projection beyond the face of the wall (offset) of the concrete base is 15 cm on side

b. Stepped footing:

Stepped footings are provided where the ground has a slope; otherwise it becomes uneconomical to provide foundations at the same level. It consists of two or more footing of brick or stone masonry and a concrete bed below the ground level

2. Combined footing:

This type of footing is adopted when the space between two columns is so small that the foundation for individual columns will overlap.
Note : Construction of structures on slopes which are suspected of being unstable and subject to land slips shall be avoided **(Clause 7.1.7.3)**

- **Dimension of Foundation**

  The Dimensions of the foundation in plan should be such as to support loads. The width of the footings shall be such that maximum stress in the concrete or masonry is within the permissible limits. The width of wall foundation (in mm) shall not be less than that given by:

  $$B = W + 300$$

  Where

  B = Width at base in mm, and

  W = Width of support wall in mm.

Thickness of Footing (Clause 7.2.12 Part 6 section 2 of NBC 2005):

The thickness of different types of footings, if not designed according to 7.1. should be as designed as follows.

Thickness of Footings (Table 5 and clause 7.2.12)

Sl. No.	Type of footing	Thickness of footings Minimum	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 a)For normal structures	a)200mm b)Twice the maximum offset in a stepped footings c)300 mm	For footing resting on top of the pile. For footings restings on soil
	b)For lightly loaded structures	a)150mm b)200mm	a)Resting on soil b)Resting on soil
iii	Reinforced concrete	a)150mm b)200mm	a)Resting on soil b)Resting on soil

Note:

i) The minimum thickness of the foundation of the edge should not be less than 150 mm.

ii) If the bottom of a pier is to belled on as to increase its load carrying capacity, such bell should be atleast 300 mm thick at its edge.

Raft foundation (Clause 7.3.1. to 7.3.3.):

Distribution of contact pressure underneath a raft is affected by the physical characteristics of the soil supporting it. Consideration must be given of the increased contact pressure developed along the edges of foundation on cohesive soils and the opposite effect on granular soils, Long-term consolidation of deep soil layers shall be taken into account in the analysis. This may necessitate evaluation of contact pressure distribution both immediately after construction and after completion of the consolidation process. The design must be based on the worst conditions.

- The minimum depth of foundation shall generally be not less than 1m.
- The raft may rest on soil directly or on lean concrete.
- A raft generally occupies the entire area of the building.
- Raft foundation shall generally be designed on reinforced cement concrete.
- When the supporting soil is not too compressible, a flat concrete slab having uniform thickness throughout (a true mat) is most suitable.
- A slab may be thickened under heavy loaded columns to provide adequate strength for shear and negative moment. Pedestals may also be provided in such cases.
- A slab and beam type of raft is likely to be more economical for large column spacing and unequal column loads particularly when the supporting soil is very compressive.
- For very heavy structures, provision of cellular raft or rigid frames consisting of slabs and basement walls may be considered.

Ring and shell foundation: This type of foundation is normally not in vogue**.**

Deep Foundation:

Deep foundation consists of pile and pier foundation. Pier foundations are rarely used for building. This consists in carrying down through the soil a huge masonry cylinder, which may be supported on solid rock.

1. Pile foundation:

Pile is an element of construction used foundation. It may be driven in the ground vertically or with some inclination to transfer the load safely. Loads are supported in two ways, i.e. either by the effect of friction between the soil and the pile skin or by resting the pile on a very hard stratum. Former is called friction pile and the latter one is load-bearing pile.

Pile Foundations are further grouped into driven cast in-situ concrete piles, Bored cast in-situ concrete piles, Driven precast concrete piles, Bored precast concrete piles, Under-reamed concrete piles.

Pile foundation (Clause 8.2.1. to 8.2.4.):

Piles foundations transfer load from a structure to sub-surface strata having adequate load bearing capacity. Construction of a pile foundation requires a careful choice of piling system, depending upon the subsoil condition, the load characteristics of a structure settlements and any other special requirement of a project.

Bored and driven cast-in-situ concrete piles including under-reamed piles
(Clause 8.1.1. to 8.2.11.)

Cast-in-situ pile is built in its permanent location with in a hole made for this purpose. The hole may be made by excavation of earth or by driving a suitable casting. The various type of cast-in-situ piles are simple pile, pedestal pile, raymond pile, vibra pile etc., depending on the design requirements.

The minimum cement content shall be 400 Kg/m^3 in all conditions. For piles up to 6 m, minimum cement content of 350 Kg/ m^3 without provision for under water concreting may be used under favourable non-aggressive subsoil condition and where concrete of higher strength is not needed structurally or due to aggressive site conditions. For concreting in aggressive surroundings due to presence of sulphates, etc the provisions given in IS 456: 2000 shall be followed.

- Steel reinforcement and the minimum grade of cement to be used for pile shall conform to IS 456:2000.(8 1.2)
- The piles shall have the necessary structural strength to transmit the loads imposed on them ultimately to the soil. (8.2)
- Pile foundation shall be designed to transmit the load to the soil without causing any soil failure, settlement, functional distress. (8.2)
- The pile shaft should have adequate structural capacity to withstand all loads (vertical, axial or otherwise) and moment of earth. (8.2)
- Minimum spacing of piles shall be 2.5 times the dia meter of shaft and in case of piles resting on rock, a spacing of two times of the diameter may be adopted. (8.2.4.1)
- Load test on pile shall not be carried out earlier than four weeks from the time of casting the pile. (8.2.1.4)
- The factor of safety should be judiciously chosen after considering the reliability of ultimate bearing capacity of a pile, type of superstructure and loading and allowable total/differential settlement of the structure.
- The maximum permissible increase over the safe load of pile as arising out of wind load is 25 percent. (8.2.7)
- The pile cap shall be deep enough to allow for necessary anchorage of the column and pile reinforcement and the minimum thickness shall be 300 mm.(8.2.10.2)
- The pile cap is generally cast over a 75 mm thick levelling course of concrete and pile should project 50 mm in to the cap concrete.(8.2.10.6 & 8.2.10.7)
- The grade beam supporting the wall should be designed with minimum over all depth of 150 mm.(8.2.11)

Driven precast concrete piles (Clause 9.3.):

Unlike cast in-situ piles, precast concrete piles are casted in advance to the specific requirements before driving at the site. Pile driving machinery and equipments are needed for driving the precast concrete piles.

The design criteria indicated for cast in-situ pile will also apply for precast piles.

Under-reamed piles (Clause 11):

Under-reamed piles are bored cast in-situ and bored compaction concrete type having one or more bulbs formed by enlarging the bore hole for the pile stem. These piles are suited for expansive soils which are often subjected to considerable ground movements due to seasonal moisture variations. These also find wide application in other soil strata where economics are favourable.

- From practical consideration, under reamed piles of more than 10m depth shall not be used without ensuring their construction feasibility and load carrying capacity by initial load test in advance.(11)
- The minimum length of the pile shall be 3.5m below ground level.(11.2.1.1)
- The minimum stem dia metre of under-reamed pile utpo 5m depth in dry conditions (ie) strata with low water table can be 200 mm and 300 mm in strata with high water table and 250 mm for compaction under-reamed pile for normal condition. For piles of more than 5 m depth the minimum dia meter in the two cases shall be 375 mm and 300 mm respectively and 375 mm for strata consisting of harmful constituents such as sulphate etc.(11.2.1.2)

Foundations on Expansive Soils:

Whenever an expansive soil is encountered, it is essential to entrust to geotechnical experts. Following alternatives are generally considered while designing foundations on expansive soils.

i) Taking the foundations below the zone of moisture variation or to a more suitable non-expansive stratum by piles.

ii) When shallow foundations are provided one or more of the following precautionary measures may be taken.

(a) The most effective type of foundation is raft foundation with reinforced concrete.

(b) Providing surface drainage away from the structure by suitable method.

(c) Replacing the expansive subsoil and providing shallow foundation.

(d) Subsoil treatment such as chemical treatment etc. However such sub soil treatment is generally applied to road construction.

(e) Replacement of expansive material for the top 500 to 1000 mm with granular material / murrum .

Foundation on Made – up Ground:

Sites on partly made-up and partly natural ground, or on fill comprising mixed material or material, which has been compacted unevenly, shall be avoided as being likely to give variable support from place to place. Where such sites cannot be avoided it may be advisable to adopt raft foundation unless a firm bed can be reached by short piles or piers. The loose soil may be excavated without any difficulty and it may be replaced partially with consolidated sand. In the case of fill or very weak soils such layers of sand must be stabilized by adding 200 Kg cement to every Cu. m of sand in order to prevent any lateral movement under the column load. In normal cases, the pit under the footing is filled in with plain concrete composed of 1m^3 gravel or broken stones 0.5 m^3 sand 200 Kg cement. (ie..1:4:8)

Causes of Foundation Failures:

- A foundation failure is a serious event, since it may trigger the collapse of the entire structure. This is because most structures are systems in which the support of the upper levels is always dependent on the structural integrity of the lower elements.

The most common categories of foundation failures are:-

1	Undetermining of safe support	6	Design error
2	Load transfer failure	7	construction error
3	Lateral movement	8	Floating and water-level changes
4	Unequal support	9	Vibration efforts.
5	Drag-down and heave	10	Earthquake efforts.

Seismic Protection:

As per the guidelines of National Earthquake Hazards Reduction programme and Building seismic safety council 1994, the soil profile types are defined by the shear wave velocity of the top 30 meter of soil and classified as follows:-

A. Hard rock with a shear wave velocity of 1,500 m/s
B. Rock with a shear wave velocity of 760-1,500 m/s
C. Very dense soil / soft rock with a shear wave velocity of 360 – 760 m/s
D. Stiff soil with a shear wave velocity of 180-360 m/s
E. Soft soil with a shear wave velocity of less than 180 m/s
F. Special soils requiring site-specific evaluation, such as :
   - Soils vulnerable to potential failure or collage under seismic loading, such as liquefiable soils, highly sensitive clays, and collapsible weak cemented soils
   - Peats and / or highly organic clays thicker than 3 meters
   - Very-high-plasticity clays, thicker than 8 meters, and PI > 75
   - Very thick soft/medium stiff clay deeper than 30 meters.

Audit Approaches

1. Cases of defective investigations and incorrect selection of site for buildings has to be identified with reference to investigations reports and execution of the work. The site originally selected for construction might be altered due to poor soil conditions or other factors, which ultimately lead to delay in execution of the work and also escalation of cost. Such of those cases may be identified and suitable comments made.

2. The Department would also resort to construction of the building without ensuring the soil conditions, settlement effect of the soil and also improving the ground to increase the strength of the soil. This ultimately lead to collapse of the structure, developing cracks and causing damages to superstructure and substructure involving additional expenditure on carrying out rectification work. Such of those cases may be identified and suitably commented.

3. The design of the building is based on strength of the soil and also various loads such as dead, imposed, wind, seismic, snow load etc., It should be verified from the records whether structure is designed for various aspects effecting the strength of the building. The cases of failure on design leading to extra expenditure on carrying out rectifications for strengthening has to be analysed and commented

4. Whenever building is proposed to be constructed in expansive soil, the type of foundations should be selected on geo-technical investigation. Case of failure of foundations due to incorrect selection of type of foundation and geo-technical investigation may be examined and appropriate comments drawn.

5. Failure of foundation leading to collapse of structure is prevalent in many places. The failure is mainly due to undermining the safe support, lateral movement , earth quake effect, floating and water level, unequal support etc.,. The actual cost of failure should be identified and suitable comments made on the failure of the department.

6. Generally 30% of the total cost is spent on foundation. The foundation should be designed to techno-economical design based on various factors (safe bearing capacity of the soil, type of soil, seismic zone and various loads) affecting the structure is to be considered and appropriate foundation has to be chosen. Failure of the department in selection of cost effective foundation and design failure have to be identified and commented suitably.

7. As per circular No.137 of 1981 (WKS II (5) /87721 dated 14.3.1981 of the CE (Building), wherever RCC footing for foundation or raft is laid, a mud mat of 7.5cm thick with cement concrete 1:5:10 using 40mm metal has to be laid under RCC for getting mixed up with the soil. The mud mat serves no other purposes and hence the thickness should not be more than 7.5cm in any case. In some cases the mud mat was laid for a thickness of more than 7.5cm on the plea that the soil in slushy. If the soil is slushy, the same should be made stable by spreading sand to the required same depth and the mud mat should be laid over this surfaces. Cases of providing mud mat in the form of levelling course to* a thick over than 7.5cm for *RCC footing for foundation or raft foundation have to be analysed and extra cost commented.

8. As per circular No.225 of 1951 (WKS II (5)/80225 dt 29.9.1981 the basement level should be atleast 60cm above maximum flood level of the area and the road level for building for Taluk Office, Registrar office, Archives etc., where very important permanent records are to be maintained and coastal area building should have basement of 240cm above high tide level. The cases of flooding of the building may be examined and suitable comment on defective selection of site may be commented.

9. As per Circular No. 1 of 1987 (AEE/T 10- B.87221/87-1 dated 2.2.1987, refilling the basement with excavated expansive clay soil should be avoided as it would create side thrust on the walls and leaving cracking of the floor. Hence filling sand may be used for basement. Case of any failure of floor may be examined and suitable comment drawn on the cost for replacement of floor.

10. Anti-termite treatment to the foundation of new building is being made in routine manner. As per circular No. 15 of 1987, (AEE T 10-B 87221/87) specific prior approval of SE should be obtained for providing such treatment even if there is provision in the estimate without provision it should not be under taken at all unless there is dire necessity as per soil conditions. Cases of non-observance of the guidelines leading to extra cost may be analysed and commented.

11. As per Circular number 232 of 1980 (WKS III /5/87221/80-232 dt 14.10.1982, the type foundation to be adopted for any building should be decided after testing the soil to ascertain safe bearing capacity with reference to the nature of soil and maximum and minimum water table level at the proposed site. In case of black cotton soil and other expansive clayey soil and cohesive soil under reamed pile foundation is suitable. The cause of failure of foundation, collapse of building may be analysed with reference to soil parameters and type of foundation adopted and suitable comment made pointing out the failure.

12. As per Circular No.160 of 1981 (WKS III (5)/87221/81-160 dt 4.5.1981 CE (Buildings) Randam Rubble masonry is to be adopted for foundation in hilly area and also in plain for load bearing wall instead of brick masonry as the cost of RR masonry is economical compared to brick masonry. (The general tendency to compare 375mm RR with 230mm brick masonry in super structure and opting for brick works in foundation must stop). Considering deterioration of brick masonry in long run due to absorption of moisture, the type of masonry foundation adopted may be analysed and comments made on extra cost compared to the cost of masonry in RR and brick work.

13. There is a practice of adopting coursed rubble masonry instead of randam rubble masonry. As per Circular number 160 of 1981 of CE (Buildings), RR masonry is adequate and the contractor would quote higher rates for squaring the face of the stone on all points and also for adoption of uniform height of stones for each courses. In case of masonry work with stone, the actual type of masonry adopted may be examined and extra cost on adoption of coursed masonry compared to RR masonry may be commented.

6. STRUCTURAL DESIGN – MASONRY

(Part 6 section -4 of National Building code of India 2005)

The Superstructure consists mainly of walls, doors, windows, lintels and roof. The purpose of the superstructure is to provide the necessary utility of the building, structural safety, fire safety, sanitation and ventilation. The art of construction in stone or in bricks is called masonry. The former is called stone masonry and the latter is called brick masonry.

Design Consideration (Clause 4):

Masonry structure gain stability from the support offered by cross walls – floors-roof and other elements such as piers and butterasses. Load bearing walls are structurally more efficient when the load is distributed and the member is as small as possible. . These matters should receive careful consideration during the planning stage of masonry structures.

The following are the main aspects for design consideration

1.Lateral support and stability
2.Effective weight
3. Effective length

1. Lateral support (Clause 4.2):

Lateral support for a masonry element, such as load bearing wall or column are intended :

a) To limit slenderness of a masonry element so as to prevent or reduce possibility of buckling of the member due to vertical loads and

b) To resist horizontal components of forces so as to ensure stability of a structure against overturning.

Structural design (Clause 5):

The building as a whole shall be analyzed by accepted principle of mechanics to ensure safe and proper functioning in service of its component parts in relation to the whole building. All component parts of the structure shall be capable of sustaining the most adverse combinations of loads, which the building may be reasonably expected to bear during and after construction.

Design Loads (Clause 5.1& 5.2):

Loads to be taken into consideration for designing masonry components of a structure are:

a) Dead loads of walls, columns, floors and roofs;
b) Live loads of floors and roof;
c) Wind loads on walls and sloping roof; and
d) Seismic forces.

Notes:

(i) When a building is subjected to other load such as vibration from railways: machinery, etc, these should be taken into consideration accordingly to the best judgment of the designer

(ii) During construction, suitable measures shall be taken to ensure that masonry is not liable to damage or failure due to action of wind forces, back filling behind walls or temporary construction loads.

Design Thickness / Cross-section (Clause 5.5):

Walls and columns bearing vertical loads shall be designed on the basis of permissible compressive stress. Design consists in determining thickness in case of walls and section in case of columns in relation to strength of masonry units and grade of mortar to be used, taking in to consideration various factors, such as slenderness ratio, eccentricity, area of section, workmanship, quality of supervision, etc, subject to further provision of nature of the wall viz solid walls, cavity walls, faced walls.

- Free standing walls, subjected to wind pressure or seismic forces shall be designed on the basis of permissible tensile stress in masonry or stability

- Normally masonry of retaining walls shall be designed on the basis of zero-tension, and permissible compressive stress. However, in case of retaining walls for supporting horizontal thrust from dry material, retaining walls may be designed on the basis of permissible tensile stress at the discretion of the designers.

- For walls and columns, stress worked out separately for vertical loads and lateral loads and shall be combined and elements designed on the basis of permissible compressive stress.

- Non load bearing walls, such as panel walls, curtain walls and partition walls which are mainly subjected to lateral loads, according to present state of art are not capable of precise design and only approximate methods based on some tests are available.

Methods of Construction (6.1):

Various types of load bearing and non-load bearing masonry walls are:

a) Brickwork
b) Stone masonry
c) Hollow concrete block masonry,
d) Gypsum partition blocks,
e) Autoclaved cellular concrete block masonary and
f) Lightweight concrete block masonry.

Construction of building in seismic Zones *(Clause 6.1.2):*

No special provisions on construction are necessary for building constructed in Zones II. Special features of construction for earthquake resistant masonry building are necessary for construction of building in zone III, IV and V

Categories of building:

(Section 4 clause 7.1 and Table 12) of NBC 2005 of Clause 6.4.2 of Table 6 of IS: 1893 - Part 1 2002)

For the purpose of specifying the earthquake resistant features in masonry, the building have been categorised in to five categories A to E based on the seismic zone and importance of building.

Structure	Importance factor	Building categories for earthquake resisting features			
		Seismic Zone category			
		II	III	IV	V
i) Important service and community buildings such as hospitals, schools, monu mental structures, emergency buildings like telephone exchange, television stations, radio stations, railway station, fire station buildings, large community halls like Cinemas assembly halls and sub way station and power station.	1.5	A	B	C	D
ii) All other building	1.0	B	C	D	E

Masonry Units *(Clause 7.2 Section 4)*

Bricks/Blocks having a crushing strength not less than 3.5 mpa shall be used. However, higher strength of masonry units may be required depending upon number of storey and thickness of wall .

Mortar (Section 4 Clause 3.3 of NBC :2005 and Table 1 and IS: 2250 - 1981):

Mortar for masonry shall conform to accepted standard. The mix proportions and compressive strength of some of the commonly used mortar are given below.

Sl. No.	Grade of mortar	Mix proportion		Minimum comprensive strength at 28 days in N/mm^2
		Cement	Sand	
1	H1	1	3	10
2	H2	1	4	7.5
3	M1	1	5	5.0
4	M2	1	6	3.0
5	M3	1	7	1.5
6	L1	1	8	0.7

Recommended Mortar Mixes:

(Clause 7.3.1 and 7.4.6)

Category of Construction	proportion of cement- lime-sand
A	M2 (cement-sand 1:6) or M3 (lime-cinder 1:3) or richer
B, C	M2 (cement-lime-sand 1:2:9 or Cement –sand 1:6) or richer
D, E	H2 (cement-sand 1:4) or M1 (cement-lime-sand 1:1:6) or richer

Where steel reinforcing bars are provided in masonry the bars shall be embedded with adequate cover in cement sand mortar not leaner than 1:3 (minimum clear cover 10mm) or in cement concrete of grade M15 (minimum clear cover 15mm or bar diameter whichever more), so as to achieve good bond and corrosion resistance.

Stone masonry (Clause 8.3):

The construction of stone masonry is normally Randum Rubble (RR) or dressed stone type, coursed rubble masonry (CR), uncoursed rubble masonry and Ashlar masonry. The strength of masonry depends on the quality of mortar needed for constructions filling the space between the joints, pointing and strength of the stone used. The mortar should be cement-sand (1:6) lime- sand (1:3) or clay mud of good quality. The wall thickness of RR masonry should not be larger than 450 mm, preferably it should be about 350 mm. Bonding element of adequate length should be provided at corners and junctions of the wall.

The masonry should preferably be brought to course at them 600 mm light.
Height of the stone masonry walls (randam rubble or half dressed should be restricted as follows)

i story height = 3 m (maximum)
ii span of wall between cross walls limited to 5.0 m
iii For categories A and B = 2 storeys with flat roof or one storey plus attic is if walls are built in cement sand 1:6 cement mortar
iv) For categories C and D = Two storeys with roof or two storeys plus attic for pitched roof if walls are built in 1:6 cement mortar.

Jointing and pointing:

All joints shall be full of mortar. Pointing shall be avoided as far as possible. But where unavoidable, it shall be carried out as the work proceeds using the same mortar used for construction. If carried out by raking out the joint later on after hardening, specifically prepared mortar shall be used. The maximum thickness of joints shall be 20 mm for random rubble and 10 mm for square rubble.
(Clause 7.10 of IS 1597 Part I - 1967)

1. Coursed rubble masonry:

In this type of rubble masonry, the size of the stones varies from 50-200mm. The safe permissible load is 550KN/m^2 (if cement mortar issued). The masonry work is carried out with stones of equal height in one particular course. This masonry is adopted for public buildings, residential buildings, etc.

2. Uncoursed rubble masonry:

In this type of masonry, the stones are not of same height. They are levelled at every 30-50cm. First larger stones are laid and the spaces are filled with spalls. This masonry is used for the construction of compound walls, godowns, garages, labour quarters, etc. since they are cheap.

3. Randum Rubble Masonry:

In this type of masonry, stones are arranged in a randum fashion to give a good appearance. Great skill is necessary to make this type of masonry structurally stable. This type of masonry is used for the construction of residential buildings, godowns, etc. The safe permissible load is 330KN/m^2 if lime mortar is used and it is 880 KN/m^2 (granite stone), if cement mortar is used.

4. Ashlar Masonry

In this type of masonry, square or rectangular stones are used. Stones need not be of the same height and the height can vary from 30 to 35 cm. The length of the stone should not exceed three times the height of the stone. The allowable load for granite in lime mortar is 1640 KN/m^2 in this masonry. The beds , sides and face are finished and chisel dressed. Thickness of the mortar joint is not more than 3 mm. This gives a perfectly smooth appearance but is costly.

Brick masonry (Clause 8.2):

1.Construction of structure with brick masonry in lime mortar/cement mortar is in wider use in the country for a long time.

The fired brick should have a compressive strength not less than 3.5 mpa. Strength of the bricks and wall thickness should be selected for the total building height.

As per IS 1077:1976 the class of brick is classified on the basis of compressive strength which varies from 3.5 mpa to 12.5 mpa (3.5,5,7.5,10,12.5 mpa) The brick when tested shall not be more than 20% by weight immersed in cold water for 24 hours. (Clause 6.2 of IS 1079:1976)

The mortar should be lime sand (1:3) a clay mud of good quality or cement mortar 1:6 The height of building shall be restructured to the following where each storey height shall not exceed 3m.

a) For categeries A.B.& C – 3 storeys with flat roof and the strength plus attic for pitched roof.
(b)For category D – 2 storeys with flat roof and one storey plus attic for pitched roof..

IS: 1905–1987 Code of Practice for Structural use of Un-Reinforced Masonry and Hand Book on Masonry Design & Construction SP:20 (S&T) – 1991 stipulates optimum mortar mixes for maximum masonry strength with bricks of various strength which is given below:

Brick's strength	Mortar mix (by volume) Cement: Sand	Mortar type
Above 5 N/mm (Country bricks) in Tamil Nadu	1 : 6	M2
Above 5 but below 7.5 N/mm (Second class) (Chamber bricks)	1 : 5	M1
Above 7.5 but below 15 N/mm (First class) (wire cut bricks)	1 : 5	M1
Between 14.90 and 25 N/mm (precast cement blocks)	1 : 4	H2
25 and above 25 N/mm (precast Concrete blocks)	1 : 3	H1

It is better to decide the type of brick to be used in the masonry and then appropriate mortar mix to achieve optimum strength of the brick masonry as listed below:

i) Brick work in cement mortar 1:6 using country bricks/third class bricks.
ii) Brick work in cement mortar 1:5 using second class bricks
iii) Brick work in cement mortar 1:3 using first class bricks/first class meteric bricks/wire cut bricks.
iv) Brick panel/partition wall of thickness 11.5 cm in cement mortar 1:6 using country bricks/third class bricks or cement mortar 1:5 using second class/first class bricks.

- Bricks are to be well soaked in water before use.

- Brick works shall generally be measured in cubic metres unless otherwise specified. Wall half bricks in width and less shall be measured in square metre.

- No extra payment will be made for finishing brick work face joints and it shall be included by the contractor in his unit rate for brick work.

(Standard specification No.31 of TNBP)

Components of superstructure of the building:

A few items of components of the superstructure of the building are given below.

i) Beam: Beams are structural members that can carry transverse loads which produce bending moments and shear Beams may be horizontal (most common) or sloping (as roof beams). Horizontal beams carry only transverse loads while sloping beams carry both axial and transverse loads.

Beams may be termed simple beams when the end connections do not carry end moments due to any continuity developed by the connection. A beam is continuous when it extends across more than two supports and is called a fixed beam if the ends are rigidly attached to other member so that a moment can be carried across the connection.

ii) Plinth beam: Plinth is a structural member in the basement constructed in RCC.

iii) Columns: Columns are structural elements used primarily to support compressive loads. Compression member in a truss may be known as chord members or web members, depending on their truss location. Columns may also be called by various other names, such as braces or struts.

Reinforced concrete columns are of square, rectangular or circular cross sections. The load carrying capacity of the columns depends on the strength of concrete and steel. If the percentage of steel used is less in a column, the steel will reach its strength prior to concrete. The column will not fail since it can take more loads at this stage Due to this increase in load, steel will yield and the concrete will reach its full strength. Hence, the strength of the entire material is utilized. On the other hand, if the percentage of steel used is large, then concrete fails first and the failure will be spontaneous.

iv) Lintel: A lintal is a horizontal member which is placed across an opening to support the portion of the structure above it. The function of a lintel is same as that of a beam. The usual concrete mix used for lintel is 1:2:4 plain concrete lintels can be used up to a span of 800mm. The amount of reinforcement depends upon the span. R.C.C. lintel can be precast or cast-in-situ precast R.C.C lintels are convenient for spans up to 2m.

v) Roofing: A roof is the uppermost part of a building which is supported on structural members and covered with roofing material to give protection to the building against rain, wind, heat, snow, etc.

A roof must be designed and constructed to meet the requirements of different climates and the covering material available. A roof should be durable, strong enough to take the loads coming on it, be well drained and water proof. Roofing are different kinds viz. RCC roof, Steel trusses, patent tiles, Asbestos cement sheet etc.

vi) Weather Proof Course: Weather proof course is also known as weathering course. Weathering course is a layer provided on the top of R.C.C. or Madras terrace roof to protect the roof from the weathering agencies like rain, wind sun and snow. Weathering course prevents entry of rainwater into the roof slab or terrace. It also arrests the penetration of heat into the room below the roof.

Weathering course consists of lime concrete with broken brick aggregate and two courses of flat tiles set in cement mortar 1:3 mixed with crude oil. Lime concrete has a proportion of 1:2.5 (lime: broken brick aggregate). Lime concrete is laid to a thickness of 100 mm and compacted to a thickness of 75 mm. A minimum slope of 1 in 50 is given to the lime concrete layer towards the rainwater drainage pipes. After the concrete is cured, by sprinkling water for six days, two courses of flat tiles or pressed tiles are laid in cement mortar 1:3 with crude oil.

vii) Flooring: The floor consists of the following two components viz base course and floor covering. There are various type of flooring. The selection of flooring can be made considering the following factors:

1. Initial cost	2. Appearance
3. Cleanliness	4. Durability
5. Damp resistance	6. Sound insulation
7. Thermal insulation	8. Smoothness
9. Hardness	10. Comfortability
11. Fire resistance	12. Maintenance

Types of Flooring

a.Concrete flooring This type of flooring is most commonly used in buildings of all types.The concrete flooring consists of a top layer of cement concrete 25 –40mm thick laid on a 100-150 mm base of suitable mix of concrete (either lime or cement concrete, 1:2:4 or 1:3:6).

b. Mosaic flooring: This consists of tiles available in a variety of patterns and colours. This is widely used in theaters, temples, bathrooms and superior type of buildings. A hard concrete base is made and when it is wet a 20-mm layer of cement mortar (1:2) is laid. Upon this bed, small pieces of broken tiles are arranged in definite patterns. After this, ordinary cement or coloured cement is sprinkled at the top and the surface is dried and rubbed with pumice stone to get a polished surface Nowadays, mosaic tiles are laid on hardened concrete and rubbed with pumice stone to get a polished surface.

c. Terrazzo flooring This is a special type of concrete flooring in which marble chips are used as aggregates and this concrete upon polishing with carborundum stone present a smooth surface. Any desired colour can be obtained by using marble chips of different shades and sizes. The aggregate shades are exposed by grinding.

d. Granolithic flooring This flooring is a finishing coat over the concrete surface, which is used to provided a hard surface for the floors. This flooring consists of rich concrete (1:1:2) made with very hard and tough quality coarse aggregate. The thickness of the finish should not be less than 25-35 mm. To improve the wearing qualities, sand should be replaced by fine aggregate of crushed granite. Abrasive grit at 16-22 N/m^2 may be sprinkled to provide a hard surface.

e. Tiled flooring Tiles either of clay or cement concrete are manufactured in different shapes. These tiles are commonly used for high-class hotels, offices, residential building etc.

f. Marble flooring This flooring is commonly used for superior type of floor construction. The construction is exactly the same as that of mosaic flooring except that marble pieces are used instead of mosaic tiles.

g. *Stone flooring* Stone flooring provide a hard, durable and wear-resisting floor surface and hence it can be used for godowns, stores, workshop, etc.

h. Industrial flooring In most of the industries cement concrete flooring is commonly adopted since it is moderately cheap, easy to construct and quite durable The floor consists of the following two components.

a) Base concrete
b) Wearing surface

The two components of the floor can be constructed either monolithically (i.e. laying the wearing surface immediately after the base concrete is laid) or non-monolithically. The method of laying cement concrete flooring on ground floor of an industry can be broadly divided into the following three steps.

i. Preparation of sub-base with watering and consolidation.
ii. Laying of the base concrete of 7.5 to 10 gm thick lean concrete mix 1:3:6 to 1:5:10.
iii. Laying the wearing surface in cement concrete 1:2:4 of 4 cm thick with neat finishing.

i. Granite Flooring Granite flooring is a superior type of flooring commonly used in residential buildings, shopping complex, hospitals, offices, etc. where extra cleanliness is an essential requirement. Granite stone is available in the form of 8 mm and 12mm thick tiles and 20 mm thick slab. Before laying the tiles, neat cement slurry

is spread over the bedding mortar and the tiles are laid flat over it. Then they are pressed gently into the bedding mortar with the help of wooden mallet, till a levelled surface is obtained. Also, a thin paste of cement is applied on the bottom of the tiles before laying. After a day the joints between adjacent tiles are cleaned of loose mortar. etc. to a depth of 5 mm This is done by using wire brush and then joints are grouted with cement slurry of the same shade as that of the tiles. The flooring is then cured for seven days.

j. Damp proofing Damp proofing is the method adopted to prevent the entry of dampness into a building, so as to keep them dry, habitable and safe. The provision of damp roofing courses prevents the entry of moisture from walls, floors and basement of a building.

1. Causes of dampness

There are various causes which are responsible for the entry of dampness in a structure. They are listed below.

(a) Entry of moisture from the ground
(b) Entry of rain water
(c) Exposed tops of walls
(d) Deposition of atmospheric moisture on wall, floors and ceilings
(e) Location of a site that cannot be easily drained.
(f) Orientation of walls - the walls obtaining less sunshine and heavy showers of rain are liable to become damp.

2.Effects of dampness :-

Following are the effects of dampness in a structure.

1. A damp building creates unhealthy conditions for those who occupy it.
2. Corrosion of the metals used in building construction is evident.
3. Formation of unsightly patches on the wall surface and ceilings.
4. Formulation of dry-rot leading to the decay of timber in a damp atmosphere.
5. Deterioration of electrical fittings.
6. Floor covering materials are seriously damaged.
7. Acceleration of the growth of the termites.
8. Softening and crumbling of the plaster.

Materials used for damp - roofing

(a) Hot bitumen with a minimum thickness of 3 mm.
(b) Mastic asphalt
(c) Bituminous felts
(d) Metal sheets of lead, copper and aluminum with protective coating

k. Plastering

Plastering is the process of covering rough wall and uneven surface in the construction of houses and other structures with a plastic called plaster or mortar.

Objectives of plastering

1. To provide an even, smooth, regular, clean and durable finished surface and to improve the appearance.
2. To protect the surface from the effects of atmospheric agencies
3. To conceal the defective workmanship.
4. To cover up to the use of inferior quality and porous material and the joints

formed in masonry work.

5. To provide a satisfactory base for white washing, colour washing painting or distempering.
6. In the case of internal plastering, the object is to protect the surface against dust and vermin nuisance.

Types of plasters

1**. Lime plaster**:

Lime plaster is an intimate mixture of equal proportion of lime and sand, ground in a mortar mill to form a paste of required consistency. Sand to be used in the mortar should not pass through a 100 mesh sieve for more than five per cent or a 50 mesh sieve for more than 20 per cent. Water and sand used should be clean and free from all deleterious materials.

Fat lime or poor lime is used in lime plaster. To improve the strength of lime mortar, small quantity of cement is added. This mortar is mainly used for external work.

2. Cement plaster:

Cement plaster is an intimate mixture of Portland cement and sand with required amount of water to make a plastic mass. The proportion of cement and sand depends upon the nature of work. The ingredients are first mixed in a dry state and water is added to make a paste. This plaster should be used within 30 minutes since cement starts setting after 30 minutes.

3. Mud plaster:

Mud plaster is prepared with equal volumes of clay or brick earth and of chopped straw, hay loose soil or cowdung and hemp. The ingredients are mixed and left for seven days with large quantity of water. Then, it is again mixed before using till it reaches the required consistency. Mud plaster made of sand and clay also be used.

4. Waterproof plaster This plaster consists of one part of cement, two parts of sand and pulverized alum at the rate of 12kg/m^3 of sand. In order to make this plaster waterproof, soap water containing about 75gm soap/ litre of water is added.

Methods of Plastering

Plaster may be applied in one or two or three coats. In the cheapest construction one coat of plaster is used. In ordinary works two coats are adopted and in superior jobs, three coats are applied.

Audit Approaches

1. As per clause 7.10 of IS:1597 Part-I, the work of RR masonry involved joining and pointing. All joints shall be full of mortars and pointing shall be avoided as far as possible. However, separate item of work of pointing allowed to contractors for RR masonry works should be commented pointing out extra cost.

2. Clause 3.3 and Table 1 under section 4 of NBC and IS:2250 of 1981 prescribe the mortar mix required for building work. Buildings constructed are also classified as A,B,C,D and E category with reference to importance of buildings and seismic zone. The cement mortar mix required for category of construction A,B and C is 1:6 whereas for the category of construction of D and E is 1:4. In Tamilnadu all the areas come under seismic ZoneII and III and all the buildings constructed in these zones come under category of construction A,B and C. Hence all construction activities either with RR or brick work cement mortar mix of 1:6 is to be adopted. The use of richer mix (1:5, 1:4 etc.,) for the building works may be identified and extra cost involved thereon has to be commented.

3. As per IS 1077:1976, the class of bricks is classified based on compressive strength which varies from 3.5 MPa to 12 MPa. The schedule of rates prescribes rates for Class II bricks and class III bricks and the kiln burnt brick of size 8 ¾ " x 4 ¼ "x 2", 8 ¾ " x 4 ¼ "x 2 ¾ " etc. come under class III. The compressive strength of class III brick ranges from 3.5 MPa to 5 MPa. IS 1077:1976 also stipulates that brick for Masonry work should have compressive strength not less than 3.5 MPa. IS 2250 : 1981 and clause 3.3 and table 1 under clause 3.3/Part VI/ Sec 4 of National Building code, 2005 prescribe the grade of Mortar with the respective compressive strength required for masonry work. According to which and also with reference to IS 1905 : 1987 cement mortar (cm) mix of 1:6 has to be used for masonry work with brick in Tamilnadu on the basis of seismic zones classification. However audit scrutiny disclosed that the division had adopted smaller size bricks though higher size of bricks are available with richer cement mortar mix. The various size of brick available in Tamilnadu with reference to Schedule of Rates and the number of bricks, quantity of cement mortar required for 10m^3 of brick work prescribed in the data approved by CE (Buildings) are given below:

Brick Size	*Number of bricks*	*Quantity of cement mortar*
8 ¾ " x 4 ¼ "x 2"	*6750*	*2.8*
8 ¾ " x 4 ¼ "x 2 ¼ "	*6010*	*2.8*
8 ¾ " x 4 ¼ "x 2"	*6570*	*3.0*
8 ¾ " x 4 3/8 "x 2 ¾ "	*4590*	*2.5*
9 x 4 3/8 "x 2 ¾ "	*4600*	*2.5*
9 x 4 ½" x 3"	*4100*	*2.2*

The cases of adoption of smaller size of bricks though higher size of bricks are available in particular divisions may be examined with reference to data in the technically sanctioned estimate and schedule of rates. The adoption of smaller size of bricks involved extra cost on increase in quantity of cement mortar and number of bricks. The extra cost involved may be worked out and comment drawn.

7. PLAIN AND REINFORCED CONCRETE
(Key IS 456 – 2000)

IS 456-1978 Code of Practice for Plain and Reinforced Concrete was adopted by BIS on 03.10.1978. The experience in the past decade and increasing numbers of failure in recent past emphasize the need for more stringent durability provisions. Hither to, in the code the attention was focused on achieving the required strength of concrete at site. The focus has now been shifted to durability. Hence the entire code has now been revised as IS : 456 – 2000 with durability as the main objective.

The present revision has the following aspects covered in greater detail

(i) Durability aspect
(ii) New materials
(iii) Enhanced quality
(iv) Design concept
(v) Additional elements.

Durability Aspect *(Clause 8):*

The factors influencing durability include:
i. the environment;
ii. the cover to embedded steel;
iii. the type and quality of constituent materials;
iv. the cement content and water/cement ratio of the concrete;
v. workmanship, to obtain full compaction and efficient curing; and
vi. the shape and size of the member.

The degree of exposure anticipated for the concrete during its service life together with other relevant factors relating to mix composition, workmanship, design and detailing should be considered. The concrete mix should be chosen to provide adequate durability under these conditions.

New Materials *(Clause 5):*

Use of new materials like Fly ash, Silica fume, Rice husk ash, Metakaoline, Blast furnace slag, Super plasticisers etc, in concrete is encouraged and the need for increased durability demanded modifications in the materials clause of the code.

The materials required for cement concrete shall be cement, aggregates water and reinforcement.

Aggregates:

Aggregates shall comply with the requirements of IS:383-1970 . As far as possible preference shall be given to natural aggregates. The nominal maximum size of coarse aggregate should be as large as possible within the limits specified but in no case greater than one-fourth of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For most work, 20mm aggregate is suitable for RCC works.

Plums above 160 mm and up to any reasonable size may be used in plain concrete work up to a maximum limit of 20 percent by volume of concrete when specifically permitted by the Engineer-incharge. The plums shall be distributed evenly and shall not be closer than 150 mm from the surface.

For heavily reinforced concrete members as in the case of ribs of main beams, the nominal maximum size of the aggregate should usually be restricted to 5 mm less than the minimum clear distance between the main bars or 5 mm less than the minimum cover to the reinforcement whichever is smaller.

Coarse and fine aggregate shall be batched separately. All-in aggregate may be used only where specifically permitted by the engineer – in charge.

Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete.

Properties of Concrete *(Clause 6.2)*

The design of concrete mix is normally based on 28 days characteristic strength of concrete. The characteristic strength of different grade of cement concrete mix is given below.

(Key clauses 6.1, 9.2.2 , 15.1.1, 36.1 and Table 2)

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm cube at 28 Days in N/mm^2
(1)	(2)	(3)
Ordinary Concrete	M 10	10
	M 15	15
	M 20	20
Standard Concrete	M 25	25
	M 30	30
	M 35	35
	M 40	40
	M 45	45
	M 50	50
	M 55	55
High Strength Concrete	M 60	60
	M 65	65
	M 70	70
	M 75	75
	M 80	80

Notes:

i. In the designation of concrete mix M refers to the mix and the number to the specified compressive strength of 150mm size cube at 28 day, expressed in N/mm^2.

ii. For concrete of compressive strength greater than M 55, design parameters given in the standard may not be applicable and the values may be obtained from specialized literatures and experimental results.

1mpa = Newton / mm x 10.2 = kg kg/m^2

For concrete of grade M 30 and above, the rate of increase of compressive strength with age shall be based on actual investigations.

Environment (Exposure condition) – *(Clause 8.2.2) :*

General environment to which the concrete will be exposed during its working life is classified into five levels of severity (i.e.) 1. Mild 2. Moderate 3. Severe 4. Very severe 5. Extreme

i) Mild

Protected against weather / Aggressive conditions, not situated in coastal areas.

ii) Moderate

Sheltered from severe rain, exposed to condensation and rain, continuously under water, in contact or buried under non-aggressive soil ground waste, sheltered from salt air coastal area.

iii) Severe

Exposed to severe rain, alternate wetting and drying, completely immersed in seawater exposed to coastal, environment.

iv) Very severe

Exposed to seawater spray, corrosive fumes, in contact with aggressive subsoil/ground water.

v) Extreme

Surface members in tidal zone, members in direct contact with liquid/solid aggressive chemicals.

Cover *(Clause 26.4 & 8.2.3):*

The protection of the steel in concrete against corrosion depends upon adequate thickness of good quality concrete. The nominal cover to the reinforcement shall be provided as per clause 26.4.

Nominal cover to be provided to all the reinforcement to meet durability requirement (Key Table 16 of IS: 456 - 2000)

Mild	20 mm
Moderate	30 mm
Severe	45 mm
Very severe	50 mm
Extreme	75 mm

Note :

i). For main reinforcement upto 12mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
ii). For exposure condition such as severe very severe & extreme, reduction of 5 mm may be made where concrete grade is M 35 and above.
iii). The tolerance for nominal cover shall be 0 to +10 mm (Clause 12.3.2).
iv). The minimum cover for column shall be 40mm. In case of columns of minimum diameter of 200mm or less, where reinforcing bars do not exceed 9 mm, a nominal cover of 25mm may be used.

v) For footing: Minimum cover shall be 50 mm (Clause 26.4.2.2):

Nominal cover to meet specified period of Fire Resistance *(Clause 26.4.3)*

General requirements of fire protection are given in IS 1642. The nominal cover to meet specified period of fire Resistance is given in the table.

Fire resistance	Nominal Cover						
	Beams		Slabs		Ribs		Columns
	Simply Supported	Continuous	Simply supported	Continuous	Simply supported	Continuous	
H (hours)	mm	mm	mm	mm	mm	mm	mm
0.5	20	20	20	20	20	20	40
1	20	20	20	20	20	20	40
1.5	20	20	25	20	35	20	40
2	40	30	35	25	45	35	40
3	60	40	45	35	55	45	40
4	70	50	55	45	65	55	40

(Key Table 16 A of IS: 456 – 2000)

Concrete Mix Proportion (8.2.4):

Grades of Concrete :

(a) Minimum Grade of Concrete

In the developed world, even for ordinary structures the minimum grade of concrete is the equivalent of M25 or M 30. It is now realized that these grades are easily realized in the field by proper mix design, particularly with the availability of 43 and 53 grade of cement in the country. Further, in case of nominal mix, the same proportion (1:2:4) used for M 15 grade now give M 20 grade without any problem. In the revision of the code, the minimum grade of concrete has been related to exposure conditions.

For mild exposure condition, i.e. for concrete surfaces protected against weather or aggressive conditions except those situated in coastal areas, the minimum, grade shall be M 20 for RCC structures.

Although minimum grade of concrete has been kept as M20, provision have been given for use of concrete of lesser strength for plain concrete construction, lean concrete, simple foundation for masonry walls or other simple walls or other simple or temporary construction.

(b) Maximum grade of Concrete:

For concrete of comprehensive strength greater than M 55 design parameters given in the Code may not be applicable and the values may be obtained from specialist literatures and experimental results.

Maximum cement content *(Clause 8.2.4.2)*

Cement content not including fly ash and ground granulated blast furnace slag in excess of 450 Kg/m^3 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.

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)

Sl. No	Exposure	Plain concrete			Reinforced Concrete		
		Minimum Cement Content kg/m3	Maximum Free Water – Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m3	Maximum Free Water – Cement Ratio	Minimum Grade of Concrete
1	2	3	4	5	6	7	8
I	Mild	220	0.60	-	300	0.55	M 20
II	Moderate	240	0.60	M 15	300	0.50	M 25
III	Severe	250	0.50	M 20	320	0.45	M 30
IV	Very severe	260	0.45	M 20	340	0.45	M 35
V	Extreme	280	0.40	M 25	360	0.40	M 40

Note:

1. Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of 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 pozzolona and slag specified in IS 1489 (Part I) and IS 455 respectively.
2. Minimum grade for plain concrete under mild exposure condition is not specified.

Table 6 under clause 8.2.4.1 of IS 456:2000 prescribes adjustments to Minimum Cement Contents for aggregates other than 20 mm nominal Maximum Size

Sl.No.	Nominal Maximum Aggregate Size mm	Adjustments to Minimum Cement Contents
1	2	3
i	10	+40
ii	20	0
iii	40	-30

Concrete Mix Proportioning

Mix Proportion (*Clause 9.1):*

The determination of the proportions of cement, aggregates and water to attain the required strengths shall be made by designing the concrete mix and by adopting nominal concrete mix.

Design mix concrete is preferred to nominal mix. If design mix concrete cannot be used for any reason on the work for grades of M 20 or lower, nominal mixes may be used with the permission of engineer-incharge, which, however, is likely to involve a higher cement content.

Design Mix Concrete *(Clause 9.2):*

The mix shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than appropriate values given in table. The target mean strength of concrete mix should be equal to the characteristic strength plus 1.65 times the standard deviation. Mix design done earlier not prior to one year may be considered adequate for later work provided there is no change in source and the quality of the materials.

Target mean strength for different Design mix		
Grade of Design mix	Compressive Strength N/mm^2	Target mean Strength N/mm^2
M 15	15	25
M 20	20	30
M 25	25	36
M 30	30	42
M 35	35	47
M 40	40	52
M 45	45	58
M 50	50	63

Standard deviation based on test strength of sample *(Clause 9.2.4.2)*

The calculation of the standard deviation shall be brought up to date after every change of mix design. Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in Table 8 may be assumed for design of mix in the first instance. As soon as the results of samples are available, actual calculated standard deviation shall be used and the mix designed properly.

Table 8 Assumed Standard Deviation
(Clause 9.2.4.2 and table 11)

Grade of Concrete	Assumed Standard Deviation N/mm2
M 10 M 15	3.5
M 20 M 25	4.0
M 30 M 35 M 40 M 45 M 50	5.0

Note:

The above values correspond to the control having proper storage of cement; weigh batching of all materials; controlled addition of water; regular checking of all materials, aggregate gradings and moisture content; and periodical checking of workability and strength. Where there is deviation in the values given in the above table it shall be increased by 1 N/mm^2

Concrete in Aggressive Soils and Water (*Clause 8.2.6):*

The destructive action of aggressive waters on concrete is progressive. The rate of deterioration decreases, as the concrete is made stronger and more impermeable, and increases as the content of the water increases. Where structures are only partially immersed or are in contact with aggressive soils or waters on one side only, evaporation may cause serious concentrations of salts with subsequent deterioration, even where the original salt content of the soil or water is not high.

Note:

Guidance regarding requirements for concrete exposed to sulphate attack is given is 8.2.2.4.

At sites where alkali concentrations are high or may become very high, the ground water should be lowered by drainage so that it will not come into direct contact with concrete.

Additional protection may be obtained by the use of chemically resistant stone facing or a layer of plaster of Paris covered with suitable fabric, such as jute thoroughly impregnate with bituminous material.

Concrete in Sea-water *(Clause 8.2.8):*

Concrete in sea-water or exposed directly along the sea-coast shall be at least M 20 Grade in the case of plain concrete and M 30 in case of reinforced concrete. The use of slag or pozzolana cement is advantageous under such conditions.

Nominal Mix Concrete *(Clause 9.3):*

Nominal mix concrete may be used for concrete of M 20 or lower. The proportions of materials for nominal mix concrete shall be in accordance with Table 9.

The cement content of the mix specified in Table 9 for any nominal mix shall be proportionately increased if the quantity of water in a mix has to be increased to overcome the difficulties of placement and compaction, so that the water-cement ratio as specified is not exceeded.

Table 9 Proportions for Nominal Mix Concrete
(Clauses 9.3 and 9.3.1)

Grade of Concrete	Total Quantity of Dry Aggregates by Mass per 50 kg of Cement, to be Taken as the Sum of the Individual Masses of Fine and Coarse Aggregates, kg.	Proportion of Fine Aggregate to Coarse Aggregate (by Mass)	Quantity of Water per 50 kg of Cement, Max
(1)	(2)	(3)	(4)
M5	800	Generally 1:2 but subject to an upper limit of 1:1 ½ and a lower limit of 1:2 ½	60
M 7.5	625		45
M 10	480		34
M 15	330		32
M 20	250		30

Note :-

The proportion of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of fine aggregates becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used.

Example

For an average grading of fine aggregate (that is, Zone II of Table 4 of IS 383), the proportions shall be 1:1 ½, 1:2 and 1:2 ½ for maximum size of aggregates 10mm, 20mm and 40 mm respectively.

Batching (Ready mix) *(Clause 10.2)*

Ready-mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and medium project sites, the concrete shall be sourced from ready-mixed concrete Plants or from onsite or offsite batching and mixing plant (see IS: 4926)

It is important to maintain the water – cement ratio constant at its correct value and the grading I Course and fine aggregate should be checked frequently.

Mixing *(Clause 10.3)*

Concrete shall be mixed in a mechanical mixer. The mixer should comply with IS:1791and IS:12119. The mixers shall be fitted with water measuring (metering) devices.

Formwork *(Clause 11)*

The formwork shall be designed and constructed so as to remain sufficiently rigid during placing and compaction of concrete, and shall be such as to prevent loss of slurry from the concrete. For all concrete construction some sort of temporary staging, either of timber or steel, is required so as to form mould of forms to hold the concrete till it sets. Such a temporary staging is called centering, form work, shuttering or false work. Approximately the cost of the formwork is 15 percent of the total cost of structure. Hence great care should be taken to effect economy in the design of formwork. Good formwork should satisfy the following requirements:

i) The form work should have sufficient strength to carry the dead weight of the concrete and the live loads which are likely to be present during the construction stage.
ii) All joints in formwork should be stiff so that the deformations caused by the dead and live loads shall be minimum. All joints shall be watertight.
iii) Surfaces of the formwork shall be plane or exactly following the requirements so that after removal of form work, it should not be a costly item to finish the surface of concrete
iv) The form work shall be as light as possible.

It is necessary to see that the concrete poured into the formwork will not stick to it. Otherwise, it may become difficult to remove the shuttering and during this process some amount of surface concrete may be liable to be damaged. To remedy this, it is usual that the interior faces of formwork should be given a coating of a thin layer of oil. Sometimes these faces are given a coating of soft soap or they are whitewashed. Canvas or oilpaper may also be used for this purpose.

Assembly of Reinforcement *(Clause 12)*

Reinforcement shall be bent and fixed in accordance with procedure specified in IS: 2502. The high strength deformed steel bar should not be re-bent or straightened without the approval of Engineer-in-Charge. Unless otherwise specified by Engineer-in-Charge, the reinforcement shall be placed within the following tolerances:

a. for effective depth 200 mm or less	+ 10 mm
b. for effective depth more than 200mm	+ 15 mm

Welded Joints or Mechanical Connections of reinforcement may be preferred over tieing the reinforcement *(Clause 12.4 to 12.6)*

Compaction *(Clause 13.3)*

Concrete should be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into corners of the formwork.

Whenever vibration has to be applied externally, the design of formwork and the disposition of vibrators should receive special consideration to ensure efficient compaction and to avoid surface blemishes.

Concreting under Special Conditions *(Clause 14)*

Under – Water Concreting *(Clause 14.2)*

When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of the mix to be used shall be submitted to and approved by the engineer-in-charge before the work is started.

The water-cement ratio shall not exceed 0.6 and may need to be smaller, depending on the grade of concrete or the type of chemical attack. For aggregates of 40 mm maximum particle size, the cement content shall be at least 350 kg/m^3 of concrete.

Coffer-dams or forms in still water shall be sufficiently tight to prevent loss of mortar through the walls. De-watering by pumping shall not be done while concrete is being placed or until 24 hours thereafter.

Concrete cast under water should not fall freely through the water. Concrete shall be deposited, continuously until it is brought to the required height.

Reinforced Concrete

Reinforced concrete is a composite material consisting of cement concrete and steel reinforcement. The combination of the two materials makes reinforced concrete as an extensively used composite material in the construction of almost all types of structures.

Plain concrete is a material strong in compression but very weak in tension. The tensile strength of concrete is less than one-tenth of its strength in compression. Hence plain concrete members have limited application. Concrete strengthened by steel reinforcement is called Reinforced cement concrete. Long steel reinforcements are embedded in concrete while casting the same to make columns, beams, slabs etc.

Beams subjected to transverse loads and moments bend. As a beam bends there will exit compression and tension zones in the body of the beam. While the compression in the compression zone is resisted by concrete, the tension in the tension zone will be resisted by steel reinforcements.

The reinforcement used shall conform to the requirements of IS: 432-specification for mild steel and high tensile steel bars and hard drawn wires for concrete reinforcement (Revised). High strength deformed steel bars and the reinforcement shall be free from loose mill scale, loose rust, oil and grease or any such harmful matter immediately before placing the concrete.

Prestressed Concrete:

A prestressed concrete member is a member of concrete in which internal stresses are introduced in a planned manner, so that the stresses resulting from the superimposed loads are counteracted to a desired degree. In order to get the maximum advantage of a prestressed concrete member, it is necessary to use not only high strength concrete but also high tensile steel wires. Concrete used for prestressed work should have a cube strength of 35 N/mm^2 for post-tensioned system and 45 N / mm^2 for pretensioned system. High tensile steel wires used in prestressed concrete work are called tensions. High tensile steel should be used for the following reasons:

Post – tensioning system:

The basic principle in all post-tensioning systems is to introduce prestress in the concrete member cast previously by tightening the tendons accommodated in the ducts which are formed while casting the end of the concrete member, the desired prestressing force is obtained. After the wires are pulled, they are anchored in their stretched position against the end of the concrete member by a suitable wedging device. The various systems followed differ in the arrangement of wires, in the process of jacking and in the anchorage devices.

Stability of the structure *(Clause 20):*

The stability of a structure as a whole against overturning shall be ensured so that the restoring moment shall be not less than the sum of 1.2 times the maximum overturning moment due to the characteristic dead load and 1.4 times the maximum overturning moment due to the characteristic imposed loads. In case where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Restoring moment due to imposed loads shall be ignored.

The anchorages or counterweights provided for overhanging members (during constructions and service) should be such that static equilibrium should remain, even when overturning moment is double.

The structure shall have a factor against sliding of not less than 1.4 under the most adverse combination of the applied characteristic forces. In this case only 0.9 times the characteristic dead load shall be taken into account.

To ensure stability at all times, account shall be taken of probable variations in dead load during construction, repair or other temporary measures. Wind and seismic loading shall be treated as imposed loading.

In designing the framework of a building provision shall be made by adequate moment connections or by a system of bracings to effectively transmit all the horizontal forces to the foundations.

Under transient wind load the lateral sway at the top should not exceed H/500, where H is the total height of the building. For seismic loading, reference should be made to IS 1893.

Effective Span *(Clause 22.2):*

The effective span of a member shall be as follows:

(a) Simply Supported Beam or Slab:

The effective span of a member that is not built integrally with its supports shall be taken as clear span plus the effective depth of slab or beam or centre to centre of supports, whichever is less.

(b) Continuous Beam or Slab:

In the case of continuous beam or slab, if the width of the support is less than 1/12 of the clear span, the effective span shall be as in 22.2 (a) above. If the supports are wider than 1/12 of the clear span or 600 mm whichever is less, the effective span shall be taken as under.

(i). For end span with one end fixed and the other continuous or for intermediate spans, the effective span shall be the clear span between supports;

(ii). For end span with one end free and the other continuous, the effective span shall be equal to the clear span plus half the effective depth of the beam or slab or the clear span plus half the width of the discontinuous support, whichever is less;

(iii). In the case of spans with roller or rocket bearings, the effective span shall always be the distance between the centres of bearings.

(c) Cantilever:

The effective length of a cantilever shall be taken as its length to the face of the support plus half the effective depth except where it forms the end of a continuous beam where the length to the centre of support shall be taken.

(d) Frames:

In the analysis of a continuous frame, centre to centre distance shall be used.

Spacing of Reinforcement *(Clause 26.3):*

The diameter of a round bar shall be its nominal diameter and in case of deformed bars or crimped bars, the diameter shall be taken as the diameter of a Circle giving on equivalent effective area. The maximum distance between different structures is given below.

a) Slab *(Clause 26.3.3.b)*

Horizontal distance between parallel main reinforcement bars shall not be more than

3 times the effective depth of the slab (or)

300mm whichever is smaller.

b) Beam (Clause 26.5.1.6):

Maximum spacing of shear reinforcement in no case shall exceed 300mm.

c) Column ***(Clause 26.5.3.1 & 26.5.3.2):***

(i) Columns are provided with longitudinal reinforcement and transverse reinforcement.
(ii) The minimum number of longitudinal bars provided in a column shall be four in rectangular columns and six in circular columns.
(iii) The bars shall not be less than 12mm in diameter.
(iv) The diameter of transverse reinforcement need not exceed 20mm.
(v). Pitch of transverse reinforcement shall be not more than least of the following distance.
a) The least lateral dimension of compression member.
b) 6 times the smallest diameter of longitudinal reinforcement bar to be tied.
c) 300mm.

Audit Approaches:

1. The third revision of the IS:456 was published in the year 1978. At that time 33 grade cement was predominantly available in market. Now higher grade of cement viz 43 grade and 53 grade having higher compressive strength is available in the market. In case of nominal mix, the same proportion (1:2:4) used for M15 grade concrete involving 324 kg cement for 1 cum of concrete now give M20 grade. IS: 456-2000 prescribes minimum cement content of 250kg. for plain cement concrete and 300 kgs for reinforced cement concrete. The test result of cement concrete carried out by Anna University and Highway Research Station, Chennai also disclosed that 320 kg. cement was required for the design mix of M 20 grade and that proportion had achieved target mean compressive strength of 34.38 N/mm^2 at 28 days against the prescribed compressive strength of 20 N/mm^2 for M 20 grade concrete. But the Public works Department and Highways Department had not revised the data and continued to adopt 432 kgs. cement for M 20 grade with nominal mix of 1:1 ½:3, though 320 kgs. Cement was actually required for M 20 grade concrete as per test result. A comparative analysis of existing practice for adoption of data for cement concrete mix of various nominal mix corresponding to the design mix, minimum cement content prescribed in IS 456-2000 for different design mix and actual quantity of cement required for achieving the design mix on the basis of test conducted by Anna University and Highways Research Station, Chennai are given in the enclosed statement. The compressive strength of different grade of design mix and the target mean strength for different design mix prescribed in IS 456-2000 and Ministry of Roads Transport and Highways are also given in the statement.

The use of higher grade of cement would result in saving in cement content as the compressive strength of higher-grade cement was much higher than the lower grade cement. The design mix prescribed in IS: 456-2000 for different grade involved saving in cement content compared to the existing data for cement concrete adopted by the department for the past three decades. But the data for cement concrete and reinforced cement concrete of different grade of design mix corresponding to the nominal mix (in volumes basis) has not been revised so far. As a result the estimate cost had automatically been boosted abnormally involving extra expenditure to the Government / over payment to the contractor as the design mix involves less consumption of cement than that specified in the tender documents.

Comparative analysis of cement requirements

As per the existing practice and standard data with reference to IS 456:1978			Minimum cement content required for cum using 20 mm size aggregate concretes as per IS 456:2000				Cement requirement for 1 cum of Cement Concrete as per test results					
Nominal Mix	Corresponding Mix	Quantum of cement content for 1 cum of concrete using 20 mm size aggregate	Plain Concrete		Reinforced Cement Concrete		Anna University			Highway research station		
			Grade of concrete mix	Minimum Cement Content kg /cum	Grade of Concrete	Minimum cement Content kg / cum	Grade	Cement Content kg/cum	Com-pressive strength achieved	Grade	Cement content kg/cum	Compressive strength achieved
1:1:2	M.25	648 Kg	M.25	280	M.40	360	M.30	400	43.73	M.30	400	42
1:1.5:3	M.20	432 Kg	M.20	260	M.35	340	M.25	360	34.76	M.25	380	36
1:2:4	M.15	324 Kg	M.20	250	M.30	320	M.20	320	34.38	M.25	380	36
1:3:6	M.10	216 kg	M.15	240	M.25	300						
					M.20	300						

Comparative analysis of Strength of different grade of Cement

Sl.No.	Grade of Cements	IS Specification	Compressive Strength of Concrete	Fine ness	Setting time	
1	33 grade	IS 269:1989	33mpa	Not less than 225 m2 / kg	Initial setting time not less than 30 minutes	Final setting time not more than 600 minutes
2	43 grade	IS 8112 : 1989	43 mpa			
3	53 grade	IS 12269:1987	53 mpa			

2) Clause 6.1.2, 8.2.4.1 and 9.1.2 prescribed different grade of cement for various environment exposure condition. Appropriate grade of concrete mix is to be adopted on the basis of exposure condition. Cases of using higher grade of mix on mild and moderate exposure environment may be identified and comments made on excess use of cement

3) Table 16 of IS: 456:2000 stipulates nominal cover to be provided to all the reinforcement to meet the durability requirement on the basis of environment exposure condition. Cases of non-compliance and excess cost may be commented.

4) As per Table 6 of IS 456:2000, when aggregates of 40mm size are used for cement concrete, 30% of the cement content could be reduced. Cases of non-reduction of cement contest may be identified and commented.

5) As per clause 8.2 4.2 of IS 456:2000 the maximum cement content for any work should not exceed 450Kg/M^3. Cases of excess use of cement than that prescribed quantum may be identified and commented.

6) As per circular No.41 of 1989 (No.AEE / TW / B / 153720 / 88-41 / dt: 16.5.1987 of Chief Engineer (Buildings) all RCC works within a distance a 24Km, as the crow flies from the sea should be provided with 1:1.5:3 mix and other areas be provided with 1:2:4. As per IS 456:2000, the coastal area lies in severe exposure environment condition and design mix of M30 with minimum cement content of 320Kg has to be adopted. Non-adoption of design mix and excess cost involved on excess use of cement may be analysed and commented.

8. ELECTRICAL AND ALLIED INSTALLATION

(Key part 8- section 2 of NBC 2005 and General Specification for Electrical works by CPWD)

1. PLANNING:

Planning of Electrical Installation *(Clause 4.1):*

The design and planning of an electrical installation involve consideration of all prevailing conditions and is usually guided by the requirement of the consumer. A competent Electrical Engineer should take the responsibility of detailed designing and planning to meet the requirement of various functional needs, efficiency, economy, energy conservation, aesthetics, appropriate technology, safety and avoidance of possible fire hazards. Some of the guiding factors are:

a) the type of supply, occupancy, envisaged load and the earthing arrangement available.
b) the atmospheric condition, such as cooling air temperature, moisture or such other conditions which are likely to affect the installation adversely.
c) the possible presence of inflammable or explosive dust, vapour or gas.
d) the degree of electrical and mechanical protection necessary.
e) the importance of continuity of service including the possible need for standby supply.
f) the probability of need for modification or future extension.
g) the probable operation and maintenance cost taking into account the electricity supply tariffs available.
h) the relative cost of various alternative methods.
i) the need for radio and telecommunication interference suppression;
j) case of maintenance.
k) safety aspects.
l) energy conservation; and.
m) the importance of proper discrimination between protective devices for continuity of supply and limited isolation of only the affected portion.

Co-ordination *(Clause 4.1.3):*

Proper co-ordination and collaboration between the architect, civil engineer and the electrical and mechanical engineer shall be effected from the planning stage of the installation. The provisions that will be needed for the accommodation of substation, transformer, switch rooms, service cable ducts, rising mains and distribution cables, sub-distribution boards, openings and chases in floors and walls for all required electrical installations, etc, shall be specified in advance.

Before starting wiring and installation of fittings and accessories, information should be exchanged between the owner of the building/architect/electrical contractor and the local supply authority in respect of tariffs applicable, types of apparatus that may be connected under each tariff, requirement of space for installing meters, switches, etc, and for total load requirements of lights, fans and power.

While planning an installation, consideration should be taken of the anticipated increase in the use of electricity for lighting, general-purpose socket outlet, kitchen heating, etc. It is essential that adequate provision should be made for all the services which may be required immediately and during the intended useful life of the building, for the householder may otherwise be tempted to carry out extension of the installation himself or to rely upon use of multiplug adopters and long flexible cords, both of which are not recommended.

Provision for future growth of load (Clause 2.3.5 of General Specification for Electrical works CPWD):

The useful life of the building may be more than 50 year. Experience indicates 5 to 10% growth of Electricity load every year. Therefore building should have adequate space provision for augmentation of electrical supply and associated distribution network.

Space for Electrical Services (Clause 2.3.6 of General Specification for Electrical works CPWD):

The building has to provide space for various electrical equipments and service. These include electrical substation to house High Tension switchgear, Metering, transformers, LT panel, generating sets, essential LT Panel, voltage correction devices, UPS, Battery Room, Electrical switch rooms, vertical shafts for power, communication, fire alarm, UPS cabling, wet riser, associated doors, cutouts in floors/slabs, cables routes/trenches/ducts, cable entry pipes, etc. space for distribution board etc. All such provisions are essential to provide an efficient, safe and aesthetic electrical system for the building.

Location and requirement of substation *(Clause 4.2):*

Electrical substation may be required for following reasons:

a. When Electric load is in excess of permitted Low Tension supply limit of 'Electrical Supply Authority', which necessitates setting up of substation.

b. When it is desired to have a substation for technical reasons.

The ideal location for an Electric substation for a building or group of building would be at the load centre and shall be located on the ground floor in a separate building with easy access and shall be above the highest flood level of the locality. In case the substation has to be located within the main building itself for unavoidable reasons, then it should be located on ground floor with easy access from outside. Also suitable mechanical ventilation and fire detection/ protection system to be provided to conform to B.I.S requirements and requirements of local fire authority. Only dry type transformers and switchgear to be provided, unless they are installed in a separate service building separated from the main building. Emergency power supply equipment (such as generating sets) shall not be allowed to be installed above ground floor or below first basement level of building. Facility for connection from substation to adjoining building to feed emergency load shall be permitted.

Location of switch room *(Clause 4.3):*

Where it is not necessary to provide a substation, a switch room shall be provided. This shall be preferably near the entrance of the building on the ground floor. This switch room shall receive LT supply and distribute the power supply.

System of Supply *(Clause 5.1):*

All electrical equipments, accessories shall be suitable for voltage and frequency of supply. Use of low voltage, medium voltage or high voltage system or combination there of is a matter of expert calculation, judgment, comparative studies, prevailing tariff, for ensuring better quality of equipment, better safety etc. Use of high voltage supply entails provision of suitable transformer substation, Incase of connected load of 100 KVA and above the relative advantage of high voltage three-phase supply should be considered. Which demands additional cost and space. However, such additional cost may be justified for following reasons:

a. Advantage in tariff
b. More effective earth fault protection.
c. Elimination of interference with supplies to other consumers permitting use of large size motors etc.,
d. Better control of voltage.

Stand-by System (Clause 2.3.10 of General Specification for Electrical works CPWD):

Whenever reliable power supply is intended, it is essential to plan for stand by system like: -

(i) Incoming supply from two sources.
(ii) Minimum 2 No Transformers, so that in case of failure of one transformer, there is a standby.

Planning for peak-Non peak loads in office buildings (Clause 2.3.11 of General Specification for Electrical works CPWD):

In a typical office building, peak loads is between 10AM to 5 PM. Holidays and after office hours demand is hardly 5% of peak load. Hence for such period a smaller capacity transformer may be planned to reduce energy losses on account of 'Core Loss' of transformer.

Quality of Electric Supply (Clause 2.4 of General Specification for Electrical works CPWD):

The parameters which decide the quality of Electric supply are:-

a. Voltage
b. Frequency.
c. Absence of harmful harmonies.
d. Protection against Surge/Lightning.

Modern buildings use large number of electromechanical, electronic devices, which require quality electric supply for their proper operation and protection. Hence, based on specific needs, suitable additional equipments like voltage correctors, filters, surge protectors, UPS etc. may be provided as an integral part of the electric power system.

Stand by Generator Set (Clause 2.5. of General Specification for Electrical works (PWD):

In the event of main power failure, it is necessary to provide standby generating sets to meet the requirement of essential power supply, so that the normal working of offices and other institution, which provide service to the public /users, don't suffer. The essential power loads are as below:-

Residential:

Water supply pump sets, Lifts, Fire protection / Fire fighting system, Street lighting essential community needs.

Non-residential:

Water supply pump sets, Lifts, Fire protection / Fire fighting system Lights and fans, Exit lights, Staircase lights etc, other requirements like critical air-conditioning, essential power out lets etc., Therefore, it is necessary to provide for essential power supply system consisting of

i)Standby DG sets.
ii)Essential LT power panels.
iii)Essential rising mains
iv)Main boards, DB's, essential wiring etc.

Power factor management (Clause 2.6 of General Specification for Electrical works CPWD):

Conditions of supply of electricity boards or licenses stipulate the lower- limit of power factor which is generally 0.85.,

(i) Low power factor results in high current resulting in higher voltage drop and system losses. In order to have control over these parameters, power factor of 0.85 to 0.95 is to be maintained by the power consumers. Heavy penalty is imposed in case of low power factor.

Percentage reduction of load current and transformer loss due to power factor improvement is given in table below:

Initial power Factor	Power factor improvement	% Reduction in load current	% reduction in transformer losses
0.7	0.9	23.7	40
0.7	1.0	30.0	51
0.8	0.9	10.0	21
0.8	1.0	20.0	36
0.9	1.0	10.0	19

ii) Effect of leading power factor:

Leading power factor causes higher voltage; resulting in:

a) Increase in hysterics and eddy current losses.
b) Transformer may operate in saturated BH curve, resulting in generation of harmonies, which may lead to heating, and failure of capacitor.

iii) Automatic power factor correction capacitor (APRC) Bank:

Properly designed APRC panel shall be provided to maintain power factor automatically at desired level.

Uninterrupted power supply (UPS) *(Clause 10.4):*

To meet the requirement of no break power supply for requirement like computer/communication/security needs etc. it may be necessary to provide for centralized/de-centralized UPS system

Allied Services (Clause 2.8 of General Specification for Electrical works (PWD):

The modern building, besides electric wiring, has to provide for following services:-

- Telephone wiring.
- Communication cabling.
- Computer cabling, networking, dedicated earthling.
- Audiovisual system
- Security system
- Sound re-enforcement
- Stage lighting
- External lighting
- Architectural in-built lighting.
- Solar Energy system.
- Photo voltaic power system
- Other specific lighting services etc.
- Building management system.
- It is for the electrical planning engineer to coordinate provision of these services in consultation with the user, Architect, structural engineer and specialized agencies.
- Also it is necessary to provide for space/shafts/routes and in-built provisions for all these services.

Lux level (Clause 2.9 of General Specification for Electrical works (PWD):

Proper lighting level is to be maintained and BIS specifies lux levels required for various applications. Lower lux level reduces efficiency of working. Aged person requires higher lux level. For normal office working a middle-aged man requires 350 lux. A person of 55 to 60 years age may require 500 lux. Proper designing is required for achieving satisfactory lux levels in conformity with BIS.

False ceiling coordination: (Clause 2.10 of General Specification for Electrical works CPWD):

False ceiling electrical layout will be coordinated with Architect and the Civil Engineer so that the drawing provides for symmetrical and aesthetic layout of Fans, Light fittings, A/C Diffuses, Fire detectors, Sprinklers, Speakers etc.,

Functional areas like Auditorium, Conference hall, Computer rooms, and library (Clause 2.11 of General Specification to Electrical Works of CPWD)

Special attention is to be paid for functional areas to meet the client's requirements, and functional requirements in coordination with the architect and to provide for specialized services like audiovisual system, public address system, sound reinforcement, stage lighting, conference system, security needs etc. It may be noted that provision of such services at a latter stage will not only mar the aesthetics of the building, also will compromise with efficiency of such services for want of proper space etc.

Areas like Hospital, Stadium (Clause 1.12 of General Specification for Electrical works CPWD):

Planning of such buildings require high degree of professionalism, for application of latest technology to provide efficient and effective installation.

Out door Lighting High Mast Lighting, Road Lighting, Security Lighting Garden Lighting, Illuminated fountains (Clause 2.13 of General Specification of Electrical Works CPWD)

Present day modern building require highly aesthetic lighting making use of a variety of lighting design, themes and fixtures available. For proper aesthetic effect, high level of professional approach is needed based on computer-aided design and calculation.

Street Light Poles (Clause 2.14 of General Specification for Electrical works (CPWD):

Hot dipped galvanized poles with integrated in-built control box and lighting brackets is a preferred option to ensure long life of poles and to delay effect of corrosion.

Cables: ***(Clause 5.2.2 of NBC)***

The smallest size of the cable that shall be used will depend upon the method of laying cables permissible maximum temperature it shall withstand, voltage drop over the length of the cable, the prospective short-circuit current to which the cable may be subjected, the characteristics of the overload protection gear installed, load cycle and thermal resistivity of the soil.

High Voltage (HV) Busbar Trunking/Ducting ***(Clause 5.2.3 of NBC)***

HV bus bar system is used for transporting power between HV generators, transformers and the infeed main switchgear of the main HV switchgear.

MV / LV Medium / Low Voltage Busbar Trunking / Rising mains ***(Clause 5.2.4 of NBC):***

Where heavy loads are to be carried, busbar systems are preferred. The busbar are available for continuous run from point or with tap offs at standards intervals and have to be chosen as per specific requirement. There are two types of MV/LV bus duct system for power distribution system:

a) Conventional type

Conventional type bus duct is used for large power handling between transformer and switchgear and large power loads, such as compressor drive motor etc. This type is generally used in plant rooms, riser shafts, substations etc.

b) Compact and sandwich type

Compact type is available either air insulated or sandwich type for use within areas of the building which are put to other higher (aesthetic) level of use they could be used in false ceiling spaces or even in corridors etc.

Transformers ***(Clause 5.2.5. of NBC)***

General design objective while selecting the transformer(s) for a substation would be to provide at least two or more transformers, so that a certain amount of redundancy is built in, even if a standby system is provided. The total installed transformer capacity would be marginally higher than the anticipated maximum demand. During the periods of lowest it would be desirable to operate only one transformer and switch in additional transformers as the load variation takes place in a day. The minimum size of a transformer would quite often depend on the minimum load that is anticipated over a period of about 4 hours in a day. Total transformer capacity is generally selected on the basis of present load, possible future load, operation and maintenance cost and other system conditions and selection of the maximum size (capacity) of the transformer is guided by short-circuit making and breaking capacity of the switchgear used in the medium voltage distribution system. Maximum size limitation is important from the aspect of feed to a down stream faults.

For reasons of reliability and redundancy it is normal practice to provide at least two transformers for any important installation. Where two or more transformers are to be installed in a substation to supply a medium voltage distribution system, the distribution system shall be divided into separate section each of which shall be normally fed from one transformer only.

Switchgear ***(Clause 5.2.6. of NBC)***

Switchgear (and its protective device) shall have breaking capacity not less than the anticipated fault level in the system at that point.

It shall be mandatory to provide power factor improvement capacitor at the substation. As general rule, the KVA rating of the capacitor should not exceed the no-load magnetizing KVA of the motor. Generally it would be necessary to provide an automatic control for switching in capacitors matching the load power factor and the bus voltage. Such a scheme would be necessary as capacitors permanently switched in the circuit may cause over voltage at times of light load.

Reception and Distribution of Main Supply (Clause 5.3 of NBC))

There shall be a circuit breaker or miniature circuit breaker or a load break switch fuse on each live conductor of the supply mains at the point of entry. The wiring through the installation shall be such that there is no switch or fuse unit in the earthed neutral of conductor. The main switch shall be easily accessible and situated as near as practicable to the termination of service line.

Energy meters ***(Clause 5.3.1.4 of NBC)***

Energy meters shall be installed in residential building at such a place, which is readily accessible to the owner of the building and the authority.
In multi-storeyed building meters shall be installed with tapping point for meter of the rising main (bus trunking) on individual floors

Main Switches and Switchboard ***(Clause 5.3.2. of NBC)***

All main switches shall be either of metal-clad enclosed pattern or of any insulated enclosed pattern. The location of the main board should be such that it is easily accessible for fireman and other personal to quickly disconnect the supply in case of emergency.

Note: Woodwork shall not be used for the construction or mounting of switches and switch boards installed in a building.

High Tension Service Connection
(Extract of Tamilnadu Electricity Board Auditor's Hand Book of 2004)

- Every consumer requiring 63 KVA or 112 KW or 150 HP should obtain HighTension (HT) supply. Below this the consumer can avail Low Tension (LT) Supply.
- Every consumer shall maintain a power factor of 0.90 lag in case of HT supply, failing which he shall be liable to pay compensation.

- Wherever the consumer exceeds the sanctioned demand, charge shall be based on the recorded demand or such percentage of the sanctioned demand (now 90% of the sanctioned demand) whichever is higher. The exceeded demand shall be charged at double the normal rate.

- Minimum monthly charges are payable even when no electricity was consumed.

- Where metering of the High Tension Service Connection is in the Low Tension side on the secondary side of the transformer. The average losses in the transformer shall be calculated as follows and added to the energy consumption indicated by the meter.

$$\text{Average loss} = 720 \times 1.0 \times C \quad \frac{\text{unit per month}}{100}$$

where C = KVA rating of the transformer.

- The transformer loss arrived at by the above formula shall be added to the energy consumption even when the recorded energy consumption is nil.

- 1% of the transformer capacity for transformer above 63 KVA will be added to the recorded maximum demand on the Low Tension side to arrive at the equivalent High Tension demand.

- The transformer loss has also to be billed at 20% extra charges of peak hour charge vide SE/IEMC/D.221/99, dated.20.3.99.

- Maximum demand charges for any month will be levied on the KVA demand actually recorded in that month or 90% of the sanctioned demand whichever is higher vide TNERC Tariff order dated.15.3.2003.

- Levy of Low Power Factor (LPF) Compensation charge.

- The average power factor for HT service shall not be less than 0.90 (vide G.O.Ms.No.35, dated.1.3.94). If the average Power Factor (PF)is less than 0.90, LPF compensation charges shall be levied as follows.

Below 0.90 and upto 0.85	1 % of current consumption charge for every reduction of 0.01 in power factor.
Below 0.85 to 0.75	1.5% of CC charge for reduction of 0.01 in PF from 0.90
Below 0.75	2% CC charges for every reduction of 0.01 in PF from 0.90

In case of LT supply the consumer should maintain a power factor 0.85 Lag.Where the rating is in terms of KVA, it shall be converted to KW by multiplying it by a power factor -85 and where the rating is in terms of HP, it shall be converted to KW by multiplying by a factor of 0.746.

(Key: Extract from Tamil Nadu Electricity Supply Code)

ELECTRICAL POWER DISTRIBUTION AND WIRING (CLAUSE 3 OF GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS (CPWD)

The distribution/wiring system essentially consists of provision of cables, switchgear, rising main, bus-ducting earthing, laying of pipes/conduits etc.(in surface or recess) based on proper detailed designing to decide on various sizes/capacities of these components and various controls and safeties involved, to provide an efficient, reliable, safe and adequate electrical distribution and wiring system.

System of distribution and wiring (Clause 3.2)

- The wiring shall be done from a distribution system through main and/or branch Distribution Boards (DB). The system design and location of boards will be properly worked out.
- Each main distribution board and branch distribution board shall be controlled by an incoming circuit breaker/linked switch with fuse. Each outgoing circuit shall be controlled by circuit breakers/switch with fuse.
- For non-residential building, as far as possible, DBs shall be separate for light and power.
- Only fuse type DBs shall be used. Rewirable type fuses shall not be used.
- Three phase DBs shall not be used for final circuit distribution as far as possible.
- 'Power' wiring shall be kept separate and distinct from light wiring, from the level of circuits i.e. beyond the branch distribution boards. Conduits for light/power wiring shall be separate.
- Essential/non-essential/UPS distribution each will have a completely independent and separate distribution system starting from the main switchboard upto final wiring for each system. As for example, conduit carrying non-essential wiring shall not have essential or UPS wiring – wiring for essential and UPS supply will have its own conduit system. No mixing of wiring is allowed.
- Generally, no switchboard will have more than one source of incoming supply. More than one incoming supply will be allowed only at main board with proper safety and interlocking so that only one source can be switched on at a time.
- Each Main distribution Board (MDB)/DB/switch Board will have reasonable spare outgoing ways for future expansion.
- Balancing of 3-phase circuit shall be done.

Wiring (Clause 3.3)

Wiring is classified as Sub main & circuit wiring Sub main wiring shall mean the wiring from one main/distribution switchboard to another. Circuit wiring shall mean the wiring from the distribution board to the1st tapping point inside the switch box, from where point wiring starts.

Measurement of sub main and circuit wiring: (*Clause 3.3.2*)

- Circuit and sub main wiring shall be measured on linear along the run of the wiring. The measurement shall include all lengths from end to end of conduit or channel as the case may be. The increase on account of diversion or slackness shall not be included in the measurement.
- The length of circuit wiring with two wires shall be measured from the distribution board to the nearest switch box from which the points wiring starts. Looping of switch boxes also will be counted towards circuit wiring measured along the length of conduit/channel.
- When wires of different circuits are grouped in a single conduit/channel the same shall be measured on linear basis depending on the actual number and sizes of wires run.
- Protective (loop earthing) conductors, which run along the circuit wiring, shall be measured on linear basis and paid for separately.

Note: Conduit-carrying sub main will not carry circuit/point wiring. Similarly conduit carrying circuit wiring will not carry sub main/point wiring. Conduit carrying points wiring will not carry sub main circuit wiring.

Measurement of other wiring work *(Clause 3.3.3)* :

Except as specified above for point wiring, circuit wiring submain wiring and other types of wiring shall be measured separately on linear basis along the run of wiring depending on the actual number and sizes of wires run.

Point wiring *(Clause 3.4):*

A point (other than socket outlet point) shall include all work necessary in complete wiring to the outlets such as ceiling rose, connector, lamp holder etc., from the controlling switch. In the case of point with more than one point controlled by the same switch, such points shall be measured in parts. No recovery shall be made for non-provision of more than one switch in such cases.

A light point controlled by two-way switches shall be measured as two points. Similarly in the case of call bell points with a single call bell outlet, controlled from more than one place, the points shall be measured in parts No recovery shall be made for non-provision of more than one ceiling rose or connector for connection to call bell in such cases.

Wiring System *(Clause 3.5):*

Wiring shall be done only by the looping system. In wiring, no joints in wiring will be permitted any where, except in switch box or point outlets, where jointing of wires will be allowed with use of suitable connector.

Cables *(Clause 3.12):*

i.) Copper conductor cable will only be used for submain / circuit / point wiring.
ii) Minimum size of wiring:
Light Wiring: 1.5sq.mm
iii) Power wiring: 4.0sq.mm

Wiring Accessories: The following are some of accessories normally used in wiring.

a. Control switches for point:
b. Switch Box:
c. Switch box covers
d. Ceiling rose:
e. Lamp holders
f. Indoor and Outdoor fittings
g. Fans, Regulator and Clamps, Exhaust fans

AIR CONDITIONING AND HEATING ***(Part 8 – Section 3 of National Building code 2005)***

The object of installing ventilation and air conditioning (AC) facilities in buildings shall be to provide conditions under which people can live in comfort, work safely and efficiently.

Pre-planning ***(Clause 3.2)***

Cooling load estimate shall be carried out prior to installing air conditioning equipment. Calculation of cooling load shall take into account the following factors:

- Recommended indoor temperature and relative humidity
- Outside design conditions.
- Details of construction and orientation of exposures like roof, floor, walls, partition and ceiling.
- Fenestration area and shading factors;
- Occupancy – Number of people and their activity;
- Ventilation – Requirement for fresh air;
- Internal Load – Lighting and other heat generating sources like computers, equipment and machinery; and
- Hours of use.

Design Considerations ***(Clause 4.2 of NBC)***

Systems for air conditioning need to control temperature and humidity w0ithin predetermined limits throughout the year. Various types of refrigerating systems are available to accomplish the tasks of cooling and dehumidifying, which are essential feature of air conditioning. Systems for air conditioning may be grouped as all – air type, air and water type, all water type or unitary type.

Special applications like hospitals / operating theatres, computer rooms, S laboratories, libraries, museums/art galleries, sound recording studios, shopping malls, etc shall be handled differently.

In the case of large installations (500 TR and above), it is advisable to have a separate isolated equipment room where possible.

All – air system

This type of air conditioning system provides complete sensible and latent cooling, preheating and humidification in the air supplied by the system. Most plants operate on the recirculation principle, where a percentage of the air is extracted and the remainder mixed with incoming fresh air.

Air and water system

The supply of air from central plant provided the necessary ventilation air and the small part of the total conditioning. The major part of room load is balanced by water through a coil in the terminal unit, which can be either a fan coil unit or an induction unit.

In this system a separate hot water flow and chilled water flow is taken to the terminal units but a common return is taken from these units to the plant room. Although the most expensive method of circulating the water, it is the only satisfactory one, if reasonable control is required throughout the year.

All water system

In the simplest layout the fan coil units may be located against an outside wall with a direct, fresh air connection. A superior arrangement utilizes a ducted, conditioned, fresh air supply combined with mechanical extract ventilation. Control of unit out put may be achieved by fan speed and water flow/temperature control. Electric power is required at each terminal unit

This system allows better control on energy consumption under partial load conditions due to diversity or seasonal load variations.

Unitary systems

Such systems are usually those incorporating one or more units or packaged air conditioners having a direct expansion vapour compression refrigeration system.

Compressor:

Compressor is one of the main components of AC unit. Compressor is a device, which compresses low-pressure low temperature refrigerant gas to high-pressure high temperature super heated refrigerant gas. There are various types of compressors viz centrifugal compressors, screw compressors reciprocating compressors etc. depending on the function and use.

Unitary Air Conditioner *(Clause 7)*

These are self-contained air conditioning units comprising a compressor and evaporator with fans for evaporator and air – cooled condenser. Unitary air conditioners are generally installed in windows and, therefore, they are also known as window air conditioners.

- Most of the manufacturers supply unitary air conditioner in capacities of 3500W (1 TR), 5250 (1.5 TR) and 7000 W (2TR).
- Unitary air conditioners are suitable for bedrooms, office cabins, general office area, hotel rooms and similar applications where normal comfort conditions are required upto a distance of 6 m from unitary air conditioner.
- Power consumption of window air conditioners of 1TR (3500W) rated capacity should not exceed 1.55 KW/TR. However, in smaller sizes, the power consumption may exceed. Rotary compressors normally consume 7 percent to 8 percent less power compared to the above value for reciprocating compressors.

- Noise level of window air conditioner inside the conditioned room should be as low as possible. However it should not exceed 65 DBA for 5250W (1.5TR) or smaller capacity window air conditioners.

Split Air Conditioner *(Clause 8)*

Split air conditioner has an indoor unit and an outdoor unit interconnected with refrigerant piping and power and control wiring. Indoor unit comprises of a filter, evaporator and evaporator fan for circulation of air in the conditioned space. Outdoor unit has a compressor, air-cooled condenser with condenser housed in a suitable cabinet for outdoor installation. Split air conditioner includes primary source of refrigeration for cooling and dehumidification and means for circulation and cleaning of air, with or without external air distribution ducting.

Split air conditioners may be provided with either reciprocating compressor or screw compressor. Screw compressor generally consumes about 10 to 12 percent of power compared to reciprocating compressor.

- Split air conditioners are suitable for wide range of applications including residences, small offices, clubs, restaurants, showrooms, departmental stores etc.
- Split air conditioners are available in various capacities. viz. 1 TR, 1.5 TR, 2 TR, 3 TR etc.

Packaged Air Conditioner *(Clause 9)*

Packaged air conditioner is a self-contained unit primarily for floor mounting, designed to provide conditioned air to the space to be conditioned.

The unit comprises a compressor, condenser and evaporator, which are interconnected with copper refrigerant piping and refrigerant controls. It also includes fan for circulation of air and filter. The unit is provided with compressor and fan motor starter and factory-wired safety controls.

Compressor is a device, which compresses low-pressure low temperature refrigerant gas to high-pressure high temperature super heated refrigerant gas. Compressors may be reciprocating type or scroll type for packaging unit applications.

Condenser condenses high pressure high temperature refrigerant gas to liquid refrigerant at approximately the same temperature and pressure by removal of sensible heat of refrigerant by external means of water cooling or air cooling.

The packaged units are also available with microprocessor-based controller installed in the unit, for digital display of faults as also several other functions. The packaged unit can also be provided with winter heating package or humidification package. The packaged unit may be provided with either water-cooled condenser or a remote air-cooled condenser with interconnected copper refrigerant piping. The units are available with reciprocating compressor as also scroll compressor, which consume about 10 to 12 percent lesser power. In a water-cooled condenser unit, condenser-cooling water is circulated through the cooling tower with necessary piping and pumpsets.

- Packaged units are suitable for wide range of application including offices, clubs and restaurants, showrooms and departmental stores, and computer rooms, etc.,
- Normally the packaged air conditioners are manufactured in sizes of 17500W (5 TR), 26250 W (7.5 TR), 35000 W (10 TR) and 52500 W (15 TR). Packaged units with scroll compressors are also available in capacity up to 58100W (16.6 TR).

Electric Air Heater *(Clause 10.2.2):*

The air velocity through the heaters should be sufficient to permit the absorption of the rated output of the finned tube heaters within its range of safe temperatures and the exact velocity determined in conjunction with the manufactures of the heater. Electrical load should be balanced across the three-phase of the electrical supply.

With all electric air heaters, care should be taken to preclude the risk of fire under abnormal conditions of operation.

INSTALLATION OF LIFTS AND ESCALATORS (*Part 8,Section 5 of National Building Code 2005)*

The Passenger lifts shall normally be provided only when the number of floors to be served exceeds four or the height of the building exceeds 14.5 meters. However, lifts for special purposes such as hospital lift, goods lift and VIP lift may be provided to serve even a lesser number of floors depending upon the particular requirements. The number of lifts for a particular building shall be decided keeping in view any probable future expansion.

The passenger lifts shall be so placed as to be easily accessible from various entrances to the building. For maximum efficiency they should be grouped and located suitably in the building. Passenger lift is used in residential building. Office building, hospitals, shops and departmental stores.

Goods lifts shall also be similarly placed for achieving least horizontal movement of goods. The ideal arrangement of lifts depends upon the particular use in the respective building and shall be determined in every individual case.

In selecting the location for lift installation in any building particular attention shall also be given to the fire rescue aspect in conformity with the local municipal by laws and prevention of water entry into the pit.

- The installation shall be carried out in conformity with the local lifts Act and Rules. The installation shall also conform to requirements of Local Municipal Bylaws.
- All electrical works in connection with installation of electric lifts shall be carried out in accordance with the provisions of Indian Electricity Act 1910 and the Indian Electricity Rules 1956 amended upto date.

Preliminary Design *(Clause 6.1):*

Number of Lifts and Capacity:

Two basic considerations, namely, the quantity of service required and the quality of service desired, determine the type of lifts to be provided in a particular building.

The number of passenger lifts and their capacities, the load and speed, required for a given building depend on the characteristics of the building. The most important of these are.

a. Number of floors to be served by the lift
b. Floor to floor distance
c. Population of each floor to be served
d. Maximum peak demand, this demand may be unidirectional, as in up and down peak periods, or a two-way traffic movement.
e. Quantity of Service

The quantity of service is a measure of the passenger handling capacity of a vertical transportation system. It is measured in terms of the total number of passengers handled during each five-minute peak period of the day. A five-minute base period is used as this is the most practical time over which the traffic can be averaged.

The recommended passenger handling capacity for various buildings is as follows:

Type of Building	Handling Capacity
Office – Diversified tenants	10 to 15 percent
Office – Single tenant	15 to 25 percent
Residential	7.5 percent

Quality of Service:

The passenger waiting time at the various floors on the other hand generally measures the quality of service. The following shall be the guiding factor for determining this aspect.

Quality of Service or Acceptable Interval:

20 to 25 seconds	Excellent
30 to 35 seconds	Good
35 to 40 seconds	Fair
45 seconds	Poor
Over 45 seconds	Unsatisfactory

Note: For residential buildings longer intervals should be permissible.

Traffic Peaks:

The maximum traffic flow during the peak period is usually used as a measure of the vertical transportation requirement in an office building.

Capacity:

The minimum size of car recommended for a single purpose buildings is one suitable for a duty load of 884 kg. Generally, for large office buildings cars with capacities up to 2040 kg are recommended according to the requirements.

Speed

It is dependent upon the quantity of service required and the quality of service desired. Therefore, no set formulae for indicating the speed can be given. However, the following general recommendations are made.

No. of Floors	Speed
4 to 5	0.5 to 0.75m/s
6 to 12	0.75 to 1.5 m/s
3 to 20	1.5 m/s to 2.5 m/s
Above 20	2.5 m/s and above

Layout:

The shape and size of the passenger lift car bears a distinct relation to its efficiency as a medium of traffic handling. The width of the car is determined by the width of the entrance and the depth of the car is regulated by the loading per square meter permissible under this Code. Centre opening doors are more practicable and efficient entrance units for passenger lifts.

Escalators *(Clause 14)*

Escalators are deemed essential where the movement of people, in large numbers at a controlled rate in the minimum of space, is involved, for example, railway stations, airports, etc. In exhibitions, big departmental stores and the like, escalators encourage people to circulate freely and conveniently.

As the escalators operate at a constant speed, serve only two levels and have a known maximum capacity, the traffic study is rather easy. Provided the population to be handled in a given time is known, it is easy to predict the rate at which the population can be handled.

For normal peak periods, the recommended handling capacities for design purposes should be taken as 3200 to 6400 persons per hour depending upon the width of the escalator.

Audit Approaches

1. The civil work is being executed by Civil Wing and Electrical works by Electrical wing of the Public Works Department. The building should be put into beneficial use immediately on completion of civil works. But cases of undue delay in completing electrical works, ultimately leading to delay in putting the assets into use may be identified and commented, with financial implications and delay.

2. The consumer should avail HT connection if the installation have the capacity / connected load economical load of 150 HP or 112 KW or 63 KVA and others can avail LT connection. But the consumer may avail HT connection even though the capacity of installation is less than 150HP or 112KW or 63 KVA leading to unnecessary payment of electricity charges.

3. The HT consumer is required to assesses the load and execute agreement on the requirement of load.

(i) Cases may arise when the recorded demand was far less than the sanctioned demand In such cases the consumer has to pay charges for 90% of the sanctioned demand leading to unnecessary payment.

ii) Cases may also arise were the recorded demand is far in excess of sanctioned demand. In that case the consumer has to pay double the charge for the excess demand. Thus, incorrect assessment of demand may be analysed and commented.

4. The consumers are required to maintain the prescribed power factor of .90 lag for HT and 0.85 lag for LT connections. Failure to maintain the prescribed power factor is liable for payment of penalty. To improve the power factor the consumers are required to install capacitors. Failure to maintain the prescribed power factor and consequential extra cost on payment of penalty may be commented.

5. As per clause 2:3:10 of General Specification for electrical works of CPWD, it is essential to plan for stand by system like incoming supply from two sources and minimum two transformers should be provided so that in case of failure of one transformer, there is a stand by to ensure reliable power supply. Cases of providing more number of transformers or / and source of incoming supply from more than two sources may be analysed and comments drawn on extra cost.

6. Selection of appropriate Air conditioning (AC) systems with reference to the requirement has to be analysed and comments if any attempted on defective selection type of AC. The selection of the capacity more than the requirement may be commented.

7. The selection of lift, number of lifts with reference to the handling capacity, number of floors, speed etc., may be analysed and commented on each aspect

9. FIRE PREVENTION AND FIRE PROTECTION

(Key : Part.4 National Building Code, 2005)

Classification of Building Based on Occupancy *(Clause 3.1)*:

General Classification:

All buildings, whether existing or hereafter erected shall be classified according to the use or the character of occupancy in one of the following groups.

Group A	Residential, Lodging houses, Private dwellings, Dormitories, Apartment houses (flats) and Hotels.
Group B	Educational
Group C	Institutional
Group D	Assembly
Group E	Business
Group F	Mercantile
Group G	Industrial
Group H	Storage
Group J	Hazardous

Fire Zones Demarcation *(Clause 3.2)*:

The city or area under the jurisdiction of the Authority shall be demarcated into distinct zones, based on fire hazard inherent in the buildings and structures according to occupancy, which shall be called as 'Fire Zones'. The fire zones shall be made use of in land use development plan and shall be designated as follows:

a. Fire Zone No.1 – This shall comprise areas having residential, educational institutional and assembly, small business and retail mercantile buildings, or areas which are under development for such occupancies.
b. Fire Zone No.2 – This shall comprise business and industrial buildings, except high hazard industrial buildings or areas, which are under development for such occupancies.
c. Fire Zone No.3 – This shall comprise areas having high hazard industrial buildings, storage buildings and buildings for hazardous use or area which are under development for such occupancies.

Temporary Buildings or Structures *(Clause 3.2.5):*

- Temporary buildings and structures shall be permitted only in Fire Zones No. 1 and 2 as the case may be, according to the purpose.
- Such buildings and temporary structures shall be completely removed on the expiry of the period specified in the permit.
- Adequate fire precautionary measures in the construction of temporary structures and pandals shall be taken.

General Requirements of All Individual Occupancies *(Clause 3.4):*

- All buildings shall satisfy certain requirements which contribute , individually and collectively, to the safety of life from fire, smoke, fumes and panic arising from these or similar causes.
- A high rise building during construction shall be provided with the following fire protection measures, which shall be maintained in good working condition at all the times:

  a. Dry riser of minimum 100 mm diameter pipe with hydrant outlets on the floors constructed with a fire service inlet to boost the water in the dry riser
  b. Drums filled with water of 2000 litres capacity with two fire buckets on each floor; and
  c. A water storage tank of minimum 20000 litres capacity, which may be used for other construction purpose.

Life Safety *(Clause 4.1):*

Every building shall be so constructed, equipped, maintained and operated as to avoid undue danger to the life and safety of the occupants from fire, smoke, fumes or panic during the time period necessary for escape with exit. The exit may be a doorway; corridor, passageway(s) to an internal staircase, or external staircase, or to a verandah or terrace(s), which have access to the street or to the roof of building or a refuge area. An exit may also include a horizontal exit leading to an adjoining building at the same level.

Lifts and escalators shall not be considered as exits.

Fire Protection *(Clause 5.1.1):*

All buildings depending upon the occupancy use and height shall be protected by fire extinguishers, wet riser, down-comer, automatic sprinkler installation, high/medium velocity water spray, foam, gaseous or dry powder system in accordance with the provisions of accepted standard.

Class of Fire

Class A : Fires involving paper, wood, Textile, packing materials etc.
Class B : Fire involving Oil, Petrol, Solvent, Grease, Paints
Class C : Fire involving Electrical Hazards, Motor vehicle Gaseous substance under pressure.
Class D : Fire involving chemicals, metal and acid like.
Class E : Fires involving electrical equipment, delicate machinery etc.

Mode of Fire Protection

1. Sand/Water buckets
2. Dry/Wet Hydrant risers
3. Heat/Smoke Detectors
4. Automatic/Manual Fire Alarm
5. Sprinklers
6. Lightening Conductors.
7. Fire Dampers in AC Ducts
8. Fire Doors with fusible links
9. Pressurization Plant
10. Public Address System
11. Fire Escapes/External Stairs

Coverage (Floor) Area

1. Water/Sand Bucket	100 sq.mt.	5. Sprinklers	6 sq.mt.
2. Extinguishers (9 lts)	600 sq.mt	6. Heat Detectors	16 sq.mt
3. Hydrant Riser (Outlet 100mm dia)	100 sq.mt	7. Smoke Detectors	50 s.q.mt
4. With landing valve and first aid hose reel)	930 sq.mt		

Choice of Extinguishers

Type pf Extinguishers	**Suitable for class of fire**
1. Soda Acid Type	Class – A
2. Foam Type	Class – B
3. Dry Chemical Power Type	Class – B, C, D & E
4. Carbon-di-oxide Type	Class – B, C & E
5. Water Carbon-di-oxide Type	Class – A
6. Carbo-Tetra-Chloride Type	Class – C

Water Requirement for the Fire Fighting

Q = 3000 P

Q = Fire Demand in Litres/Minutes
P = Population in Thousands

Note: The rate must be maintained at a minimum pressure of 1 to 1.5Kg/cm

Audit Approaches

The prescribed Fire Protective measures provided in the building have to be analysed. Non-compliance of the standards and also loss if any due to fire may be analysed and commented.

10. WATER SUPPLY DRAINAGE SANITATION AND APPROACH ROADS

(Part 9 Scheme 1 of National Building Code 2005)

Water Supply *(Clause 4)*:

A minimum of 70 to 100 litre per head per day may be considered adequate for domestic needs of urban communities, apart from non-domestic needs as flushing requirements.Minimum requirements for water supply for buildings others than residences shall be as follows:

Water Requirements for Buildings Other than Residences (Table 1 and Clause 4.1.2)

Sl.No.	Type of Building	Consumption (Per day in liters.)
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 (upto 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	15 per seat
xi)	Schools:	
	a. Day schools	45 per head
	b. Boarding schools	135 per head

Note:

For calculating water demand for visitors a consumption of 15 litres per head, per day may be taken.

The Authority shall make provision to meet the water supply requirements for fire fighting in a city/area, depending on the population density and types of occupancy.

- The quality of water to be used for drinking shall be potable as per the prescribed standard. For purposes other than drinking, water if supplied separately, shall be absolutely safe from bacteriological contamination so as to ensure that there is no danger to the health of the users due to such contaminants. *(Clause 4.2.3)*
- Estimate of total water supply requirements for buildings shall be based on the occupant load consistent with the provisions of 4.3. *(Clause 4.1)*

- In a building, provision is required to be made for storage of water for the following reasons:
  a. to provide against interruptions of the supply caused by repairs to mains, etc:
  b. to reduce the maximum rate of demand on the mains;
  c. to tide over periods of intermittent supply; and
  d. to maintain a storage for the fire fighting requirement of the building. *(Clause 4.4.1)*
- The water may be stored either in overhead tanks (OHT) and /or underground tanks (UGT). *(Clause 4.4.2)*

- All pipe work shall be so designed, laid or fixed and maintained as to remain completely water-tight, thereby avoiding wastage, damage to property and the risk of contamination.

(Clause 4.11.4)

No water supply line shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure pit or any material of such nature that is likely to cause undue deterioration of the pipe, except where it is unavoidable. *(Clause 4.11.5)*

Drainage and sanitation *(Clause 5):*

There are various type of sanitary appliance viz. water closet, bidet, urinal washbasin, wash trough, sink, bathtub, drinking fountain etc., in any buildings. The waste water is collected through service and discharged to public sewerage disposal system.

Choice of Material for Pipes *(Clause 5.3.2):*

Salt glazed stoneware pipe

For all sewers and drains in all soils, except where supports are required as in made-up ground, glazed stoneware pipe shall be used as far as possible in preference to other types of pipes.

Cast iron pipes

These pipes shall be used in the following situation:

a) in bed or unstable ground where soil movement is expected:
b) in-made-up or tipped ground;
c) to provide for increased strength where a sewer is laid at insufficient depth, where it is exposed or where it has to be carried on piers or above ground:
d) under buildings and where pipes are suspended in basements and like situations;
e) in reaches where the velocity is more than 2.4 m/s; and
f) for crossings of watercourses.

Note: In difficult foundation condition such as in the case of black cotton soil, the cast iron pipes shall be used only when suitable supporting arrangements are made.It shall be noted that cast iron pipes even when given a protective paint are liable to severe external corrosion in certain soils.

Asbestos cement pipes:

Asbestos cement pipes are commonly used for house drainage systems and they shall conform to accepted standards. They are not recommended for underground situations.

PVC pipes:

Unplasticized PVC pipes may be used for drainage purposes; however, where hot water discharge is anticipated, the wall thickness shall be minimum 3mm irrespective of the size and flow load.

Manholes *(Clause 5.5.10):*

General

A manhole or inspection chamber shall be capable of sustaining the loads which may be imposed on it. The size of the chamber should be sufficient to permit ready access to the drain or sewer for inspection, cleaning, rodding and should have a removable cover of adequate strength; constructed of suitable and durable material. Where the depth of the chamber so requires, access rungs, step irons, ladders or other means should be provided to ensure safe access to the level of the drain or sewer. If the chamber contains an open channel, benching should be provided having a smooth finish so as to allow the foul matter to flow towards the pipe and also ensure a safe foothold.

No manhole or inspection chamber shall be permitted inside a building or in any passage therein. Further, ventilating covers shall not be used for domestic drains. At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manholes as far as possible.

Spacing of manholes

The spacing of manholes for a given pipe size should be as follows;

Pipe Diameter mm	Spacing of Manhole in metres
a. Up to 300	45
b. 301 to 500	75
c. 501 to 900	90
d. Beyond 900	Spacing shall depend upon local condition and shall be got approved by the Authority

Where the diameter of a drain is increased, the crown of the pipes shall be fixed at the same level and the necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at a lower level, but in such cases the peak flow level of the two sewers shall be kept at the same level.

Size of manhole:

The manhole or chamber shall be of such size as will allow necessary examination or clearance of drains. The size of manhole shall be adjusted to take into account any increase in the number of entries into the chamber.

Manholes may be rectangular, arch or circular type. The minimum internal size of manholes, chamber (between faces of masonry) shall be as follows:

a. Rectangular Manholes
   1. For depths less than 0.90m — 900 mm x 800 mm
   2. For depths from 0.90 m and up to 2.5m — 1200 mm x 900 mm

b. Arch Type Manholes
   For depths of 2.5 m and above — 1400 mm x 900 mm

Note: The width of manhole chamber shall be suitably increased more than 900 mm on bends, junctions or pipe with diameter greater than 450 mm so that benching width on either side of channel is minimum 200 mm.

c. Circular Manholes

   1. For depths above 0.90 m and upto 1.65 m — 900mm diameter
   2. For depths above 1.65 m and upto 2.30 m — 1200 mm diameter
   3. For depths above 2.30 m and upto 9.00m — 1500 mm diameter
   4. For depths above 9.00 m and upto 14.00 m — 1800 mm diameter

Storm water Drainage *(Clause 5.5.11*):

The object of storm water drainage is to collect and carry, the rain-water collected within the premises of the building, for suitable disposal.

Design factors

Estimate of the quantity that reaches the storm water drain depends on the following factors;

a. Type of soil and its absorption capacity determined by its soil group.
b. Ground slope and the time in which the area is drained.
c. Intensity of the rainfall for a design period.
d. Duration of the rain/storm.

Rain – water pipes for roof drainage *(Clause 5.5.11.6):*

The Roof of a building shall be so constructed or framed as to permit drainage of the rain-water there from by means of a sufficient number of rain-water pipes of adequate size so arranged, jointed and fixed as to ensure that the rain-water is carried away from the building without causing dampness in any part of the walls or foundation of the building or those of an adjacent building.

Rain-water pipes shall be constructed of cast iron, PVC, asbestos cement, galvanized sheet or other equally suitable material and shall be securely fixed.

The factors that decide the quantity of rain water entering are:

a. Intensity of rainfall, and
b. Time of concentration selected for rain-water pipe.

The rain water pipes of cast iron (coefficient of roughness 0.013) shall normally be sized on the basis of roof areas. The vertical down take rain-water pipes, having a bell mouth inlet on the roof surface with effective cross-sectional area of grating 1.5 to 2 times the rain-water pipe area, may be designed by considering the outlet pipe as weir.

Sizing of Rain-water Pipes for Roof Drainage

(Clause 5.5.11.6.8)

Dia of Pipe (mm)	Average Rate of Rainfall (mm/h)					
	50	75	100	125	150	200
	Roof Area (m^2)					
50	13.40	8.09	6.6	5.3	4.4	3.3
65	24.10	16.0	12.0	9.6	8.0	6.0
75	40.80	27.0	20.4	16.3	13.6	10.2
100	85.40	57.0	42.7	34.2	28.5	21.3
125	159.71	106.73	80.50	64.3	53.5	40.0
150	249.60	166.82	125.27	100.00	83.6	62.7

Note: For rain water pipes of other materials, the roof areas shall be multiplied by 0.013/coefficient of roughness of surface of that material. The storm water may be led to a suitable open drain to a water course.

Rain – Water Harvesting *(Clause 5.5.12)*

To supplement the ever growing shortage of protected, pure and safe water supply for human consumption rainwater is an ideal source, which can be conserved and used in a useful manner by the people. The amount of rainfall available varies from region to region. Each area has to develop its own method and system to conserve, store and use it to suit its requirements and local conditions. There are several methods by which rain-water can be stored, used and conserved. Each system depends on the amount of precipitation, the period in which the rainfall occurs in a year and the physical infrastructure for example, space available to store the water, etc.

There are several techniques available for catching and storing the rain water. Two major systems that are used in urban and semi-urban developed areas are:

a) Artificial ground water recharge, and
b) Roof top rain-water harvesting.

Solid Waste Management *(Clause 6)*

Efficient collection and disposal of domestic garbage from a building or activity area is of significant importance to public health and environmental sanitation and, therefore, an essential part of the construction of the built environment. Not withstanding the provisions given herein, the solid waste management shall have to comply with relevant statutory Rules and Regulations in force from time-to-time.

In designing a system dealing with collection of domestic garbage for a built up premises/community/ environment, the aim shall be to provide speedy and efficient conveyance as an essential objective for design of the system. The various available systems may be employed in accordance with various system which may be adopted individually or in combination as appropriate in specific situations.

Approach Road:

As per Circular No 1441 of 1981 (No Wks III (57) 87221/80-14 dated 19.3.1981) of CE (B), roads laid for giving approaches inside the compound of building must be either gravel road or black topped (BT) roads. As the Water Bound Macadam (WBM) road will get damaged completely if it is not black topped, no proposal should be formulated for laying WBM roads without immediately following with black topping. The type of road should be decided for each compound as per the necessity and the volume of traffic. IRC 37: 2001 and IRC SP: 20-2002 prescribe standards for designing pavement thickness. In case if the volume of traffic is less than 450 CVPD, the pavement has to be designed adopting IRC SP: 20 – 2002 and in case of traffic more than 450 CVPD IRC 37:2001 has to be adopted. The flow of commercial vehicle in any office complex or residential building complex etc is always less than 450 CVPD. Hence the pavement of the road has to be designed adopting IRC SP: 20 – 2002.

Audit Approach

1. On completion of the building works, the water supply and sanitary works are to be completed to put the buildings into beneficial use. Cases where there was undue delay in providing water supply or not providing sufficient potable water leading to keeping the building vacant for a long time may be analysed and commented on blocking of the investment cost, consequential avoidable expenditure incurred by the user agency (Viz HRA, Rent etc)

2. The size of manhole, distance between manholes constructed for sanitary work, class and type of pipe used may be examined with reference to standards and appropriate comments drawn on extra cost.

3. Failure of identifying the appropriate source and location for drawal of water leading to wasteful expenditure on source creation, size and type of pipe adopted for conveyance main etc., has to be analysed and appropriate comments drawn.

4. As per CE (B) Circular No.141 dated: 19.3.1981, the type of road to be formed should be decided in each case as per the necessity and the volume of traffic. But the departments provide Bituminous Macadam (BM) and Semi Dense Bituminous Carpet (SDBC) to approach road within complexes. It is contrary to the circular of Chief Engineer (Buildings) and also IRC specifications. The traffic intensity at office complex or building or quarters are very meager as the complex is not opened for through traffic and hence IRC:SP : 20-2002 has to be adopted for design and WBM and premix carpet of 20mm thick should be provided. Cases of providing BM and SDBC for approach roads may be identified and comments included on excess expenditure.

11. MAINTENANCE MANAGEMENT

(Clause 26 under Part 7) of NBC

Maintenance management of building is the art of preserving over a long period what has been constructed. Whereas construction stage lasts for a short period, maintenance continues for comparatively very longer period during the useful life of building. Inadequate or improper maintenance adversely affects the environment in which people work, thus affecting the overall output. In the post construction stage the day to day maintenance or upkeep of the building shall certainly delay the decay of the building structure. Though the building may be designed to be very durable it needs maintenance to keep it in good condition.

Building Maintenance *(Clause 26.3):*

Any building (including its services) when built has certain objectives and during its total economic life, it has to be maintained. Maintenance is a continuos process requiring a close watch and taking immediate remedial action. It is interwoven with good quality of house keeping. It is largely governed by the quality of original construction. The owners, engineers, constructions, occupants and the maintenance agency are all deeply involved in this process and share a responsibility. Situation in which all these agencies merge into one is ideal and most satisfactory.

There are two processes envisaged, that is, the work carried out in anticipation of failure and the work carried out after failure. The former is usually referred to as preventive maintenance and the latter as corrective maintenance. The prime objective of maintenance is to maintain the performance of the building fabric and its services to provide an efficient and acceptable operating environment to its users.

Maintenance in general term can be identified in the following broad categories.

a. Cleaning and servicing – This is largely of preventive type, such as checking the efficacy of rainwater gutters and servicing the mechanical and electrical installations. This covers the house keeping also.
b. Rectification and repairs – This is also called periodical maintenance work undertaken by, say, annual contracts and including external replastering, internal finishing etc.
c. Replacements – This covers major repair or restoration such as re-roofing or re-building defective building parts.

Factors Affecting Maintenance:

a. Technical factors – These include age of building, nature of design, material specifications, past standard of maintenance and cost of postponing maintenance.

b. Policy – A maintenance policy ensures that value for money expended is obtained in addition to protecting both the asset value and the resource value of the buildings concerned and owners.
c. Financial and economics factors
d. Environmental – All buildings are subject to the effects of a variety of external factors such as air, wind precipitation, temperature etc., which influence the frequency and scope of maintenance.
   The fabric of building can be adversely affected as much by the internal environment as by the elements externally. Similar factors of humidity, temperature and pollution should be considered. Industrial buildings can be subject to many different factors subject to processes carried out within. Swimming pool structures are vulnerable to the effects of chlorine used in water.
e. User – The maintenance requirements of buildings and their various parts are directly related to the type and intensity of use they receive.

Maintenance Policy *(Clause 26.3.3)*

The policy should cover such items as the owner's anticipated future requirement for the building taking account of the building's physical performance and its functional suitability. This may lead to decisions regarding:

a. the present use of the building anticipating any likely upgradings and their effect on the life cycles of existing component or engineering services; and
b. a change of use for the building and the effect of any conversion work on the life cycles of existing components or engineering services.

Maintenance Work Programmes *(Clause 26.3.4):*

The programming of maintenance work can affect an owner or his activities in the following ways:

a. maintenance work should be carried out at such times as are likely to minimize any adverse effect on output or function.
b. programme should be planned to obviate as far as possible any abortive work. This may arise if upgrading or conversion work is carried out after maintenance work has been completed or if work such as rewiring is carried out after redecorations.
c. any delay in rectifying a defect should be kept to a minimum only if such delay is likely to affect output or function. The cost of maintenance increases with shortening response times.
d. maintenance work completed or being carried out should comply with all statutory and other legal requirements.

Planning of Maintenance work *(Clause 26.3.6)*

Work should take account the likely maintenance cycle of each building element and be planned logically, with inspections being made at regular intervals. Annual plans should take into account subsequent years programmes to incorporate items and to prevent additional costs. It should be stressed that the design of some buildings can lead to high indirect costs in maintenance contracts and therefore, careful planning can bring financial benefits. Decisions to repair or replace should be taken after due consideration.

Inspections (Clause 26.6):

Regular inspections are actual part of the procedures for the maintenance of buildings. They are needed for a variety of purposes and each purpose requires a different approach if it is to be handled with maximum economy and efficiency. A more detailed inspection covering all parts of a building is needed to determine what work should be included in cyclic and planned maintenance programme.

Frequency of Inspection *(Clause 26.6.2):*

Inspection should be carried out at the following frequencies:

a) Routine – Annual basis
b) General – Annual basis
c) Detailed – The frequency should not normally exceed a 5 year period

Maintenance of Electrical Appliances (*Clause 26.7):*
Planning of Maintenance Work *(Clause 26.7.1):*

If the authorized person has complete knowledge of the electrical appliances to be worked upon, then safety will be more assured. If the person attending to the job is not technically competent to handle the job then more careful planning is required before hand.

As far as the electrical equipments / installations are concerned, it is not possible to lay down precise recommendations for the interval between the maintenance required. The recommendation for frequency of maintenance in this regard from the manufacturer is more relevant. The manufacturer should be requested to specify minimum maintenance frequency under specified conditions. These intervals depend greatly upon the design of the equipment, the duty that it is called on to perform and the environment in which it is situated.

PREVENTION OF CRACKS *(Clause 27):*

Cracks in buildings are of common occurrence. A building component develops cracks whenever stress in the component exceeds its strength. Stress in a building component could be caused by externally applied forces, such as dead, imposed, wind or seismic loads, or foundation settlement or it could be induced internally due to thermal movements, moisture changes, chemical action, etc.

Cracks could be broadly classified as structural or non- structural. Structural cracks are those which are due to incorrect design, faulty construction or overloading and these may endanger the safety of a building. Extensive cracking of an RCC beam is an instance of structural cracking. Non-structural cracks are mostly due to internally induced stresses in building materials and these generally do not directly result in structural weakening. In course of time, however, sometime non-structural cracks may, because of penetration of moisture through cracks or weathering action, result in corrosion of reinforcement and thus may render the structure unsafe. Vertical cracks in a long compound wall due to shrinkage or thermal movement is an instance of non-structural cracking. Non-structural cracks, normally do not endanger the safety of a building, but may look unsightly, or may create an impression of faulty work or may give a feeling of instability. In some situations, cracks may, because of penetration of moisture through them, spoil the internal finish, thus adding to cost of maintenance. It is, therefore, necessary to adopt measures of prevention or minimization of these cracks.

(For complete details on causes and prevention of non-structural cracks, reference shall be made to SP 25 : 1984 'Handbook on causes and prevention of cracks in buildings'.)

Repairs and Seismic Strengthening of Buildings *(Clause 28)*
General Principles and Concepts (*Clause 28.1*):

The buildings affected by earthquake may suffer both non-structural and structural damages. Non – structural repairs may cover the damages to civil and electrical items including the services in the building. Repairs to non-structural components need to be taken up after the structural repairs are carried out. Care should be taken about the connection details of architectural components to the main structural components to ensure their stability.

Non – structural and architectural components get easily affected / dislocated during the earthquake. These repairs involve one or more of the following:

a. Patching up of defects such as cracks and fall of plaster;
b. Repairing doors, windows, replacement of glass panes;
c. Checking and repairing electric conduits/wiring;
d. Checking and repairing gas pipes, water pipes and plumbing services;
e. Re building non structural walls, smoke chimneys, parapet walls, etc;
f. Re-plastering of walls as required;
g. Rearranging disturbed roofing tiles;
h. Relaying cracked flooring at ground level; and
i. Redecoration – white washing, painting, etc.

The architectural repairs as stated above do not restore the original structural strength of structural components in the building and any attempt to carry out only repairs to architectural/non-structural elements neglecting the required structured repairs may have serious implications on the safety of the building. The damage would be more severe in the event of the building being shaken by the similar shock because original energy absorption capacity of the building would have been reduced.

Structural Repairs:

Prior to taking up of the structural repairs and strengthening measures, it is necessary to conduct detailed damage assessment to determine:

a. The structural condition of the building to decide whether a structure is amendable for repair; whether continued occupation is permitted; to decide the structure as a whole or a part require demolition, if considered dangerous;
b. If the structure is considered amendable for repair then detailed damage assessment of the individual structural components (mapping of the crack pattern, distress location; crushed concrete, reinforcement bending/yielding, etc). Non-destructive testing techniques could be employed to determine the residual strength of the members; and
c. To work out the details of temporary supporting arrangement of the distressed members so that they do not undergo further distress due to gravity loads.

After the assessment of the damage of individual structural elements, appropriate repair methods are to be carried out component wise depending upon the extent of damage. The repair may consist of the following:

a. Removal of portions of cracked masonry walls and piers and rebuilding them in richer mortar. Use of non-shrinking mortar will be preferable.
b. Addition of reinforcing mesh on both faces of the cracked wall, holding it to the wall through spikes or bolts and then covering it, suitably, with cement mortar or micro concrete.
c. Injecting cement or epoxy like material which is strong in tension, into the cracks in walls.
d. The cracked reinforced cement elements may be repaired by epoxy grouting and could be strengthened by epoxy or polymer mortar application like shotcreting, jecketting, etc.,

Seismic Strengthening (*Clause 28.1.3):*

The main purpose of the seismic strengthening is to upgrade the seismic resistance of a damaged building while repairing so that it becomes safer under future earthquake occurrences. This work may involve some of the following actions:

a. increasing the lateral strength in one or both directions by increasing column and wall areas or the number of walls and columns.
b. Giving unity to the structure, by providing a proper connection between its resisting elements, in such a way that inertia forces generated by the vibration of the building can be transmitted to the members that have the ability to resist them. Typical important aspects are the connections between roofs or floors and walls, between intersecting walls and between walls and foundations.
c. Eliminating features that are sources of weakness or that produce concentration of stresses in some members. Asymmetrical plan distribution of resisting members, abrupt changes of stiffness from one floor to the other, concentration of large masses and large openings in walls without a proper peripheral reinforcement are examples of defects of this kind.

d. Avoiding the possibility of brittle modes of failure by proper reinforcement and connection of resisting members.

Seismic Retrofitting (*Clause 28.1.4):*

Many existing buildings do not meet the seismic strength requirements of present earthquake codes due to original structural inadequacies and material degradation due to time or alterations carried out during use over the years. Their earthquake resistance can be upgraded to the level of the present day codes by appropriate seismic retrofitting techniques:

Strengthening or Retrofitting Versus Reconstruction (*Clause 28.1.5):*

Replacement of damaged buildings or existing unsafe buildings by reconstruction is, generally, avoided due to a number of reasons, the main ones among them being;

a. higher cost than that of strengthening or retrofitting,
b. preservation of historical architecture, and
c. maintaining functional, social and cultural environment.

Audit Approach.

A comparative study on expenditure incurred on each building may be analysed with reference to Register of Public Buildings and estimates sanctioned in each year to identify.

i) Abnormal increase in maintenance cost vis-à-vis the actual requirements.

ii) Not carrying out periodical maintenance to the building warranting a huge expenditure on carrying out major repairs vis-à-vis the causes for the major repairs.

iii) Necessity and cost for carrying out replacement and major repairs to the newly constructed assets.

iv) Failure of the department to safe guard the assets.

Suitable comments on the above aspects may be drawn and commented.

12. RENT AND LEASE

Leasing Public Building

Public buildings not immediately required for Government use are leased out to commercial or Central Government Department or Private person. Similarly Private building required for Government departments are also taken on lease for Government purpose.

Building may be for residential or non- residential purposes. There is no clear definition in the Tamil Nadu (Lease & Rent) Control Act 1960 for finding out of residential or non-residential purpose. Where the building is used partly for residential and partly for non-residential purpose the predominant purpose would be the deciding factor for such clarification.

Hostels are classified as residential building (Govt.Lr.No.17312 / AG 1 / 71-9 / Home / Dated 11-11-1971)

1. RULES RELATING TO LEASING OF GOVERNMENT BUILDINGS

- As per para 243 of TNPWD Code it is the duty of the Executive Engineer PWD Divisions to get tenants for public buildings not immediately required for Government use.
- Para 275 of TNPWD code stipulates that Chief Engineer (Buildings) is competent to lease the Government buildings to co-operative in public auction the buildings occupied by co-operative canteens / private persons, and the lease rent should be credited to PWD Accounts only. But the concurrence of the occupying Department should be obtained before leasing out.
- The Section Officers and the Assistant Engineer concerned is responsible for the proper collection of rent etc.

(CE's (B) Lr.No. CTO(B) / 113103 / 82-46 / Dt. 15-4-88)

General Principles for Recovery of Rent:

The rent charged for the buildings should not be less than the rent calculated by taking into account 9 percent for residential buildings and 12 percent for non-residential building for interest on the capital cost of the building comprising of :

i) Replacement cost of the building (i.e.) the present value of the building, including sanitary, water supply and electrical installations and fittings in the building plus.

ii) Current value of land

(Para 275 of TNPWD code and G.O.Ms.No. 2160 PWD / DT. 3-11-87 &CE's (Gl) Wks 11/3/67092 / 73-2 / Dt. 15-10-73 and CE's (B) No. CTO / B/69229 / 87 / CR 10 yers / Dated 25-03-1988)

Calculation of Land Value :

The land value is calculated adopting the following principle:

i) The current market value of land obtained direct from the local sub registrar of Registration Department (instead of Revenue Department)

(G.O.Ms.No.1143 PWD / Dt. 7-6-1989)

ii) The maximum extent of land should be restricted to 1 ½ times the built up area or actual extent of the built up area whichever is less.

iii) Where the number of building is more than one in the same compound the available land shall be divided by the number of separate buildings and adopting for calculation, subject to the maximum of 1 ½ times of the built up area.

iv) The value of the site occupied by residential building and vacant space around the building and within the compound wall or barbed wire fencing shall be taken into account for calculation.

v) The extent of land in excess to the maximum limit prescribed can be treated as amenity.

vi) In case of building with more than one floor the built up area of land can be equally divided by number of such floors and the rent arrived at for each floor or proportionate to the floor area occupied.

(CE's (Gl) No. WKS. 11(3) / 67092 / 73-8 / Dt. 15-10-73 & CE's(B) NO.CTO/ B / 220958 / 87 / CR 3 yrs / Dt. 5-12-87)

Capital Cost of a Building

The cost of building is calculated on the basis of the following guidelines:

i) The cost of construction of building shall be the actual cost of construction of the building. If the actual cost of construction is not known the probable cost of construction of a building shall be calculated on the basis of schedule of rate of plinth area, which is reduced by depreciation proportionate to the age and nature of construction of the building in the manner prescribed in G.O.Ms.No. 1370 PWD / Dated / 04-07-1967.

ii) The assessed market value of sanitary, water supply and electrical fittings including their connection etc., or the prescribed maximum percentage limit (i.e. 7 ½ % for each category subject to maximum 22½%) whichever is lower. *(G.O.Ms.No. 2156 Revenue (W) Dept./Dt.7-12-89)*

iii) Cost of Amenities

- The items, which are to be treated as amenities and separately valued for are indicated below.

1. Air Conditioner
2. Lift
3. Water Cooler
4. Electric Heater
5. Refrigerator
6. Mosaic Flooring
7. Compound Walls.
8. Garden

9. Overhead tank for Water Supply
10. Electric pump and Motor for Water supply
11. Playground
12. Badminton and Tennis Courts
13. Sun Breakers
14. Vacant land appurtenant to the building in excess of the maximum limit of one and half times the built up area.
15. Usufructs, if any enjoyed by the tenant
16. Features of Special Architectural Interest

The cost towards amenities should be restricted to 15 percent for Residential building and 25 percent for non-residential buildings.

(Section 4 & Schedule I of the Tamilnadu Buildings (Lease & Rent Control) Act 1960)

.**Percentage for calculation of rent and amenities are tabulated below:**

Description	Rent / Annum	Max % allowable for amenities	Max % Allowable for water supply sanitary & Electrical installation
Residential buildings	9% Gross Return per annum on the total cost of the building and market value of land	15% of the cost of Construction and the market value of land.	Both the residential and non residential building, either the actual value of water supply, sanitary and Electrical installations or the prescribed maximum limit of 22 ½% of the depreciated value of building whichever is less should be adopted.
Non-Residential buildings	12% Gross Return per annum on the total cost of the building and market value of land	25% of the cost of Construction and the market value of land.	

Note:

1. Total cost of building is the depreciated value of building including water supply, sanitary and electrical installation and cost of amenities.
2. Either the actual value or the maximum percentage allowed whichever is less should be adopted for amenities.
3. No depreciation should be allowed for land cost.
4. In special cases where the nature of construction of a building in the opinion of the rent certifying officer requires a higher or lower rates or percentages for fitting than the rates on percentages prescribed in the schedule of plinth area rates, then the rent certifying officer may allow or disallow an amount not exceeding 30% of the cost of construction. This provision should be sparingly and judiciously exercised by the rent certifying officers themselves. The Executive Engineers should however report in detail such cases to Superintending Engineer and obtain prior approval before issuing rent certificates in such cases, as it involves fixing rates higher / lower than the rates prescribed in the schedule of plinth area rates.

(Govt. Lr.No. 41402 / G2 / 87 / Dt.7-9-89)

iv) Depreciation

The Executive Engineer may himself assess the probable age of the building by personally inspecting the building and by enquiring the local people wherever necessary. However in case of dispute, the local body may be consulted, as they will be collecting property tax for the building.

(CE's (B) Wks 11/3/152313/81 /CR 10 Yrs. / Dt. 16-10-1981)

The Depreciation Charges on the Capital Cost of the building is calculated at a standard percentage as detailed below:

No.	Name of building	Rate of Depreciation per annum
a)	Buildings built in mortar in which teak has been used throughout	1 %
b)	Buildings built partly in brick in mortar and partly in brick in mud and in which teak has been used	1 ½ %
c)	Buildings built in brick with mud and in which country wood has been used	2%
d)	Buildings like police lines, which are inferior to those of class C above, with brick in mud, unplastered walls and mud floor and in which cheap country wood has been used.	4%

(G.O. Ms.No.1370 PWD / Dt 4-7-67)

NOTE: (i) The depreciation shall be calculated for each year on the previous net value arrived at after deducing the amount of depreciation of the previous year.

(ii) The amount of depreciation shall in no case be less than 10% of the present estimate cost of the building.

(iii) The rate of depreciation of building with reference to the age of the building from the year of construction is given in Annexure. II.

- To lease out Government Building, public auction should be resorted to under all circumstances, for any purpose.

(G.O.Ms.No. 2160 PWD / Dt. 3-11-1981 & CE's (B) NO.CTO/ B / 213541 / 88 / Dt. 15-11-90)

- Allotment of Government building for various purposes has to be made only on receipt of the orders from Chief Engineer's (Buildings)

(*CE's (B) NO.CTO (B)/ 72110 / 84 / Dt. 19-4-89)*

- No rental valuation statement should be furnished to any authority without the knowledge of the competent authority.
- The buildings should not be leased out without the instructions of the CE/Building

(CE's(B) NO.CTO(B)/113103/ 82-46/Dt. 15-4-88)

- Municipal or Panchayat Taxes if any, should be paid by the occupant, direct to the authorities concerned.

(Para 275 of TNPWD Code)

- Whenever Government buildings are let to private individuals on lease, an agreement in the form prescribed in Appendix XIII of TNPWD Code, should be entered into.

(Para 246 of TNPWD Code)

The Agreement form is general one and does not preclude Superintending Engineers from inserting any special conditions, which may be found desirable in the case of particular building or individuals. Such conditions should be inserted in consultation with the Government Pleader.

(Note I under Para 246 of TNPWD Code)

- To enable the Executive Engineer to terminate the lease, at short notice, in case, the building is required by Government a clause should be added, in the agreement if necessary.
- The lease agreement should be written on a stamped paper and the cost should be borne by the lessee. The agreement need not be registered.

(Para 246 note 3 of TNPWD Code)

- The buildings not immediately required for Government use should generally be let from month to month. But could be leased only with the sanction of the Chief Engineer's (Buildings).

(Para 243 of TNPWD Code)

- The period of lease in respect of Government buildings given for commercial and other purpose at market rates of rent, should be restricted to a period of three years only.

(Note 4 under Para 275 of TNPWD Code)

Revision of Rent:

i) The rent has to be refixed once in three years.

ii) As per Tamil Nadu (Lease & Rent) Control Act 1960, rent has to be fixed at 12 percent or at higher rate of the capital cost of the building depending on the location of the building.

iii) The period of lease after the expiry of three years can be extended without auction, if the lessee agrees for revision of the rent as per the prescribed norms after the expiry of three years.

(G.O.Ms.No. 2160 PWD /Dt.3-11-1987)

Rate of Lease Rent:

The lease rent may be at concessional rate or at market rate that may be allowed by the Government from time to time.

Nominal (Concessional) lease rent may be collected for the Government buildings occupied by the following Associations / Institutions.

i) Service Association.
ii) Recreation Clubs run by Government Servants
iii) Social Welfare Organisation
iv) Canteens run by physically handicapped persons.
v) Kiosks put up by the National Association of Educated Self Employed Youths (NAESEY)
vi) Vakil's Clerks' Association

(G.O.Ms.No. 311 PWD /Dt.16.2.83 & G.O.Ms.No. 1508PWD / Dt. 22-8-79)

Market Rate of lease rent be collected for the Government Buildings Occupied by the following:

i) Co- operative Stores and Societies.

ii) Canteens run for the benefit of Students in College / School buildings.

iii) Other Organisation run on commercial lines

(Para 275(A) of TNPWD Code)

iv) Canteens run by Bar Association.

(G.O.Ms.No. 311 PWD /Dt.16.2.83 & G.O.Ms.No. 1508/ PWD / Dt. 22-8-79)

a) Canteen in Government Offices Complex:

- As a part of welfare measure for the Government employees, the capital cost of buildings restricting the actual land cost to 50% of depreciated value of buildings towards land cost or the actual cost of land whichever is less and cost of amenities, if any provided with 1/3rd remission allowed further on the lease rent so arrived at. The above method should be adopted only for arriving at the minimum of the rent to be fixed for the canteen provided for Government servants. The actual leasing out should be based on auction. For other commercial purpose, it has to be examined on a case to case basis.

  (G.O.Ms.No. 2192 PWD /Dt.15-10-1990)

- The order issued in G.O.Ms.No. 2192 PWD / Dt. 15-10-90 for fixation of lease rent for canteen purpose in Government Office Complexes shall apply to the canteen buildings in the premises of Government Industrial Training Institutes also.

  (G.O.(2D) No.24 Labour And Employment Dept./ Dt. 5-3-92)

- The newly constructed canteen building in Director of Medical Services campus may be leased out to Government Officials Co-Operative Canteen on rent-free basis besides free supply of water and electricity.

  (G.O.Ms.No. 1075 PWD /Dt.12-06-1991)

b) Collection of Rent for Cyclone Shelters:

- Cyclone Shelter constructed with the assistance of Indian Red Cross Society are declared as Government property and will be included in the Register of Public buildings for the purpose of maintenance and collection of rent, when the buildings are let out to private parties. Rent will not be collected for use of these Cyclone Shelters by the Indian Red Cross Society for charitable activities.

  (G.O.Ms.No. 1678 PWD /Dt.23-08-1982)

c) Lease of Cycle Stands in Government Office / Hospital Compounds:

- The field officials are requested to take appropriate action for the lease of cycle stands in all the Government Offices / Medical Colleges / Hospitals compound under their jurisdiction through public auction. Necessary proposals for the fixation of rent for cycle sheds should be submitted to the Chief Engineer (Buildings). The rent fixed shall be the minimum bid amount for the auction.

  (CE's(B) NO.CTO/(B)/219749/ 83-2 /Dt. 13-12-1987)
- Sending proposals for fixation of Nominal / Market rate of rent:

  Necessary proposals for fixation of nominal rent / market rent for all Government Buildings to be leased out to Service Association, Social Service Organization, Canteens Co-operative Stores / Societies etc., should be submitted to Chief Engineer (Buildings) with the particulars in the prescribed proforma. There is no need to workout the rent and it is enough if the particulars detailed in the proforma are furnished in a complete shape.

  (CE's (B) Wks 11/3/73892/80 / Dt. 17-04-1980)

2. RENT FOR RESIDENCE OF GOVERNMENT OFFICIALS:

House Rent Recovery (with effect from 01-04-1998)

In respect of employees in posts, below the revised pay scales of Rs.3050-4590, no rent recovery shall be made there to for occupying quarters provided by Government or its agencies. For others the revised rent recovery shall be as indicated below:

Class of Cities

Pay Range	Grade I(a) & I(b)	Grade II	Grade III	Other Places
	(In Percentage)			
3200-5464	1.5	1.5	1.0	1.0
5465 – 9999	3.0	3.0	3.0	2.0
10000 & above	4.0	4.0	4.0	3.0

(G.O.Ms.No. 162 Finance(P.C) /Dt. 13-4-98)

- HRA is not payable to Government Servants occupying Housing Board Quarters.

  (G.O.Ms.No. 656 Finance(P.C) /Dt. 6-8-86)

Recovery of rent from transferred Government Officials

In case of extension granted by the Government for the occupying the PWD quarters beyond the date of retirement or transfer etc. penal rent may be collected. The penal rent is one and half times the rent last paid. Rent last paid is the normal rent plus H.R.A. In case of continued occupation of the quarters, without proper authority after retirement of transfer etc. penal rent may be collected at three times rent last paid.

It is applicable to all Government Quarters borne on the Register of PWD.

(G.O.Ms.No. 831 PWD /Dt.19-05-1988)

Recovery of rent from the family of deceased Govt. Servants:

The family of deceased Government servants can retain the quarters for a period of three months from the date of death of the Government servant or the end of the academic year whichever is later, at the normal rate of rent.

(G.O.Ms.No. 967 PWD /Dt.20-06-1975)

Recovery of rent from retired Government Servants:

Retired Government Servants are allowed to retain the quarters for a period of three months from the date of their superannuation on payment of normal rate of rent.

(Govt. Ms. No. 931/ PWD / H2 / Dated 18-6-93)

Over stayal with permission :		1 ½ times of normal rate of rent upto the period of permission
Beyond that period	:	3 times the normal rate of rent

(G.O. Ms. No.831 PWD / Dt. 19-5-88 and Govt. PWD Clarification No. 112 / 1568 / Dt. 9-11-93)

3. RENT FOR GOVERNMENT TRAVELLERS' BUNGALOWS

Inspection Bungalows, Circuit Houses and Travellers' Bungalows herein after be called "Government Travelers' Bungalows".

(G.O.Ms.No. 2888 PWD /Dt.23-12-1983)

i) All Government Travellers' Bungalows shall be grouped into categories viz.ClassI & Class II. Class I Bungalows are air-conditioned bungalows and those among non-air conditioned bungalows that have the following amenities.
   a) First class construction with RCC Roof or Mangalore tiles roof over flat tiles.
   b) Rooms of size not less than 13.38 M^2 each.
   c) Cot with mattresses, bedspreads and mosquito nets.
   d) Running Water Supply
   e) Electric lights and fans
   f) Modern sanitary facilities.

   Others will be grouped as Class II

(ii) The rent for stay of 12 hours and above but less than 24 hours shall be as follows:

	On Official Duty		
	Air – Conditioned	Non – Air Conditioned	
		Class I	Class II
Single Person	Rs. 10.00	Rs. 4.00	Rs. 2.00
For every addl. Members	Rs. 5.00	Rs. 3.00	Rs. 1.00

a) For stay of less than 12 hours, half the rate shall be charged.

b) If the air conditioner is out of order or if there is power failure for over two hours, rent for air-conditioned accommodation shall be collected at the rate of Class I non air-conditioned.

- The above rates shall be applicable to all Tamil Nadu State Government Servants/ Employees of Tamil Nadu Government undertakings in the Public Sector, Members of Legislature, Members of Parliament and State Government servants of Gujarat and Rajasthan. Others shall be charged at double the above rates.
- Hon. Ministers of Government of India, Hon. Ministers of all State Governments Chairman and Deputy Chairman of the Tamil Nadu Legislative Council, Speaker and Deputy Speakers of the Tamil Nadu Legislative Assembly and high personages declared by Government as State Guests shall be exempted from payment of rent.
- The above provisions shall be applicable to all Government Travellers' Bungalows by whatever name called (Including circuit houses) except those under the control of Forests and Fisheries Department, for which separate orders are applicable.
  (Section 'F' of appendix VI of TNPWD Code amended in G.O.Ms.No. 2888 PWD /Dt. 23-12-83 and in Govt. Lr.No. 41579 / Y2 / 90-2 / Dt. 2-5-90)
- The rent collected is creditable to the Head of Account 8782 PW I Cash Remittance to the credit of Executive Engineer PWD Division AC AA 0003.

4. RENTING OF PRIVATE LANDS AND BUILDINGS FOR PUBLIC PURPOSES.

The following general principles is to be observed by the authorities while renting private land and buildings for office, residential or other public purpose, subject to the following condions:

- Avoid rental accommodation in building constructed without permission from competent authority.
- Avoid rental accommodation if suitable Govt building is available.
- Heads of Departments are permitted to lease buildings to the extent of their powers up to a period of 3 years.

(Para 242A of TNPWD code and item 44 under Appendix 5 of T.N. Financial Code Vol.II)

- Whenever private buildings are taken on lease for Government purpose an agreement in the form prescribed should be entered into and it should be got registered where the term exceeds one year.
  (Govt. PWD Lr.No. 90796 / 113/82-1/Dt. 10-12-82)
- The Chief Engineers, Superintending Engineer and Executive Engineers have powers to execute lease agreements stipulating the terms and condition of lease for houses, lands or other immovable properties provided the rent shall not exceed Rs. 5,000/ a month if the lease period is less than 3 years and by Government if the lease period more than 3years.

(*Appendix III-6 of TNPWD code)*

- Government has to give approval when a private building is taken on lease for more than 3 years at the first instance itself.
  - *(Govt. Lr. No. 48629/ H1 / Dated 18-6-86*

- The authorities competent to rent private building may sanction an amount not exceeding a month's rent by way of advance rent for the building, if such advance rent is stipulated by the land lord under the provision to section 7(1) (a) of Tamil Nadu Building lease and Rent Control Act 1960. On termination of the tenancy, the amount of advance rent shall be returned or adjusted by the owner of the building

- Certificates regarding non – availability of Government Buildings and reasonableness of rent should be obtained from the Executive Engineer, PWD concerned upto a period not exceeding three years at a time. In all the cases of renting of private buildings for Government Offices of various departments in Chennai, Madurai, Coimbatore, Trichy and Salem when carpet area of the building to be taken on lease exceeds 1000 sq.ft. the Superintending Engineer, PWD concerned, will issue the certificate regarding the reasonableness of rent. The certificate regarding the non-availability of Government Building will, however be issued by the Executive Engineer, PWD concerned.

  (Para 242(A) of TNPWD code & Govt. Lr.No.41402/G2 /Dt.7-9-89)

- The monthly rent for the private buildings owned by the State Government Employees and taken on lease / rent for Government purpose (Official / Residential) be fixed by the state PWD, Executive Engineer and checked and verified by the Superintending Engineer concerned.

  (G.O.Ms.No. 889 PWD /Dt.4-4-1986)

- Two month rent recommended by the PWD authorities be collected as centage charges for issue of reasonable rent certificates.

  (G.O.Ms.No. 182 PWD (G2) /Dt.16-5-2003)

The Centage charge for issuing reasonableness of rent certificate to Grant in aid Educational Institutions occupying private buildings is regulated as follows:

i) Buildings situated within 8 Kms from the head quarters (including inspection of site)	10% of the monthly rent, minimum of Rs.1000/- (Rupees thousand only)
ii) Buildings situated beyond 8 Kms from the head quarters (including inspection of site)	10% of the monthly rent, subject to a minimum of Rs.1000/- thousand only) TA involved should be collected in addition to the fees.
iii) Renewal of the above certificate (including inspection of site)	10% of the monthly rent, subject to a minimum of Rs.1000/-

(G.O.Ms.No. 182 PWD (G2) /Dt.16-5-2003)

(iv) No Centage charges shall be levied for the issue of Certificate to private buildings occupied by ESI dispensaries.

(Note 7 under Para 73 of TNPWD code and Govt. L and E Dept. Lr.No. 21911/K2 / 90-11/ Dt. 26-4-91)

(v)The reasonableness of rent certificate from PWD need not be insisted upon whenever the State Government takes the warehouses of Tamil Nadu Warehousing Corporation Limited, on lease, so long as economic rent is charged. The rent for the warehouse is fixed as per the numbers of bags stored.

(G.O.Ms.No. 30 PWD /Dt.4-1-80 & Govt. PWD Lr. No. 44948 / 81-1 / Dt. 10-8-81)

(vi) Rent certificate from the PWD shall not be insisted upon, when premises owned by the Tamil Nadu Housing Board, Tamil Nadu Slum Clearance Board and Tamil Nadu Tourism Development Corporation are taken on rent by Government Departments, so long as economic rent is charged.

(vii) Municipal Engineers in the rank of Executive Engineers can issue certificates for schools, offices, Hospitals located in Private Buildings. In case there is no Municipal Engineer for a municipality, the Regional Engineers can issue certificates.

(G.O.Ms.No. 334 Municipal Administration and Water Supply Dept. Dt. 11.10.84)

(viii) The Head of office that submits proposals for renting of private buildings for the sanction of Government or by the competent authority as the case may be, should the furnish information in the proforma received from the PWD and the certificate.

(Para 242(A)(f) of TNPWD Code)

(ix) The PWD authorities can approve provisional rent based on capital cost of the buildings till the final rent is approved as per TN Buildings lease and Rent control act,

(G.O.Ms.No. 1958 PWD /Dt.20-09-1984)

(x) The responsibility for payment of final rent for the private buildings taken on rent for Government purpose vest with the authority sanctioning the provisional rent.

(xi) All initial rent sanctioning authorities may accord renewal of sanction for the payment of rent without the certificate of reasonableness of rent and non-availability of Government buildings from the PWD authorities, if there is no reduction in the space requirement and if there is no enhancement of rent.

(Para 242(A) (G) of TNPWD Code)

(xii) If the rent paid to the private parties by the Government officers for the buildings occupied by the Government offices exceeds Rs. 1,20,000 per annum, Income Tax at 20% on the rent paid by them shall be deducted as per the provisions of a new section 1941 of Income Tax act & remit the same in the Treasury on the same day. *(Govt. Fin. No.68676 /BG II /94 /Dt.29-7-1994)*

Financial Powers to Sanction Rent for Private Buildings

Office	Monetary limit to sanction rents
Secretaries to Government	Rs. 15,000/- Per Month.
Heads of Departments	Rs. 12,500/- Per Month.

The above monetary limit to sanction rent is subject to the plinth area norms with reference to staff strength and reasonableness of rent being satisfied with the following further conditions.

i) The monetary limit shall be further enhanced by 5% per annum for a period of 5 years and it shall be reviewed thereafter.
ii) In respect of fixing of new rent for old building the increase of rent should not be more than 5 percent on existing rent. For example if the reasonable new rent fixed by PWD for an old building is Rs.9000/- per month, and the existing rent for the same building is Rs.7000/- per month then that increase should not be more than Rs.350/- per month and rent will be Rs.7350/- per month.
iii) In respect of fixing of rent for new buildings, the rent details of the Government office situated in the nearby areas should be collected and the average rent shall be arrived. Based on this average rent so arrived, the rent shall be fixed if it is within 5% increase over average rent arrived. (e.g) If rent fixed by PWD for a new building is Rs.12000/- and on enquiry from other Government offices situated in the nearby area if the Head of Department arrives the average rent of the same is Rs.10000/- then the rent may be sanctioned within 5% of the average rent, i.e. is up to Rs.10500/- per month.
iv) The rent may be revised or enhanced once in three years after obtaining certificate of reasonable rent from the Public Works Department. This revision of rent may be effected from the date of expiry of the three-year period even if the reasonable rent certificate was obtained at a later date.
v) The proposal of revision of rent should be sent to the Public Works Department 60 days prior to the expiry of the three-year time limit. The Public Works Department should also give the certificate of reasonable rent before 60 days.

(G.O.Ms.No.329 Finance ((Sal) dated: 30.8.2001, Government letter No.134 D.S.(PG) Finance (Salaries) dated 28.1.2002 and G.O. Ms. No.1352 PW(H!) Dated: 17.9.1993)

Enhancement of rent is not admissible except in the following circumstances.

i) Where additions, alteration or improvements to the building has been carried out.

ii) When the local body has imposed a new tax or increased the taxes on the building on the ground other than increase in the rate for the building.

iii) In both of above two circumstances, the amount of increase in rent should be equal to the rent for additions, alterations, improvements, new tax or less or additional tax as the case may be.

(CE's (B) No.Wks 11/3/67092/73-8 / Dt. 15-10-1973)

Revision of Rent

i) The rent has to be prefixed once in three years based on the capital cost as per section 4(3) of Tamil Nadu (Lease & Rent) control act 1960.

ii) All public sector undertaking owned by Government should also observe the principal for renting private building for their office accommodation. *(G.O.Ms.No. 753 PWD / Dt. 7-4-84.)*

iii) The revision of rent can be made from the date of expiry of 3 years.

iv) The guidelines issued in G.O.Ms.No. 753 PWD / Dt. 7-4-84 for leasing private buildings for use of Government will apply through out the State and will not apply in respect of building taken under Tamil Nadu (Lease and Rent) Control Act 1973.

(G.O.Ms.No.2043 PWD /Dt.15-10-1987)

v) Guidelines issued in the G.O.Ms.No. 753 PWD / Dt. 7-4-84 , G.O.Ms.No. 2043 PWD / Dt. 15-10-87 and Govt. Lr.No. 52518 / H3 / 87-2 / Dt. 15-3-88 for fixation of rent for private buildings taken on lease to house Government officer be made applicable to the private buildings taken on rent for residential purposes also.
Rent for private buildings taken on lease by Government for residential purposes be fixed at 9% on the total cost of the building as per the guidelines in the Tamil Nadu Buildings (Lease and Rent Control) Act as amended in 1973.

(GO Ms No 311 PW (H1) Dept dt:27.4.95)

vi) In respect of fixing of new rent for old building the increase of rent should not be more than 5 percent on existing rent.

vii) In respect of fixing of rent for new buildings, the rent details of other Government offices situated in the nearby areas should be collected and the average rent rate shall be arrived. Based on the average rate arrived, the rent shall be fixed if it is within 5 percent increase over average rent arrived.

(G.O.Ms.No.329 Fin (Sal.) Dept. dt.30.08.2001)

viii) The powers towards sanction of rent may be exercised after following the usual procedure with reference to staff strength and reasonable rent being satisfied and they are not given powers to increase the rent by 5% per annum automatically.

(G.O.Ms.No. 329 Fin. (Sal.) 2001 / Dt. 30-8-2001)

Reasonableness of Rent

(i) The Executive Engineer may himself assess the probable age of the building by personally inspecting the building , enquiring the local people and decide the probable age of the building for the purpose of fixing the reasonableness of rent. However in case of dispute, the local body may be consulted, as they will be collecting property tax for the building.

(CE's (B) No.Wks 11(3)/152313/81-CR 10 Yrs./ Dt. 16-10-1981)

(ii) The Executive Engineer will issue the certificate in cases where he is competent to issue the certificate or forward the proposals with his report to the Superintending Engineer who is competent to issue the certificate.

(iii). The certificate of non-availability of Govt. Building has to be issued only by Executive Engineer, PWD.

(iv) The rent certifying officers will be personally responsible for the reasonableness of the rent certified by them and for the correctness of all working sheets and plans prepared in this connection.

(CE's (B) No.Wks 11(3)/67092/73-8./ Dt. 15-10-1973)

(v) Orders of Government are not necessary for shifting a Government Office functioning in a private Building to another building, if the area occupied is within the yardstick of space for occupation and is within the reasonableness of Rent Certificate issued by PWD.

(vi) Where the Executive Engineer could not issue the certificate within 30 days from the date of receipt of full details the Superintending Engineer shall withdraw the file from the Division and issue the certificate direct to the occupying department.

(Govt. PWD Lr.No. 169 / Dt. 20-1-89)

(vii) Deciding authority to sanction rent for more than one office located in one building the total rent for the entire building should be taken into consideration for the purpose of deciding the authority to sanction rent.

(Govt. PWD Lr.No.40882/G2/88-2/ Dt. 26-4-89)

Maintenance of Register of Reasonableness of Rent Certificate Issued:

A 'Register of Rent Certificate Issued' may be maintained in Division Offices and Chennai, Madurai, Coimbatore – Nilgiris, Trichy and Salem Circle Offices with full details about the certificates issued by the concerned office, indicating the date of receipt of requisition, date of issue, plinth area of the building, location (i.e) address, rate of rent certificate etc. This register

should be available for inspection in Division offices by Superintending Engineer and in Circle Offices by Chief Engineers.
(CE's (B) No.Wks 11(3)/67092/73-8./ Dt. 15-10-1973 & Govt. PWD Lr.No.410402/G2/87/ Dt. 7-9-89)

6. LEASE OF PWD LANDS (Para 172 of TNPW D Code):

Lands incharge of the PWD are of two kinds:

a) Lands acquired by the PWD for the construction of buildings but not immediately used for the purpose and
b) Lands incharge of PWD for administrative purposes, e.g., lands in berms of canals, drains, channels etc. and at wharf.

(Para 172(I) of TNPWDCode)

A Register of lands must be maintained by both the Sub-Divisional Officers and Divisional Officers (In the PWD form P.W.1.5) Detailed Survey of the above said lands should be done and all the particulars such as dimension, areas, boundaries of land should be clearly noted there in. All lands should be demarcated wherever it has not been done by the Section Officers and Sub Divisional Officers in consultation with Revenue Officials.

The Section Officers and Sub Divisional Officers should make periodical inspection of all vacant lands in charge in proper time so as to prevent encroachments thereof.

(C.E's (GL) No.AC (1) / 122427/78-1/ Dt. 7-8-78)

The procedure prescribed in Board's standing orders should be adopted for grants of lands for temporary occupation for agricultural and non-agricultural purpose. Grants for such occupation may be made in favour of individuals, private bodies, companies or associations and local bodies. The following items are enumerated as Non-Agricultural purpose and agricultural purpose.

(i) Items for Non- Agricultural Purpose:

a) Recreation purpose with or without a pavilion or club house.
b) Bridges and culverts whether permanent or temporary
c) Bunks (for trade purposes)
d) Timber and fire wood depots.
e) Laying pipe lines
f) Unobjectionable sub-soil encroachments on road margins and other Government Porambokes
g) Temporary occupation for performances by touring cinema, circus or dramatic company

ii) Items for Agricultural Purposes:

a) Growing of grass or other fodder.
b) Raising Flower gardens
c) Planting casuarinas
d) Cultivation on plantation products.
e) Cultivation of paddy, pulses and other food grains or commercial crops like tobacco, cashew, groundnut etc.

(Para 172(iv) of TNPWD code)

- The land belongs to the Public Works Department should be leased out on Public auction. The period of lease for the land leased out to private persons shall be three years.

(G.O.Ms.No. 2160 PWD / Dt.03-11-1987)

- The proposals for leasing out-of lands belonging to other departments (i.e other than Revenue Department) to private institutions should be routed through the Revenue Department at all levels, not only at the Government level but at the taluk level, Revenue Divisional Officers, level, Collectors' level and Commissioner of land Administration's level. *(G.O.Ms.No. 221/ Revenue Department / Dt.20-02-1985)*

- The period for which temporary occupation of the lands in charge of the PWD may be sanctioned must be determined carefully in each case, with reference to the nature of the property and the consideration whether and when the property is likely to be required by Government, for any other purpose. *(Para 172(IV) of TNPWD code)*
- No lease should be granted without the orders of the competent authority.
- The delegation of powers for grant o lease for a period upto 5 years is given below:

Value of property in Rs.	Authorities
a) Exceeding One Lakh	Government
b) Exceeding 50,000 and upto One Lakh	Chief Engineer
c) Exceeding 10,000 and upto 50,000	Superintending Engineer
d) 10,000 and less	Executive Engineer

(Para 172(vii) of TNPWD Code)

- The orders of lease of land need not be registered vide Section 90 (i) (d) of the Indian Registration Act. The orders embodying such grants are also not liable to stamp duty – vide item 4 of Notification No.13 / Dt. 17th December 1938.

The period of notice for revocation of lease granted by the authority shall normally be.

Period of Grant	Period of Notice
Upto 3 Months	One Months
Upto 6 Months	Two Months
Upto One Year	Three Months
Longer Period	Six Months

- Renewal of grants can be sanctioned only by the authority competent to sanction the grant in the first instance

. *(Para 172(X) of TNPWD Code)*

- The occupying department should not be allowed to grant any lease and the Section Officer concerned will be responsible for such grant.

(CE's (B) Lr.No. CTO(B) / 113103 / 82-46 / Dt. 15-4-88)

- Government has issued orders banning transfer or lease of water course poramboke lands.

(*G.O.Ms.No. 41/ Revenue Department / Dt.20-01-1987)*

- Collectors are empowered to permit the Government Departments local bodes, Quasi-Government and autonomous bodies to install their pumping structure in Government proamboke lands.

(G.O.Ms.No. 2042/ Revenue Department / Dt.28-10-1988)

- In regard to the disposal of Government lands the Special Commissioner and Commissioner for Land Administration should be consulted and final orders on the disposed of Government Poramboke lands should be issued by the Revenue Department only.

(G.O.Ms.No. 800/ Revenue Department / Dt.21-06-1987)

The determination of charges is left to the discretion of the authorities, who are competent to sanction the grant.

In the case of clubs consisting entirely of C&D Group officers and playground required for educational institutions, nominal charges may be levied.

(Para 172 of TNPWD Code.)

(Note: Nominal rent which should not be less than the ground rent leviable on the land.)

(CE's (B) Lr.No. CTO(B) / 72110 / 84 -1/ Dt. 19-4-84)

- The full competitive rent should be levied as the charge for occupation for trade purpose.Competitive rent means the rent which the site would fetch in the open market, if offered subject to the condition stipulated by the Government.

- A reasonable fixed daily charge should be levied in accordance with rates to be prescribed by the Collector for Touring Cinema, Circuses, Dramatic Companies.

- The annual charge should be fixed at an amount not lower than the assessment of ground rent leviable on the land subject to a minimum of Rs.1/- for Occupation of Land for un-remunerative public or private purposes.

(Para 172(ix) of TNPWD D Code)

- The rent should be levied as per the orders issued by Government form time to time for rent for physically Handicapped and for NAESEY.

(CE's (B) Lr.No. CTO(B) / 72110 / 84 -1/ Dt. 19-4-84)

- The Superintending Engineers are requested to instruct the Executive Engineer to allot space to put up kiosks of the size (8'0" x 5'0") in the Government Officers / Medical institution Compounds etc., to the National Association of Educated Self Employed Youth, (NASSEY) Madras, subject to the condition stipulated in G.O.Ms.No. 1957 H&FW Dept./ Dt. 7-9-77 provided if allotment of space is not objected to by the occupying department concerned.

  (CE's (B) Memo. No.Wks 11(1)/54895/77-11 / Dt. 26-10-1977)

- A nominal rate of Rs.5/- per month will be collected from the lessee running the NAESEY kiosks in addition to the land rent collected

  (Govt Lr. No. 29763 / T2 / 82-5 / Health and Family Welfare / Dated 16-07-1984).

- In order to avoid problem and to restrict the number of bunks / stall etc., in all compound, it has been decided not to allow any bunk / stall / canteen inside any Government compound if there are shops / hotels available near the Government compound. It there is no shop / hotel available near the Government compounds, then one or two at the maximum in each category viz Betalnut shop, Tea shop and canteen can be allowed to function in a compound.

  (CE's(B) Lr.No. CTO(B) / 72110 / 84 -1/ Dt. 19-4-84)

Track Rent for under ground pipe line

According to RSO 24A, non-agricultural purpose lands can be given for temporary occupation to private persons / private company for laying pipe line subject to the condition prescribed by CE (I) Memo No.LDIS / 165566 / 84 / Dated 9-8-1960. Levy of track rent as per Para 9(D) of this order will not be applicable to State Government Departments.

(No.2639 / DI / 88-1 / Dt.24-4-88 of Secretary Rev. Dept.)

Track rent is levied at the prescribed rate given below for various locations.

Sl. No.	Location	Per Kilo Meter Rs.	Per Meter Rs.	Minimum Rate Rs.
1	Panchayat	200	0.20	25
2	Town Panchayat & Third floor	300	0.30	50
3	Second Grade Municipality and above	500	0.50	100
4	Madurai, Coimbatore, Tricy, Salem, Erode, Tirunelveli	2000	2.00	200
5	Chennai	3000	3.00	300

Note: This track rent is exempted for conveying water for Agricultural purpose. *(G.O.Ms.No. 202/ Revenue Dept. / Dt.24-04-2000)*

AUDIT APPROACHES

1. As per Para 261 of TNPWD Code, the departmental officers are required to maintain Register of Public Buildings (RPB) and update the register in the event of additions or alterations. The RPB should be scrutinized to ensure that all the assets or accounted in the Register. Cases of non inclusion of Public Buildings in the Register and occupation of these buildings by other agencies should be available. This could be examined with reference to periodical inspection report of EE / SE on Public buildings and RPB. Such cases of un authorized of occupation of the building and non recovery of lease rent may be examined and commented.

2. The lease rent file should be examined to ensure that the lease rent was calculated correctly taking into account the capital cost, amenities, land cost etc. The deviation if any leading to loss of revenue may be analysed and commented.

3. As per orders of Government in G.O.Ms.No. 753 PWD Dt 7.11.1984 and G.O.Ms.No.2160 PWD Dt: 3.11.1987 the lease rent has to be revised once in three years on the basis of current market value. The cases of non-revision of lease rent and consequential loss of revenue may be analysed and commented.

4. As per Para 246 of TNPWD Code, the department should execute lease agreement stipulating the terms and conditions of lease. Failure to execute the lease agreement would lead to disputes, which ultimately would result in non-revision of lease amount involving loss of revenue. Such cases may also be analysed and commented.

5. Para 245 of TNPWD Code, Rent should be recovered from the Commercial Departments and from the departments for Central Governments for the State Government buildings occupied by them wholly or partly for non residential purposes at the rate of 12% of capital cost. Cases of non-compliance of codal provisions in regularization of rent may be analyzed and commented.

13. IMPORTANT ORDERS OF GOVERNMENT AND CHIEF ENGINEERS

1. Fixation of norms on the various items of expenditure on the functions being attended by the VVIPs in various places in Tamil Nadu – Revised – Orders – issued.

Key:(G.O.Ms.No.1766 PUBLIC (SPECIAL B) DEPARTMENT Dated 23.12.2004)

The revised norms prescribed on various items of expenditure on the functions being attended to by the VVIPs in various places in Tamil Nadu shall be followed strictly. Since, the helipads have already been provided in most of the district at logistic places, no norms have been fixed for the expenditure on putting up of helipads. If any additional helipad is required necessary for the visit of VVIPs at particular place in the District, they may be arranged after obtaining necessary orders of the Collector of the District concerned and the actual expenditure may be got sanctioned by the Government. The revised norms for the expenditure incurred on various items of expenditure in connection with the visit of VVIP to attend the functions held on or after the 1.4.2003 is as follows.

Sl. No	Name of the Work	Revised Norms	
		Description	Expenditure (in Rupees)
1	Levelling	Leveling the function site by using Dozers (Area to be restricted to the barest minimum)	Rs. 50,000/-
2	Stage	40’ X 25’ (12.2 x 7.63 m). Hire charges for providing main dais which includes steps, photo stand, entertainment stage, ceiling decoration, floral arrangements with thermocol letters, provision of vinyl flooring and coir mat.	Rs.2,50,000/-

3	Pandal and Barricading **Barricading** 1.Barricading at function site 2. Off-site barricading	400' x 200' size pandal at function site. Provision of Thattu Pandal, hipped roof pandal, celling decoration Barricading arrangements at function site / off-site area etc., and spreading the sand in the function site.	(i) Rs.12,50,000/- for Pandal to accommodate 16,000 persons (ii) Rs.9.30,000/- for Pandal to accommodate 12000 persons (iii)Rs.6,25,000/- for Pandal to accommodate 8000 persons Rs.1,50,000/- for barricading arrangements.
4	Chairs		Rs.12,000/- per thousand chairs subject to a maximum of Rs.2,00,000/-
5	Electricity Arrangements: 1.Illumination 2.Public Address System 3.Security lighting and other lighting arrangements 4.CCTV at function site 5.AC arrangements	Hire charges for providing AC arrangements, illumination at function site, security lighting, Public Address System, CCTV and EB charges for temporary 3 phase connection, current consumption charges etc.,	Rs.5,00,000/-

2.Guidelines for incurring expenditure in connection with the visit of Chief Minister within the State of Tamil Nadu on Official Business.

Key:(G.O.Ms.No.1623 Public(Political B)Department Dated the 6.10.1987)

The following guidelines are to be observed for incurring expenditure in connection with the visit of Chief Minister within the State on official business.

(i) If the Chief Minster is the Chief Guest in a function for a scheme or programme sponsored by a department, the orders for sanction of expenditure for that function or programme will issue from that department after following the usual procedure. This will also be the case where more than one scheme or programme is involved, but a particular department is clearly identifiable as the sponsor of the function or having a larger role in the function.

(ii) If the Chief Minister is the Chief Guest in a function or a programme where schemes or different departments are involved and no particular department can be identified as the major department concerned with the function or programme, the orders sanctioning the expenditure will be issued by the Revenue Department after following the usual procedure.

(iii) The Department sanctioning the expenditure may also simultaneously sanction an advance to the Collector, if necessary.

(iv) If an autonomous body is also involved in the function, the cost apportionable to that body should be excluded while sending the estimates. That autonomous body may be requested to pay directly its share to the contractors or suppliers.

3.Standardization of doors and windows sizes for Residential building

Key:(Letter No. HDO (A) / 20119 / 2006, dated 13.6.2006 of the CE (B))

Indian Building Congress had communicated the decision of the Expert Committee on standardization of doors and windows sites for residential buildings. On examination by the Chief Architect the standard sizes of shutters for doors and the sill level for the different windows are to be furnished to the field officers for adoption while evolving drawings for residential buildings.

With regard to the window shutters it should be ensured that the shutter width shall be of uniform / in multiples of the size of shutter adopted for one window to the another window, so that the projection of sunshades can be decided accordingly.

TABLE – I

SHUTTER SIZES OF DOOR

Sl.No.	Location	Shutter Size (in mm)
1	Entrance Door (1)	1100 X 2045
2	Entrance Door (2)	100 X 2045
3	Room Door (1)	900 X 2045
4	Room Door (2)	800 X 2045
5	Kitchen and Store	800 X 2045
6	Toilet	650 X 2045

Note:

1. Masonry opening sizes shall be decided according to the sizes of frames to be used.
2. Doors and windows shutters along with frames shall be fabricated off site.
3. Main entrance for frame shall have double rebates for fixing two sets of shutters, viz., normal door shutter and grilled shutter with wire mesh.
4. The lintel level for all doors shall be at 2100 mm above finished floor level.
5. The materials to be used are left to the choice of the designers. Shutters and frames for doors shall be made of wood of any other suitable alternative materials as prescribed in the specification for the items.

TABLE – II

OPENING SIZES OF WINDOW

Sl.No.	Description	Location	Sill Height	Masonry Opening Size
1	Window (1)	Habitable Room	750	1800 X 1350
2	Window (2)	Habitable Room	900	1800 X 1200
3	Window (3)	Habitable Room	750	1500 X 1350
4	Window (4)	Habitable Room	900	1500 X 1200
5	Window (5)	Habitable Room	750	1200 X 1350
6	Window (6)	Habitable Room	900	1200 X 1200
7	Window (7)	Habitable Room	750	900 X 1350
8	Window (8)	Habitable Room	900	900 X 1200
9	Window (9)	Habitable Room	750	600 X 1350
10	Window (10)	Habitable Room	900	600 X 1200
11	Window (11)	Habitable Room	750	450 X 1350
12	Window (12)	Habitable Room	900	450 X 1200
13	Window (13)	Kitchen	1050	900 X 1050
14	Window (14)	Toilet	1050	600 X 1050
15	Window (15)	Toilet	1050	450 X 1050

Notes:

1. Sill level for windows for habitable rooms shall be at height of 750 mm or 900 mm from the finished floor level.
2. Sill level for kitchen and toilet windows shall be at 1050mm level.
3. All windows frames shall have double rebates for fixing two sets of shutters i.e. glass and wire mesh.
4. Shutters and frames for windows shall be made of wood or any alternative suitable material as prescribed in the specification for the items.

4 Entrustment of maintenance and repair works on nomination basis

Key: (G.O Ms.No. 42 PUBLIC WORKS (G2) DEPARTMENT Dated 23.02.2007)

The Government ordered for entrustment of the following building works on nomination basis upto Rs.3.00 lakhs (Rupees There lakhs only) on estimate rates only for carrying out urgent repair and maintenance works.

(i) High Court, Chennai
(ii) Ezhilagam, Chennai
(iii) Secretariat, Chennai
(iv) VVIP's Residence
(v) MLA Hostel
(vi) Raj Bhavan, Chennai and Ooty
(vii) Hospitals

The Government direct that the above works are to be entrusted to reputed contractors / construction societies at the departmental rates only following all other existing codal procedures and that no excess percentage will be allowed for the works undertaken on nomination basis.

ANNEXURE I

Unit Weights Of Building Materials. (IS: 875 (Part I – 1987)

Sl. No.	Material	Nominal size or thickness mm	Weight	
			Kg	Per
1	Aggregate, Coarse (broken stone ballast)			
	Dry, well-shaken		1600 to 1870	M^3
	Perfectly wet		1920 to 2240	M^3
	Shingles, 3mm to 38mm		1460	M^3
2	Aggregate coarse (broken brick)			
	Fine		1450	M^3
	Coarse		1010	M^3
3	Aggregate, fine (Sand)			
	Dry, clean		1540 to 1600	M^3
	River		1840	M^3
	Wet		1760 to 2000	M^3
4	Bricks (Masonry)			
	Common burnt clay bricks (IS : 1077-1987)		1600 to 1920	M^3
	Engineering bricks		2160	M^3
	Pressed bricks		1760 to 1842	M^3
	Glazed brick		208	M^3
5	Cement			
	Ordinary and Aluminous		1440	M^3
	Rapid hardening		1280	M^3
6	Cement Concrete plain :			
	With sand and crushed natural stone aggregate		2240 to 2400	M^3
7	Cement concrete reinforced with sand and gravel or crushed natural stone aggregate :			
	With 1 per cent steel		2310 to 2470	M^3
	With 2 per cent steel		2370 to 2530	M^3
	With 5 per cent steel		2530 to 2720	M^3
8	Cement concrete prestressed : (conforming IS : 1343-1960)		2400	M^3
9	Cement mortar		2080	M^3
10	Cement plaster		2080	M^3
11	Masonry stone :			
	Cast		2300	M^3
	Dry rubble		2080	M^3
	Granite ashlar		2640	M^3
	Granite rubble		2400	M^3
	Lime stone ashlar		2560	M^3
	Marble dressed		2700	M^3
	Sand stone		2240	M^3
	Live load; For live load refer Part VI Structural Design section 1, Loads.			

ANNEXURE II

Rates of Depreciation of Buildings

No of yrs.	Amount of Depreciation at				No. of Yrs.	Amount of Depreciation at			
	1%	1 ½%	2%	4%		1%	1 ½%	2%	4%
1	.01000	.01500	.02060	.04000	31	.26770	.37407	.46542	.71790
2	.01990	.02978	.03988	.07840	32	.27502	.38345	.47612	.72918
3	.02970	.04440	.05863	.11526	33	.28227	.36271	.48659	.74001
4	.03940	.05866	.07703	.15065	34	.28945	.40182	.49686	.75041
5	.04901	.07278	.09608	.18463	35	.29655	.41079	.50692	.76040
6	.05852	.08669	.11416	.21724	36	.30359	.41963	.51679	.76998
7	.06793	.10039	.13187	.24855	37	.31055	.42834	.52645	.77918
8	.07725	.11389	.14914	.27861	38	.31745	.43691	.53592	.78801
9	.08648	.12718	.16625	.30747	39	.32427	.44536	.54520	.79649
10	.09562	.14027	.18293	.33517	40	.33103	.45368	.55430	.80463
11	.10466	.15317	.19927	.36176	41	.33772	.46187	.56321	.81245
12	.11361	.16587	.21528	.38729	42	.34434	.46995	.57195	.81995
13	.12248	.17838	.23098	.41160	43	.35090	.47790	.58051	.82715
14	.13125	.19070	.24636	.43533	44	.35739	.48573	.58890	.83407
15	.13994	.20285	.26143	.45791	45	.36381	.49344	.59712	.84070
16	.14854	.21480	.27620	.47960	46	.37018	.50104	.60518	.84708
17	.15706	.22658	.29068	.50041	47	.37647	.50852	.61308	.85312
18	.16549	.23818	.30486	.52040	48	.38271	.51590	.62081	.85607
19	.17389	.24961	.31877	.53958	49	.38888	.52316	.62840	.86470
20	.18209	.26086	.33239	.55800	50	.39499	.53031	.63583	.87011
21	.19027	.27195	.34574	.57568	51	.40104	.53736	.64311	.87531
22	.19837	.28287	.35833	.59265	52	.40703	.54430	.65025	.88030
23	.20639	.29363	.37165	.60895	53	.41296	.55113	.65725	.88509
24	.21432	.30422	.38422	.62459	54	.41883	.55787	.66410	.88968
25	.22218	.31466	.39653	.63960	55	.42464	.56450	.67282	.89410
26	.22996	.32494	.40860	.65402	56	.43040	.57103	.67740	.89833
27	.23766	.33507	.42043	.66786	57	.43609	.57746	.68385	.90240
28	.24528	.34504	.43202	.68114	58	.44173	.58380	.69018	.90630
29	.25283	.35487	.44338	.69390	59	.44732	.59005	.69637	.91005
30	.26030	.36454	.45451	.70614	60	.45284	.59619	.70245	.91365

Formula for arriving depreciated value of building

For a building aged 'n' years, the depreciated value 'p' is to be worked out as follows: $P = \frac{A\,(100-r)^n}{100}$

Where

P	=	Depreciated value of the building at the end of 'n; years.
A	=	The original value of the building if known or the value arrived at current rate for a building of the same accommodation
r	=	The rate of depreciation per annum.
n	=	The number of years (age of building)

The amount of depreciation will be equal to (A-P) subject to a minimum of 10% of A.

(G.O.Ms.No. 1370 PWD /Dt.4-7-67)& Schedule 1 of Tamil Nadu Buildings (Lease & Rent Control) Act 1960

ANNEXURE III
Rental Valuation Procedure – Model Statement

Buildings:

i) Plinth area in respect of the different individual types of buildings in the premises should be worked out

Ground Floor --
First Floor --
Second Floor --

ii) Other items such as cup-board, staircase, portico, balcony, cemented platform, well,water bound macadam road, and bituminous road inside the campus etc., should be worked out.

iii) Water Supply, Sanitary and Electrical installations should be worked out as per actual.

iv) Cost for all these items should be worked out as per appropriate rates.

Land:

i. Total land area of the premises (A) and Built Up area (a) should be worked out. 1 ½ times built up area (a x 1 ½ = B) should be allowed for land area for rent purposes – extra land area available (A-B=C) should be brought under amenities.

ii. Cost as per information obtained from local Sub – Registrar should be worked out.

iii. If the total extent of land available in a building compound is less than the maximum limit prescribed above, then the land value should be restricted to the actual extent of land available.

Amenities

(Cost at appropriate rates for all the items should be worked out)

i. -----

ii. -----

iii. -----

Abstract:

i. Value of Building		Rs. 'A'
ii. Value of Other items		Rs. 'B'
	Total	Rs. 'C'
Depreciation at	(-)	Rs. 'D'
Depreciation value of Building		Rs. 'E'

iii. Water supply, Sanitary and Electrical Installation:

a) As per actual		Rs.
(i) ----------		'a'
(ii) ----------		'b'
(iii) ----------		'c'
(iv) ----------		'd'
	Total	'e'
Depreciation at	(-)	'f'
Depreciated value		'g'
b) 22 ½ of 'E"	'y'	
Less of the two (g,y) +		Rs.
	Total	Rs. 'F'
iv. Total value of land (+)		Rs. 'G"
Depreciated value of building +		
Land value		Rs. 'H'

v. Amenities

(i) -----		'a'
(ii) -----		'b'
(iii) -----		'c'
	Total	----
		'd'
Depreciation at (%)		'e'
Depreciated value		'f'
Cost of Surplus land		'g'
	Total	'h'

25% of 'H' if it is not residential building

(or)

15% of 'H' if it is residential building 'J'

Add lesser of the two

(h or j) (+) Rs.

Total Rs. 'J'

---

vi. Annual Rent	Residential Building	Non- Residential Building
	$\frac{j \times 9}{100}$	$\frac{j \times 12}{100}$
vii. Monthly Rent	$\frac{j \times 9}{100 \times 12}$	$\frac{j \times 12}{100 \times 12}$

ANNEXURE IV

Recommended Values of Illumination as per BIS: 3646(Part II) Office, Schools and Public Buildings

Sl. No.	Industrial Buildings and processes	Illumination Lux
1	Airport Buildings	
	a) Reception areas (desks)	300
	b) Customs and immigration halls	300
	c) Circulation areas, lounges	150
2.	Assembly and Concert	
	a) Foyers, auditoria	100 to 150
	b) Platforms	450
	c) Corridors	70
	d) Stairs	100
3	Banks	
	a) Counters, typing, accounting book areas	300
	b) Public areas	150
4.	Cinemas	
	a) Foyers	150
	b) Auditoria	50
	c) Corridors	70
	d) Stairs	100
5.	Libraries	
	a) Shelves (stacks)	70 to 150
	b) Reading rooms (newspapers and magazines)	150 to 300
	c) Reading tables	300 to 700
	d) Book repair and binding	300 to 700
	e) Cataloguing, sorting, stock rooms	150 to 300
6.	Museums and Art Galleries	
	a) Museums:	
	i) General	150
	ii) Displays	Special lighting
	b) Art Galleries	
	i) General	100
	ii) Paintings	200
7.	Office	
	a) Entrance halls and reception areas.	150
	b) Conference rooms, Executive offices	300
	c) General offices	300
	d) Business machine operation	450

	e) Drawing offices:			
	i)	General		300
	ii)	Boards and tracing		450
	f) Corridors and lift cars			70
	g) Stairs			100
	h) Lift landing			150
	i)	Telephone exchange		
		i) Manual Exchange rooms (on desk)		200
		ii) Main distribution frame room		150
	Schools and colleges			
	a)	Assembly halls		
		i)	General	150
		ii)	When used for examination	300
	b)	Class and lecture rooms		
		i)	Desks	300
		ii)	Chalk boards	200 to 300
		iii)	Platforms	300
	c)	Embroidery and sewing rooms		700
	d)	Art rooms		450
	e)	Laboratories		300
	f)	Libraries:		
		i)	Shelves, stacks	70 to 150
		ii)	Reading tables	300
	g)	Manual training		See appropriate trades
	h) Offices			300
	i) Staff rooms, common rooms			150
	j) Corridors			70
	k) Stairs			100
9.	Theatres			
	a) Foyers			150
	b) Auditoria			70
	c) Corridors			70
	d) Stairs			100
10.	Dental Surgeries			
	a) Waiting rooms			150
	b) Surgeries:			
		i)	General	300
		ii)	Chairs	Special Lighting
	c) Laboratories:			300
11.	Doctor's Surgeries			
	a) Waiting rooms, consulting rooms			150
	b) Corridors			70
	c) Stairs			100

	d) Sight testing (acuity) wall charts and near Vision types			450
12.	Hospitals			
	a) Reception and waiting rooms			150
	b) Wards:			
		i)	General	100
		ii)	Beds	150
	c) Operating theatres:			
		i)	General	100
		ii)	Tables	Special lighting
	d) Laboratories			300
	e) Radiology departments			100
	f) Casualty and outpatient department			150
	g) Stairs, Corridors			100
	h) Dispensaries			300
13.	Hotels			
	a) Entrance halls			150
	b) Reception and accounts			300
	c) Dining rooms (tables)			100
	d) Lounges			150
	e) Bedrooms:			
		i)	General	100
		ii)	Dressing tables, bed heads etc.	200
	f) Writing rooms (Tables)			300
	g) Corridors			70
	h) Stairs			100
	i) Laundries			200
	j) Kitchens			*200
	k) Goods and passenger lifts			70
	l) Cloakrooms and toilets			*100
	m) Bathrooms			*100
14.	Restaurants			
	a) Dining rooms:			
		i)	Tables	100
		ii)	Cash desks	300
	b) Self-carrying counters			300
	c) Kitchens			*200
	d) Cloakrooms and toilets			*100
15.	Shops and stores			
	a) General areas			+150 to 300
	b) Stock rooms			200
16.	Homes			
	a) Kitchens			200
	b) Bathrooms			++100
	c) Stairs			100

	d) Workshops	200
	e) Garages	70
	f) Sewing and darning	700
	g) Reading (casual)	150
	h) Home work and sustained reading	300

* Supplementary local lighting should be provided over kitchen equipment and at mirrors.

+ Supplementary local lighting should be used as required for counters and display areas.

++ Supplementary local lighting should be provided at mirrors.

ANNEXURE - V

Expected Useful Life of Various Electrical Equipments/Installations

S.No.	Description	Life in years
A	**Wiring of Electrical Installation**	
1.	Conduit wiring non-coastal area	20
2.	Conduit wiring coastal area	15
3.	Casing and capping wiring	15
4.	PVC wiring on batten	15
B.	**Fans**	
1.	Ceiling fan A.C.	20
2.	Exhaust fan A.C	6
3.	Table fan A.C.	8
4.	Pedestal / Air circulator	8
C.	**External Electrical Lines**	
1.	Temporary overhead lines on wooden poles	8
2.	Permanent overhead lines on steel/RCC poles	20
3.	Underground cable lines	20
D.	**Poles & Feeder Pillars**	
1.	MS pole non-coastal area	15
2.	MS pole coastal area	8
3.	Hot dipped galvanized pole non-coastal area	25
4.	Hot dipped galvanized pole coastal area	12
5.	Feeder pillar in non-coastal area	15
6.	Feeder pillar in coastal area	8
E	**Electrical Fittings**	
1.	Bracket fittings	5
2.	Fluorescent fitting	10
3.	Street light fitting	10
F.	**Sub-station equipment**	
1.	Switchgear heavy duty LT/HT	20

2.	Transformer 11KV/0.4 KV	25
G.	**Lifts**	
1.	Electric Lift	20
H.	**Electrical Motors & Pumps**	
1.	Electric Motor single phase	8
2.	Electric Motor three phase	15
3.	Electric pumps medium (1500RPM) AC	10
4.	Engine pump small up to 10.H.P. (Diesel)	10
5.	Engine pump big above 10 H.P. (Diesel)	12
6.	Diesel Generator up to 50 KW	12
7.	Diesel Generator above 50 KW	15
I.	**Refrigerators, Coolers and Air-Conditioners**	
1.	Refrigerators	8
2.	Cold storage plant with air-cooled condensing unit	8
3.	Cold storage plant with water cooled condensing unit	12
4.	Desert coolers (1500-2000 cfm) evaporative type water coolers	5
5.	Water coolers	7
6.	Room coolers	5
7.	Window type/split type Air-conditioning unit	7
8.	Packaged type air-conditioning unit with water Cooled condensers (on single shifts basis)	10
9.	Packaged type air-conditioning unit with air Cooled condensers (on single shifts basis)	8
10.	DX type central air-conditioning plant with water Cooled condensers (on single shift basis)	15
11.	Central chilled water system of air conditioning Plant with water cooled condensers (on single shifts basis)	15
12.	Evaporative type air-cooling plant above 25000 cfm (on single shifts basis)	15
13.	Evaporative type air-cooling plant above 25000 cfm (on single shifts basis)	15

	Mechanical Machinery	
a)	Asphalt Plant	
1.	Hot mix Asphalt plant (up to 10 TPH)	5
2.	Hot mix Asphalt plant (10 to 30 TPH)	7
3.	Hot mix Asphalt plant (30/45 TPH)	8
4.	Tar/Bitumen heater 1000 – 1500 Lit capacity	8
5.	Cold Asphalt mixer 30 Cft	5
6.	Asphalt power finishers	5
b)	Compaction Equipment	
1.	Hand roller ½ ton	20
2.	Diesel steel wheel roller 8/10 tons capacity	18
3.	Vibratory tandem roller 4 tons	15
4.	Sheep foot roller single/double drum	15
c)	Concrete Plants	
1.	Concrete mixer 3/5 cft capacity	7
2.	Concrete mixer 0.28/0.20 and 0.39/0.28 cu.m. Capacity	8
3.	Electrical Vibrator capacity 5 H.P	5
4.	Vibrator engine driven/immersion/screed board	
5.	Type above 2HP – 5 HP	5
d)	Earth Moving Machinery	
1.	Dozer	12
2.	Earth Rammer	6
3.	Front end loader 75 B.H.P	15
4.	Front end loader 45 B.H.P	10
5.	Motor grader 68-80 B.H.P	12
6.	Electrical driven portable swivel loader	15
e)	Miscellaneous	
1.	Air compressor 100-210	5
2.	Mobile crane – 1 ton capacity	20
3.	Grass mover 1, mid/rear mounted	10
4.	Centrifugal pump, up to 10 HP	8
5.	Trailer mounted centrifugal pump, engine driven above 10 HP – 50 HP	10
6.	Spray painting equipment complete	10
7.	Welding transformer	5
8.	Pneumatic rock drill	3
9.	Pneumatic pavement breaker	3
10.	Generating setup to 50 KW with trolley	10

11.	Insulating oil dehydration plant up to 500Lit	15
12.	Core cutting machine	5
13.	Water tank 910lit. Capacity trolley mounted	8
f)	Transport	
1.	Tipper/truck	7
2.	Tipper/truck	7
3.	Tractor 60-80 BHP	10
4.	Jeep	7
5.	Four wheel trailer	7

Note:

These are general guidelines. Proposal for replacement will be based on actual hours of operation / conditions of use and inspection by the concerned authority. Based on adverse working condition, it may be necessary to replace instillations earlier. Similarly replacement can be postponed if the existing condition is found to be satisfactory based on detailed inspection done. But it is necessary to keep close watch, when useful life is going to be over.

ANNEXURE - VI

DELEGATION OF POWERS

Sl. No.	Description	Power of Officer P.W.D.				Authority
		CE	SE	EE	AEE	
A.	**Administrative Approval (Buildings)**					
1.	a.) Works required for PWD (other than Residential Building and Electrical Works)	200000	50000	20000	_	Paras 416a, 417Aa, 428a of TNPWD Code, G.O.Ms.No.1819 PW Dt.01.09.1984
	b.) Residential Buildings	20000	50000	2500	_	
2.	Contribution works	80000	30000	15000	2000	Para 415a (iii), 417A (b), 428 of TN PWD Code. G.O.Ms.No.1819 PWD Dated.01.09.84
3.	For the purchase of Tools and Plants within the limit of budget allotment.	Full powers	25000	15000	2000	Para – 415 of TNPWD Code G.O.Ms.No.1819 PW / Dated 01.09.1984
4.	Purchase of office furniture	10000	5000	2500		Para 415 (VI) a 423 (11) of TNPWD Code. Read with G.O.Ms.No.1819 PW / Dated 01.09.1984

B.	**Technical Sanction**					
1.	Detailed estimates for work (Original)	Full powers	1 Crore	30 Lakhs	Rs.10000/- (except residential building and Electrical work)	G.O.Ms.No.140 PW (G2) Dept. Dt. 23.03.2000 Paras 415, 417, 428, 436 of D Code.
	Note : 1. For deposit works and for works which the government says "not exceeding" while according Administrative Sanction 10% over the Administrative sanction cannot be operated. 2. All structural design and foundation design for all framed structure should however be got approved through Superintending Engineer (Planning & Design)					
2.	Detailed estimates for Building Works (repairs)	---	With in limit of Budget allotment	Rs.50000 within the limit of Budget allotment	Rs.10000 (Except residential Buildings & Electrical Works). Subject to budget allocation	Paras 418(a), 429 a(1) 436 of TNPWD Code.
3.	To accord administrative approval to estimate for purchase or manufacture of Tools & Plants (not including live stock or office furniture) each estimate			25000		Para 432 (a) (i) of TNPWD Code.
4.	To sanctioning regular repairs of special Tools & Plant other than running or working expenses – each estimate		10000	5000		Para 432 (a) (i) of TNPWD Code, G.O.1819 PW dt.01.09.1984.
5.	Maintenance of ordinary Tools & Plant per year subject to the limit of appropriation allotted to Division.			5000 per annum		Para 432 (a) (i) of TNPWD Code G.O.Ms.No.1819 PW Dt.01.09.1984

6.	Ordinary maintenance of special Tools & Plant like Lorry Power roller etc. per year each plant.			60000		G.O.Ms.No.1819 PW Dt. 01.09.1984
7.	To sanction detailed estimate for the purchase and manufacture of Ordinary Tools & Plant.		500000	100000		Para 418 (a) Para 429 A
8.	Photographic charges: With in the limit of budget provision.		Full powers			Para III 421 of TNPWD Code.
9.	Stores. To accord administrative approval to estimate for purchase of Tools & Plant for store.		25000			Para V 423 (a) (i) of TNPWD Code.
10.	Working Estimates: Working estimate for a work.	Full powers	1 Crore	30 Lakhs		416, 417 e 428 A (b) of TNPWD Code.
11.	Excess over Estimates: To pass excess over any sanctioned estimate on all works, including Electrical works.	5%	5%	5%		G.O.ms.no.2844 PWD Dt.01.12.1986 Para 415 C 417 (d), 428 (c) of TNPWD code.
12.	To pass excess expenditure upto the limit noted in all works, irrespective of the amounts of the sanctioned estimate.	5000	1500	750		G.O.Ms.No.2844 PWD Dt.01.12.1986 Para 415 C 417 (d), 428 (i) of TNPWD Code.

13.	Utilization of Savings. a. Any anticipated or actual savings on a sanctioned estimate for a definite work should not, without special authority, be applied to carryout additional work not contemplated in the original project or fairly contingent on its actual execution. b. Savings due to abandonment of substantial section of any project sanctioned by any authority are not to be considered as available for work on other sanction, without the further sanction of that authority. Para 182 of TNPWD Code c. Approving of Working estimate utilising savings – Special rules for irrigation works. Para 398 of TNPWD Code					
14.	Diversion of Provision: a) To divert provision from contingencies to new works or repairs which are not provided for in the estimate.		Full powers	5000		Para 417 (f) & 428 (e) of TNPWD Code.
15.	Alteration: Alteration in the construction details is during execution without affecting administrative side of the work.	--	Upto the limit of his powers to deal finally with excess over estimate	Upto the limit of his powers to deal finally with excess over estimate.		Para 417 (e) & 428 (d) of TNPWD Code.
	Note : If such alteration affect the administrative side of the work they should be effected only after consulting the administrative department concerned.					G.O.Ms.No.294 PWD Dt.24.02.1975
16.	Re-appropriation of funds from one major work to another in the same head of account.	40000	15000	5000		Part 415 II, 7424 (i) 4331 (i) of TNPWD Code as amended in G.O.Ms.No. 2844 PWD Dt. 01.12.1986.
17.	Sale and Dismantlement of Building: (Approval of survey report) To sanction of sale and dismantlement of Govt., Buildings in charge of PWD. (Book Value)	10,00,000	5,00,000	1,00,000	---	Para 235 of D Code G.O.Ms.No.165 PWD(G2) Dt. 22-05-2008

18.	Selling the Government property of material for use on a work on account of its charitable or philanthropic nature or in connection with any special calamity such as that due to an out break of fire, floods and earthquake.		3000			Para 331 (b) of TNPWD Code.

C.	**Tender**					
1.	**Contract Calling for Tenders**		Full Powers			G.O.Ms.No.740 PWD Dt.17.04.1982
				10 Lakhs		G.O.Ms.No.490 Fin (Sal) Dt. 11.09.1998
					50000	G.O.No.140 PW (G2) Dept, Dt.23.03.2000 G.O.No.309 PW (G2) Dept, Dt.21.06.2000
2.	**Acceptance of Tenders**					
	a.) Excess upto 10% over technically sanctioned estimate	30 Lakhs	10 Lakhs			G.O.Ms.No.490 Fin (Sal) Dt.11.09.1998
	b.) Excess upto 5% over technically sanctioned estimate	1 Crore	30 Lakhs	10 Lakhs		G.O.Ms.No.140 PW (G2) Dept, Dt. 23.03.2000
	c.) Without any excess over the sanctioned estimate rates.				50000	G.O.Ms.No.309 PW (G2) Dept., Dt.21.06.2000
	d.) Tenders for works costing more Rs.1.00 Crore If Value put to tender exceeds 1 crore and for all other works with any excess beyond the powers delegated to the above officers the tender should be referred to the Tender Award Committee through the Chief Engineer concerned. (G.O.Ms.No. 555 PW (G2) Dept., Dt. 17.11.99 & EIC, WRO & CE (GI) PWD No.HDO (A) / 65964 / 99-1, Dt.02.12.1999					

3.	**Ceiling Rates:** The Chief Engineer are empowered to fix ceiling rates exceeding 5% over the sanctioned estimate rates in respect of entrustment of works to contractors.	Above 5%	Upto 5%	--	--	Para 415 V (b) & 422 (b) of TNPWD Code.
4.	**Acceptance of Sealed Quotations.** a.) acceptance of sealed quotation upto Rs.200000	Within 10% Excess over sanctioned estimate	Within 5% Excess over sanctioned estimate	--	--	Govt. PWD., No.53245 / G2 / 77-2, Dt. 04.07.77 and G.O.Ms.No. 2307 PWD Dt.26.11.87.
	b.) For Fisheries works upto Rs.500000	Within 10% Excess over sanctioned estimate	Within 5% Excess over sanctioned estimate	---	---	G.O.Ms.No.1221 Forest and Fisheries Dept., Dt. 07.09.82, 702 PWD Dt. 20.05.76 and 2307 PWD Dt. 26.11.87.
	Note : i. Calling of quotations should be resorted to only when there is no response to at least 2 (two) tender calls and the approval of the next higher authority is to be obtained for award of works based on quotations. ii. Full amount of security should be obtained from selected contractors before agreement is concluded. iii. Rules prescribed for giving due publicity to the tenders and minimum time for submission of tenders are strictly to be observed.					
5.	Entrustment of Additional work of Original contractor Additional Item / Additional Quantity Percentage over value of contract	25% or Rs.10 Lakhs	10% or Rs.2.5 Lakhs	10% or Rs.0.30 Lakhs		G.O.Ms.No.555 PW (G2) Dept., Dt.17.11.99
		Whichever is less				
	Note. The 'Excess' involved due to additional items and additional quantities shall be interpreted as gross excess. *(G.O.Ms.No.433 PWD Dt. 13.03.92)*					
6.	Powers of Sanction of Extension of Time. The orders and decision of such Executive Engineer with regard to the extension of time for completing will be subject to the ratification of Superintending Engineer for all the work for which tenders were accepted by Superintending Engineer / Chief Engineer / Board of Engineer and Government. (Clause 53.1 of GI. Conditions to Contract of TNBP as amended in Govt. Order No.2049 PWD Dt.26.09.90)					

D.	**MISCELLANEOUS**					
1.	Write Off a.) To write off the irrecoverable* value of stores or public money lost by fraud or the negligence of individuals or other causes unprofitable outlay on works and loss of revenue in each case (The total amount written of should not exceed Rs.1 lakh in a year)	15000	3000	800	---	Para 415 VI (a) 423 (d), 482 b (v) of TNPWD Code App.21 of MFC Vol.II G.O.Ms.No.1819 PW Dt.01.09.84 G.O.Ms.No. 2844 PW Dt.01.01.86
	* The expression of "Value of Stores" means the "Book value" if Satisfactory priced accounts are maintained and otherwise "Replacement Value"					
	b.) To write of losses of immovable property in each case.	10,000				Para 415 VI (a) 423 (d), 482 b (v) of TNPWD Code App.21 of MFC Vol.II G.O.Ms.No.1819 PW Dt.01.09.84 G.O.Ms.No. 2844 PW Dt.01.01.86
	c.) To adjust loss of manufacture in each case		1500			Para 415 VIII, Para 423 (f) of TNPWD Code. G.O.Ms.No.2844 PW Dt.01.12.86 Para 423 (b) (i) of TNPWD Code
	d.) To sanction estimate for losses due to depreciation of stock		10000			

2.	Demurrage and Wharfage Charges : To sanction demurrage and wharfage charges at a time incases where such charges cannot be recovered from the person responsible. All sanctions accorded under this rule should be communicated to the Accountant General.	300	---	50	---	Para 415 VI b 432 b V of TNPWD Code G.O.Ms.No.2844 PW Dt.01.12.86
3.	Law Suits To accord sanction to institute and defence of original suits and appeals in each case.	3000	----	---	----	G.O.Ms.No.2844 PWD Dt.01.12.86 Para 416 of TNPWD Code App. 14 (10) of TNFC Vol.II & Para 486 of TNPWA Code.
4.	Renting of Private Lands and Buildings for Public Purpose. a.) Powers of sanction of rent for office purpose (Rent to be paid under contingencies)	*12500	EE's Office 1000 AEE's Office 375 AE / JE's Office 150	AEE's Office 250 AE / JE's Office 75	---	Para 240 A of TNPWD Code Para 44 II (a) appendix 5 of TNFC Code Vol.III G.O.Ms.No.1819 PW Dt.01.09.84
	b.) Public purposes other than office or residential accommodation. (Rent to be charged to works)	10000	1000	250	---	
	* G.O.Ms.No.329 Fin (Sal) Dept. Dt.30.08.2001 Govt. in Fin. Dept. No.66187 / Salaries / 2001-3, Dated.16.11.2001. Clarification also issued on G.O.Ms.No.329 Fin (Sal) Dept Dt.30.08.2001 vide Govt. in Finance Dept. No.134 / DS (PG) finance (Sal) 2001, Dt.28.01.2002.					

GLOSSARY

1. Automatic Fire Detection and Alarm System - Fire alarm system comprising components for automatically detecting a fire, initiating an alarm of fire and initiating other actions as appropriate.

2. Automatic Sprinkler System.-A system of water pipes fitted with sprinkler heads at suitable intervals and heights and designed to actuate automatically, control and extinguish a fire by the discharge of water.

3.Building-Any structure for whatsoever purpose and of whatsoever materials constructed and every part thereof whether used as human habitation or not and includes foundation, plinth, walls, floors, roofs, chimneys, plumbing and building services, fixed platforms, VERANDAH , balcony, cornice or projection, part of a building ort anything affixed thereto or any wall enclosing or intended to enclose any land or space and signs and outdoor display structures. Tents, shamianahs, tarpaulin shelters, etc, erected for temporary and ceremonial occasions with the permission of the Authority shall not be considered as building.

4. Height of Building -The vertical distance measured in the case of flat roofs, from the average level of the ground around and contiguous to the building or as decided by the Authority to the terrace of the last livable floor of the building adjacent to the external wall; and in the case of pitched roofs, up to the point where the external surface of the outer wall intersects the finished surface of the sloping roof; and in the case of gables facing the road, the mid-point between the caves level and the ridge. Architectural features serving no other function except that of decoration shall be excluded for the purpose of measuring heights.

5.Combustible Material -The material which either burns itself or adds heat to a fire.

6. Covered Area - Ground area covered by the building immediately above the plinth level. The area covered by the following in the open spaces is excluded from covered area.

a. garden, rockery, well and well structures, plant nursery, waterpool, swimming pool (if uncovered), platform round a tree, tank, fountain, bench, chabutara with open top and unenclosed on sides by walls and the like;
b. drainage culvert, conduit, catch-pit, gully pit, chamber, gutter and the like;
c. compound wall, gate, unstoreyed porch and portico, slide, swing, uncovered staircases, ramp areas covered by chhajja and the like; and
d. watchman's booth, pumphouse, garbage shaft, electric cabin or sub-stations, and such other utility structures meant for the services of the building under consideration.

Note- For the purpose of this Part, covered area equals the plot area minus the area due for open spaces in the plot.

7. Fire Exit – A way out leading to an escape route having panic bar hardware provided on the door.

8. Fire resistance- Fire resistance is a property of an element of building construction and is the measure of its ability to satisfy for a stated period some or all of the following criteria;

a. resistance to collapse,
b. resistance to penetration of flame and hot gases, and
c. resistance to temperature rise on the unexposed face up to a maximum of 180 C and /or average temperature of 150 C.

9. Floor Area Ratio (FAR) - The quotient obtained by dividing the total covered area (plinth area) on all floors by the area of the plot;

$$FAR = \frac{\text{Total covered area of all floors}}{\text{Plot area}}$$

10. High Rise Building – For the purpose of this Part, all buildings 15 m or above in height shall be considered as high rise buildings.

11. Plinth Area - The built-up covered area measured at the floor level of the basement or of any storey.

12. Circuit Breaker - A mechanical switching device capable of making, carrying and braking current under normal circuit condition and also of making, carrying for a specified time, and breaking currents under specified abnormal circuit condition such as those of short circuit.

13. Direct Earthing system - A system of earthing in which the installation are so earthed as specified but are not connected within the installation to the neutral conductor of the supply system or to earth through the trip coil.

14. Fuse -A device that, by the fusion of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted when the current through it exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device.

15. Switch Disconnectors – A device used to open (or close) a circuit when either negligible current is interrupted (or established) or when the significant change in the voltage across the terminals of each of the pole of the disconnector provided an isolating distance between the terminals of each pole.

16. Switchgear - A general term covering switch devices and their combination with associated control, measuring, protective and regulating equipment also assemblies of such devise and equipment with associated interconnections, accessories enclosures and supporting structure intended in enclosure and supporting structure intended in principle for use in connection with generation, transmission, distribution and conversion of electric energy.

17. Voltage

Voltage, Extra low (ELV) – The voltage which does not normally exceed 50V.
Voltage, Low (LV) – The Voltage which normally exceeds 50V but does not normally exceed 250 V.
Voltage, Medium (MV) – The voltage which normally exceeds 250v but does not exceed 650V.
Voltage, High (HT, HV) – The Voltage which normally exceeds 650V but less than or equal to 33 kv.
Voltage, Extra High (EHT) – The Voltage, which normally exceeds 33kv.

18. Factor of Safety (with Respect to Bearing Capacity) –

A factor by which the ultimate bearing capacity (net) must be reduced to arrive at the value of safe bearing capacity (net).

19. Footing – A spread constructed in brick work, masonry or concrete under the base of a wall or column for the purpose of distributing the load over a larger area.

20. Foundation, Raft – A subtractive supporting an arrangement of columns or walls in a row or rows transmitting the loads to the soil by means of a continuous slab, with or without depressions or openings.

21. Make-up Ground – Refuse, excavated soil or rock deposited for the purpose of fillings a depression or raising a site above the natural surface level of the ground.

22. Offset – The projection of the lower step from the vertical face of the upper step.

23. Permanent Load – Loads which remain on the structure for a period, or a number of periods, long enough to cause time dependent deformation / settlement of the soil.

24. Shallow Foundation – a foundation whose width is generally equal to or greater than its depth.

Note: These cover such types of foundation in which load transference is primarily through shear resistance of the bearing strata (the frictional resistance of soil above bearing strata is not taken into consideration) and are laid normally to depth of 3m.

25. Spread Foundation – A foundation which transmits the load to the ground through one or more footings.

26. Column, Pier and Buttress –

a) Column – An isolated vertical load being member, width of which does not exceed four times the thickness.
b) Pier – A thickened section forming integral part of a wall placed at intervals along the wall, to increase the stiffness of the wall or to carry a vertical concentrated load. Thickness of a pier is the overall thickness including the thickness of the wall or, when bonded into a leaf of a cavity wall, the thickness obtained by treating that leaf as an independent wall (see Fig.1) .
c) Buttress – A pier of masonry built as an integral part of wall and projecting from either or both surfaces, decreasing in cross-sectional area from base to top.

27. Cross-Sectional Area of Masonry Unit – Net cross – sectional area of a masonry unit shall be taken as the gross cross – sectional area minus the area of cellular space. Gross cross-sectional area of cored units shall be determined to the outside of the coring the cross-sectional are of grooves shall not be deducted from the gross cross-sectional area to obtain the net cross-sectional area.

28. Curtain Wall – A non-load bearing wall subject to lateral loads. It may be laterally supported by vertical or horizontal structural members where necessary (see Fig.2).

29. Effective Height – The length of a wall or column, to be considered for calculating slenderness ratio.

30. Effective Length – The length of a wall to be considered for calculating slenderness ratio.

31. Effective Thickness – The thickness of a wall or column to be considered for calculating slenderness ratio.

32. Hollow Unit – A masonry unit of which net cross-sectional area in any plane parallel to the bearing surface is less than 75 percent of its gross cross-sectional area measured in the same plane.

33. Grout – Mortar of pourable consistency.

34. Joint – A junction of masonry units.
a) Bed joint – A horizontal mortar joint upon which masonry units are laid.
b) Cross Joint – A vertical joint, normal to the face of the wall.
c) Wall joint – A vertical joint parallel to the face of the wall.

35. Leaf – Inner or outer section of a cavity wall.
Lateral Support – A support which enables a masonry element to resist lateral load and⁄ or restrains lateral deflection of a masonry element at the point of support.

36. Load Bearing Wall – A wall designed to carry an imposed vertical load in addition to its own weight, together with any lateral load.

37. Masonry – An assemblage of masonry units property bonded together with mortar.

38. Masonry Unit – Individual units which are bonded together with the help of mortar to form a masonry element such as wall, column, pier, buttress, etc.,

39.Partition Wall – An interior non-load bearing wall, one story or part story in height.

40. Panel Wall – An exterior non-load bearing wall in framed construction, wholly supported at each storey but subjected to latest roads.

41. Shear Wall – A wall designed to carry horizontal forces acting in its plane with or without vertical imposed loads.

42. Slenderness loads – Ratio effective height or effective length to effective thickness of a masonry element.

ABBREVIATIONS

BIS	–	Bureau of Indian Standards
CC	–	Current Charge
CPWD	–	Central Public Works Department
DB	–	Distribution Board
DG Set	–	Diesel Generator Set
HT	–	High Tension
HV	–	High Voltage
IS	–	Indian Standard
KM	–	Kilo Metre
KVA	–	Kilo Volt Amphere
KW	–	Kilo Watt
LPF	–	Low Power Factor
LT	–	Low Tension
LV	–	Low Voltage
M	–	Metre
MB	–	Main Board
Mpa	–	Mega Pascal (1 Mpa=10.2 Kg/m^2)
N/mm^2	–	Newton per Millimeter Square
NBC	–	National Building Code
PWD	–	Public Works Department
RAS	–	Revised Administrative Sanction
RSO	–	Revenue Standing Orders
SBC	–	Soil Bearing Capacity
SPT	–	Standard Penetration Test
SR	–	Subsidiary Rules
TNFC	–	Tamil Nadu Financial Code
TNPWA' Code	–	Tamil Nadu Public Works Account Code
TNPWD' Code	–	Tamil Nadu Public Works Department Code
TR	–	Treasury Rules
UPS	–	Uninterrupted Power Supply
WRO	–	Water Resources Organisation