PMAY- HFA (Urban)

Pradhan Mantri Awas Yojana
Housing for All (Urban)

In the State of Andhra Pradesh

QUALITY ASSURANCE MANUAL II

By

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CHAPTER -1

Introduction: -

Besides, food and clothing, shelter is a basic human need. India has been successful in meeting the food and clothing requirements of its vast population; however, the problem of providing shelter of all is defying solutions. While there has been an impressive growth in the total housing stock from 65 million in 1947 to 187.05 million in 2001, still the county has about 26 million dwelling units shortage, which is likely to escalate in coming years. The shortage of housing is acutely felt in urban areas and according to the Census 2001, 61.82 million persons or 23.1% of the urban population resides in slums. The quality of housing stock in slums is extremely poor.

The Hon'ble President of India, in his address to the Joint Session of Parliament on 9th June, 2014 had announced "By the time the Nation completes 75 years of its Independence, every family will have a pucca house with water connection, toilet facilities, 24x7 electricity supply and access."

The Government of India have launched a comprehensive mission "Pradhan Mantri Awas Yojana – Housing for All (Urban)- PMAY- HFA (Urban)" with a vision to construct 20 million dwelling units during the mission period of 2015-2022.

With the objective of construction of EWS houses under PMAY-HFA(U) in different ULBs in Andhra Pradesh, an act has been passed by the GoAP to provide for construction of EWS houses under PMAY-HFA(U) in different ULBs for state of the Andhra Pradesh and established the Andhra Pradesh Township & Infrastructure Development Corporation (APTIDCO) for the purposes of planning, Coordination, execution, supervision, financing, and for promoting and securing the planned Development of the infrastructure in the Urban local bodies of Andhra Pradesh. The biggest ever Urban Housing programme has taken up to construct 4,81,753 houses in 99 ULBs . (which is the highest number of houses among the other states and UTs of India.)

The salient features of the project are as follows:

- Housing projects were taken up in 196 locations of 99 Urban Local Bodies in the state
- Total No. of houses sanctioned for the state are 4,81,753. (highest among other states in India)

- World's one of the best technology is adopted (Monolithic Shear Wall technology - safety, speedy, secure and environment friendly)
- Adopted technology is approved by BMTPC
- No bricks used, only steel and concrete
- Commonly acceptable best lay-out plans with desirable unit designs and plans
- Ensuring / Providing 60 feet and 40 feet width roads
- Introducing Gated Community concept for Urban poor housing programme in the state (first of its kind)
- Vitrified tiles for flooring and ceramic tiles for bathrooms
- Application of wall putty to all houses
- Providing granite platform to kitchen
- Sal wood main door and sliding window doors
- Providing infrastructure facilities like Roads, Drains, Water and Electricity to all the projects
- Providing social infrastructure like Primary Schools, Primary Health Care centres, Community Halls and Commercial Complexes for integrated development of Projects
- Providing recreational facilities like Parks and Play grounds
- Better resale value with modern facilities.

The Highlights of PMAY- NTR Urban housing are as follows

- Mostly G+3 pattern units with vitrified flooring, bathroom with ceramic flooring, ceramic dadooing in kitchen and booth room, wall putty & Emulsion paints.
- The Andhra Pradesh is first State in the entire world to adopt Monolithic Technology for housing meant for urban poor.

- Govt. of AP is first state in India to implement entire EWS housing through Shear wall Technology.
- The Completion period of all Housing Projects is fixed as **15 Months** so as to deliver the houses to the needy urban poor without any delay

Financial assistance for the PMAY- AHP houses are as follows

- Central Share – Rs 1.50 Lakhs/ unit
- State share – Rs 1.50 Lakhs/unit (in addition External Infrastructure and Land Cost will be borne by the State Govt. of AP.)

The remaining balance cost will be arranged through Bank loans and will be borne by beneficiary.

The previously published Quality Control Manual I manly focus on Quality Assurance plan for materials and civil works including documentations, for the concrete used in the structure. The Quality Control manual I doesn't contains Quality Assurance plans for finished items of works such as flooring, fixing Doors & Windows, water supply & sanitation and Electrification etc.

Hence the Quality Assurance Manual II (QAM II) has been prepared with the objective of putting in place a comprehensive, consistent and common system through Testing and Inspections for quality assurance of the finished items of works such as flooring, fixing Doors & Windows, water supply & sanitation and Electrification etc.

This QA Manual II focuses on the implementation activities of the project following contract award and primarily on supervision and quality control of c finishing works.

Its aim is to ensure that the finishing works are executed as per specifications. Quality Assurance and test results shall be interpreted as applicable for different contracts in accordance with contractual provisions.

The Manual II covers the overall quality assurance system and the field level quality control procedures for different types finishing works involved in house construction, based on IS codes. This Quality Assurance manual II has been prepared referring following sources:

a. Relevant IS Codes
b. CPWD Specifications
c. National Building Code.
d. MoRTH Specifications

CHAPTER -2

Construction Technology adopted – "Monolithic Concrete construction Technology" (Shear wall Technology)

The construction is done by Monolithic shear wall technology, which is one of the best technology in the world to achieve faster construction.

- The Monolithic Concrete Construction (shear wall technology) has been adopted as shear wall technology-based construction is faster, safer, stronger, durable, disaster resistant and environmental friendly. This technology has been approved by Building Materials and Technology Promoting Council (BMTPC).
- It has been proposed to complete the construction of all the sanctioned houses within 15 months.
- Each Dwelling unit will be provided with vitrified tile flooring, wall putty, NCL windows, and ceramic flooring and doodling in bathrooms.
- The beneficiary will pay EMI for bank loans taken instead of paying rent and will own a pucca house with modern facilities and better resale value.

Necessity

With huge shortage of skilled/unskilled labour, construction of quality houses become difficult, lead to abnormal delays in completion of projects with cost overrun. The traditional mode of construction for individual houses comprising load bearing walls with an appropriate roof above or reinforced concrete (RC) framed structure construction with infill masonry walls would be totally inadequate for mass housing construction industry. Further, such constructions are prone to poor quality control even in case of contractors with substantial resources and experience.

Hence, for undertaking mass housing works, it is necessary to have less labour dependency, innovative technologies with mechanization, which are capable of fast rate construction and are able to deliver good quality and durable structure in cost effective manner.

Monolithic Concrete construction Technology is widely recognized as one of the most practical, economically and technically feasible solutions to the problem of building cost-effective, descent, durable and earthquake-proof housing on a mass scale, quickly and efficiently.

The rapid-monolithic- disaster proof construction with aluminium formwork is an innovative technology which has empowered and motivated the mass construction projects throughout the world.

What is Monolithic Concrete construction Technology (Shear wall Technology)?

The Monolithic Concrete Construction in which all the elements are cast together with RCC by using Aluminum formwork / Similar form work, which supports wall, beam, roof slab and other elements together for concreting in one go.

The Monolithic Concrete Construction (shear wall) is faster, safer, stronger, durable, disaster resistant and environmental friendly. This technology has been approved by Building Materials and Technology Promoting Council (BMTPC).

It is fast, consumes less manpower, saves environment, needs less maintenance, provides neat interiors, earthquake resistant, gives longer life to buildings and improves aesthetics with complete flexibility of design. It is tested, experienced and widely accepted in various Governments and Corporate houses in their project all across the country.

About design considerations for monolithic shear wall construction:

RCC is the primary material used in this construction. In conventional methods, RCC walls are cast first and slab is cast later. But, in this technology both walls and slabs are cast simultaneously. Walls are designed as shear walls using limit state method as per the standard design equations given in IS13920 and IS 456. Slabs are being designed as per IS 456. Element thickness (Walls, slabs and beams) are chosen based on fire rating and structural requirements. Limit state of strength is used for the structural design of various elements of the housing units. Limit state of serviceability (Stability, Cracking and Deflection) will be followed to ascertain durability criteria.

Guidelines conforming to IS 456, IS13920, IS 1893, IS 875 are followed to design the structure. Concrete (Portland cement + 25 -35% (Flyash/GGBS) and concreting procedures will be followed as per the Indian standard guidelines and practices. GGBS/Flyash reduces the micro cracks and protect the rebar thus increases the durability of concrete. Thus, the structure built will be sound enough to be used as habitat building.

In the case of RC moment-resisting framed structures, the horizontal forces due to wind or earthquake are resisted by the frames resulting in the bending moments in columns to resist bending moment and vertical loads would be more than that required to resist vertical loads without bending moment. Similarly, additional reinforcement will be required in beams at supports. In the case of RC load-bearing walls, monolithic casting of slab along with RC walls results in a box type structure, which is very strong in resisting horizontal forces due to wind or earthquake. In view of large depth of shear walls, the resulting stresses due to bending moment and vertical loads are smaller and, in many cases, concrete alone is capable of resisting these forces.

Merits of Monolithic Construction:

1. Higher carpet area, due to thinner shear wall construction and simplified foundation design for consistent/continuous load distribution.
2. Monolithic construction of load bearing walls and slabs, produces structurally superior quality with very few construction joints, provides more seismic resistance to structure and highly durable than that of conventional column and beam slabs construction combined with brick or block work subsequently covered by plaster.
3. The walls will not have plaster, problems associated with plaster cracks, etc. eliminated.
4. Uniform quality will be achieved by using uniform grade of concrete for walls & columns and the natural density of concrete wall, result in better sound transmission coefficient. The maintenance cost of such structures will be negligible.
5. In view of the 7 days cycle of casting a floor together with all slabs, as against 40-50 days cycle in the conventional method, completed reinforced concrete structure is available for subsequent finishing, uninterrupted progress can be planned, continuity maintained in each trade, thereby providing a scope for employing increased labor force on reducing finishing item. Hence, 2/3 of construction time in overall project period can be reduced.
6. As the system establishes a kind of “Assembly line production,” phase-wise completion in desired groups of buildings can be planned to achieve early utilization of the buildings.

Selection of Aluminium Formwork

When you choose aluminium forms, you are investing in highest quality and most durable formworks (over 100 repetition) which are custom designed from state-of-art plants. This ensures the accuracy of the building dimension, finish and quality work. No joints, No re-doing of work, no repair required. The construction of block masonry for walls, plastering of walls (external/internal) was totally eliminated. In Conventional practice, the electrical work will not only take time but also damage the block work (walls) before plastering. The time, labour, materials required for these activities are huge and eliminated in monolithic construction.

Merits of Aluminium Shuttering

1. In contrast to most of the modern construction systems, which are machine and equipment oriented, the formwork does not depend upon heavy lifting equipment and can be handled by unskilled labours.
2. Unsurpassed construction speed can be achieved due to light weight of forms, and less labour required for carrying the formwork.
3. Construction carried out by this system has exceptionally good quality with accurate dimensions for all openings to receive windows and doors, right angles at meeting points of wall to wall, wall to floor, wall to ceiling, etc, concrete surface finishes are good to receive painting directly without plaster.
4. Integral and smooth finishing of wall and slab of aluminium form work can be seen vividly on walls.
5. Formwork components are durable and can be used several times without sacrificing quality or correctness of dimensions and surface.

Structural Components of Aluminium shuttering

1) Wall Components

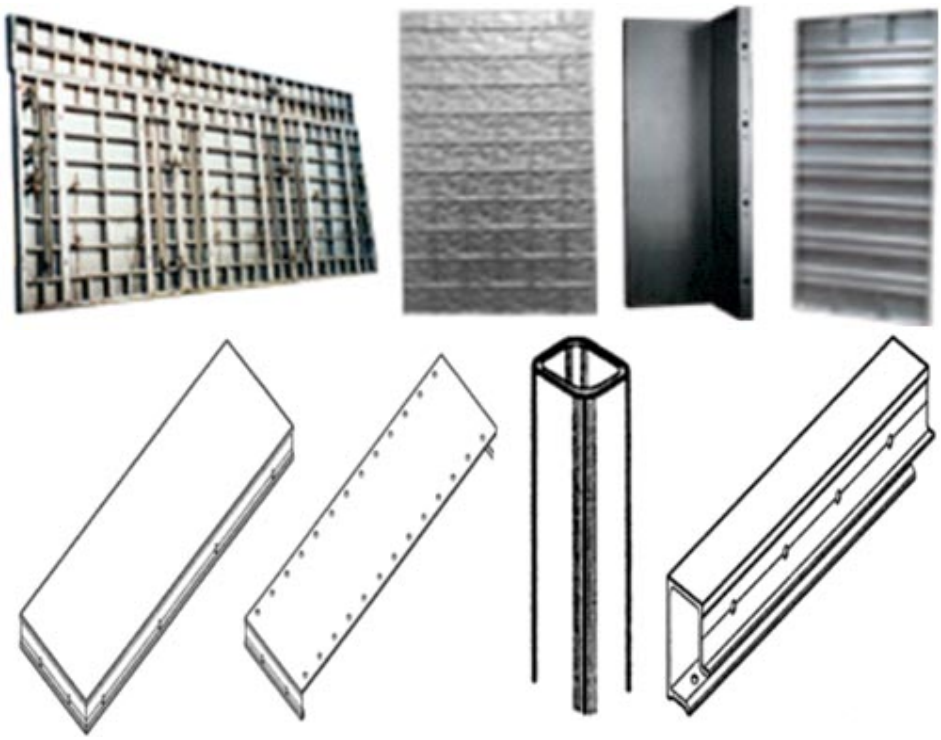
- Wall panels, Rockers, Kickers, Stub-pins

2) Beam Components

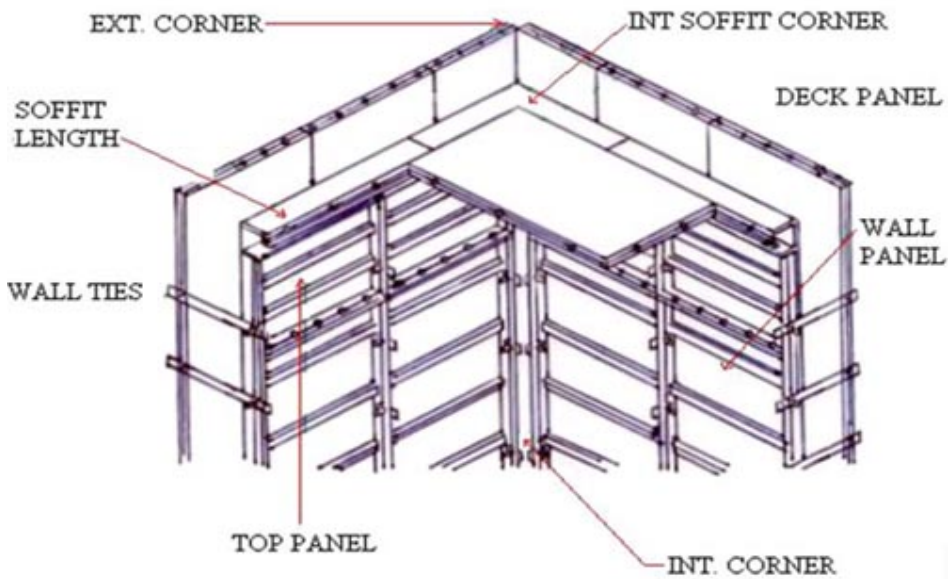
- Beam side panels, Prop head for soffit beams, Beam soffit panels, Beam soffit bulkhead

3)Deck Components

- Deck panels, Deck props, Deck prop lengths, Deck mid beams, Deck beam bars, Soffit lengths, Soffit corners etc.



Wall Assembly Details



Loads Acting on the Aluminium Formwork

In construction, the formwork has to bear, besides its own weight, the weight of wet concrete, the live load of labour, and the impact due to pouring concrete and workmen on it. The vibration caused due to vibrators used to compact the concrete should also be taken care of. Thus, the design of the formwork is an essential part during the construction of the building.

For the design of planks and joints in bending & shear, a live load including the impact may be taken as 370kg/m^2. It is however, usual to work with a small factor of safety in the design of formwork.

In the design of formwork for columns or walls, the hydrostatic pressure of the concrete should be taken into account. This pressure depends upon the quantity of water in the concrete, rate of pouring and the temperature.

The hydrostatic pressure of the concrete increases with the following cases:

- Increase in quantity of water in the mix
- The smaller size of the aggregate
- The lower temperature
- The higher rate of pouring concrete
- If the concrete is poured in layers at an interval such that concrete has time to set, there will be very little chance of bulging.

Construction Stages

The concrete quality is most important, shall be cohesive and of good quality, specially designed for flowable, into forms without segregation and bleeding (slump of 140-160mm) is needed. The concrete shall be pumped by concrete pumps (preferably boom pumps or other pumps). This type of concrete can be sourced from reputed RMC suppliers.

The construction activities are divided as pre – concrete activities, during concreting and post – concrete activities. They are as follows:

Pre – concrete Activities:

- Receipt of Forms/Shuttering material on site as ordered
- Level Surveys – Level checking are made to maintain horizontal level check
- Setting Out – the setting out of the formwork is done
- Control / Correction of Deviation – Deviation or any correction are carried out
- Erect Formwork – the formwork is erected on site
- Erect Deck Formwork – Deck is erected for labour to work

- Setting Kickers – kickers are provided over the beam.
- Dislodging of pins / wedges due to vibration.
- Beam / deck props adjacent to drop areas slipping due to vibration.
- Ensure all bracing at special areas slipping due to vibration.
- Overspill of concrete at window opening etc.

The post-concreting activities include:

- Striking
- Cleaning
- Transporting

Things to look for during concreting:


Block A4 First floor mivan shuttering in progress

Pictures show (Shear wall Technology with myvaon shuttering) the details of reinforcement, aluminium formwork of G+3 buildings

Aluminium Formwork Cycle Period

The system usually follows a 4- day cycle:

- Day 1 – The first activity consists of erection of vertical reinforcement bars and one side of the vertical formwork for the entire floor or a part of one floor.
- Day 2 -The second activity involves erection of the second side of the vertical formwork and formwork for the floor (roof slab)
- Day 3 – Fixing reinforcement bars for floor slabs and casting of walls and slabs
- Day 4 – Removal of vertical form work panels after 24 hours, leaving the props in place for 7 days and floor slab formwork in place for 2.5 days.

This construction technology is 3.5 times faster compared with Conventional Brick/Block masonry work. This can go up to 5 times for 4 days cycle time. If formwork per floor made available (single repetition), then the speed will have increased to 8-9 times.

Comparison of Speed of construction (For Typical Plan):				
Sl No	**Desription of Activity**	**Conventional**	**RMDC**	**Remarks**
1	Foundation	30	16	Excluding excavation 4 repetition
2	Plinth	10	0	
3	Columns	15	0	Includes curing
4	Beams	10	0	
5	Slab	15	0	Includes curing
6	Walls	30	24	6- day cycle-4 repetition
7	Plastering	30	0	
	Total	**140 days**	**40 days**	**3.5 times (1/3 of conventional)**
Note: In the above case Form work procured only ¼ of Plan area (4-repetitions per floor area)				

The above calculation does not include the additional cost-benefits such as the increased carpet area cost (5-8%), early occupational cost (4-5 months), and saving in interest cost, resources holding charges (4-5 months) etc. as in case of conventional construction. The wastage of materials at site not accounted (3-5%). Also, not considered

the scrap value of Aluminium forms after 100 repetitions (generally scrap value is higher compared to steel). Considering above, about 15-20% of overall cost shall be saved.

Limitations

- Generally, used in mass housing project with same plan and the multi-storey structures having same plan area at all floors.
- Huge initial investment for formwork procurement- Clients can invest and issue to contractor
- Large number of repetitions makes this technology cost -effective.
- About 70-80% of formwork elements shall be useful for new project (new plan) after first project, rest shall be suitably designed and procured for next projects
- Initial setting of formwork at site (as demo), as per drawing dimension, may take more time
- The training of labour to handle designed formworks at site- however, this would overcome with support of formwork suppliers
- All the utilities, have to lay & embedded in concrete walls/slabs, hence relocation, repair of these will be very difficult.
- Since, structure is monolithic and wall thickness is less, these houses are little warmer than the conventional during summer/ sunny days. However, this problem can be overcome by using suitable thermal insulated paint for external wall or by adopting simple thermal insulation techniques or growing creepers & plants around the external walls.
- Honeycombing and Cracks in shear wall.
- The mivan technology follows monolithic construction i.e. all the structural member viz. beam, shear wall, slab are casted at same time. In conventional construction the concrete is placed from height of 0.6 to 1 meter, and that is what recommended height to place the concrete. In Mivan Technology of construction the concrete is placed from height of 3 meter in shear wall and compacted using vibrator, now as height of placing concrete is more there are chances of segregation in concrete resulting in honeycombing and cracks in wall. In mivan construction it is generally happened that after removing formwork there is honeycombing in shear wall, in this project we had tried to fix the problem of honeycombing in shear wall.

Advantages of Monolithic Constructions: -

Quality:-

- Use of homogeneous material – M 30 Self Compaction Concrete.
- Thus replacing bricks, mortar & concrete, which are used separately.
- Variations in operations / Skills are avoided.

Consistency: -

- Standardised, system – derive repetitions are used in construction.
- Since Sigle homogenous material is used, better consistency can be achieved in production & placement.

Superior Structure System: -

- Better Structural rigidity & ductility due to shear wall design & use of homogeneous RCC
- Moisture resistance is better due to monolithic (joint – free) construction.
- Better resistance to differential thermal stresses due to climatic changes (as compared to conventional construction)
- Better resistance to lateral forces – due to Earthquake / tornado/ flood / wind forces etc.

Durability:-

- Durability & superiority of RCC over all other materials is proven.
- Monolithic structure eliminates joints, which cause cracks, moisture penetration and weakening of structure in the long term.

Sustainability:-

- Optimisation of construction materials
- Avoidance of wastages at site.
- Utilisation of industrial bye – products like fly ash, Slag.
- Recyclability of materials after useful life of the structure (RCA – Recycled Concrete Aggregate)

Economy of Scale:-

- Due to the use of homogenous material, cost of divergent material (as compared with normal construction) is reduced.
- More number of repetitions bring down the cost of formwork for mass construction.
- Relatively less number of labour hours, by increasing labour productivity.
- Due to faster pace of construction, reduction in working Capital Cost.

Use of Existing Labour: -

- No advance skills / tradesmen are required for this Technology.
- Existing labour force can be trained easily within few days of working at site.

Conclusion: -

India desperately needs a lot of rapid dwelling units. Mass housing projects with Monolithic concrete (Shear wall) technique is one of the solutions to the overgrowing problem. The speed & quality construction drives this technology;

1. Cost effective - average 15% cost saving for load bearing wall over conventional timber/plywood shuttering
2. Increased Carpet area/Usable floor space of (5 - 8%) over Conventional Design
3. Speedy construction - 1/5th - 1/6th of time required to complete construction against the conventional
4. Easy to use, since it's simplified design
5. Monolithic construction-box type strong structures with minimum/ no joints
6. Structures are better earthquake and wind resistant
7. Highly durable structures - required least maintenance
8. Smooth finish of wall/roof/floor- ready to take the paint
9. Block/Brick masonry eliminated thus Internal & External Plaster eliminated
10. Environment-friendly - no wood/timber used
11. Formwork-Lightweight section are used-hence easy to lift and used
12. Only hammer required to erect - joining by simple pins & wedges and horizontal ties
13. Aluminum shuttering material has higher scrap value compared to plywood/steel.

The cost of housing projects development could be reduced by over 30% and the completion time shortened by over 40% if more developers start using the latest construction methods and standardized project designs, (for instance, assembling housing structures from pre-fabricated components manufactured off-site). Process improvements such as efficient procurement methods would help as well.

CHAPTER -3

Self-compacting concrete (SCC)

Definition

- It's very flow able concrete with high workability that has ability to flow under it's own weight with no need of vibration and no segregation and without the separation of the constituent materials until it sets
- Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.

WHY IS SCC USED ?

- Can be placed at a faster rate with no mechanical vibration and less screening, resulting in savings in placement costs,
- Improved and more uniform architectural surface finish with little to no remedial surface work.
- Ease of filling in restricted sections and hard to reach areas.
- Improved consolidation around reinforcement
- Bond with reinforcement.

- Improved pump ability.
- Improved uniformity.
- Labor savings.
- Shorter construction periods and resulting
- cost savings.
- Service the project more efficiently.
- Reduction of vibrator noise.

Present studies in SCC that are being carried out in many countries, can be classified as follows:

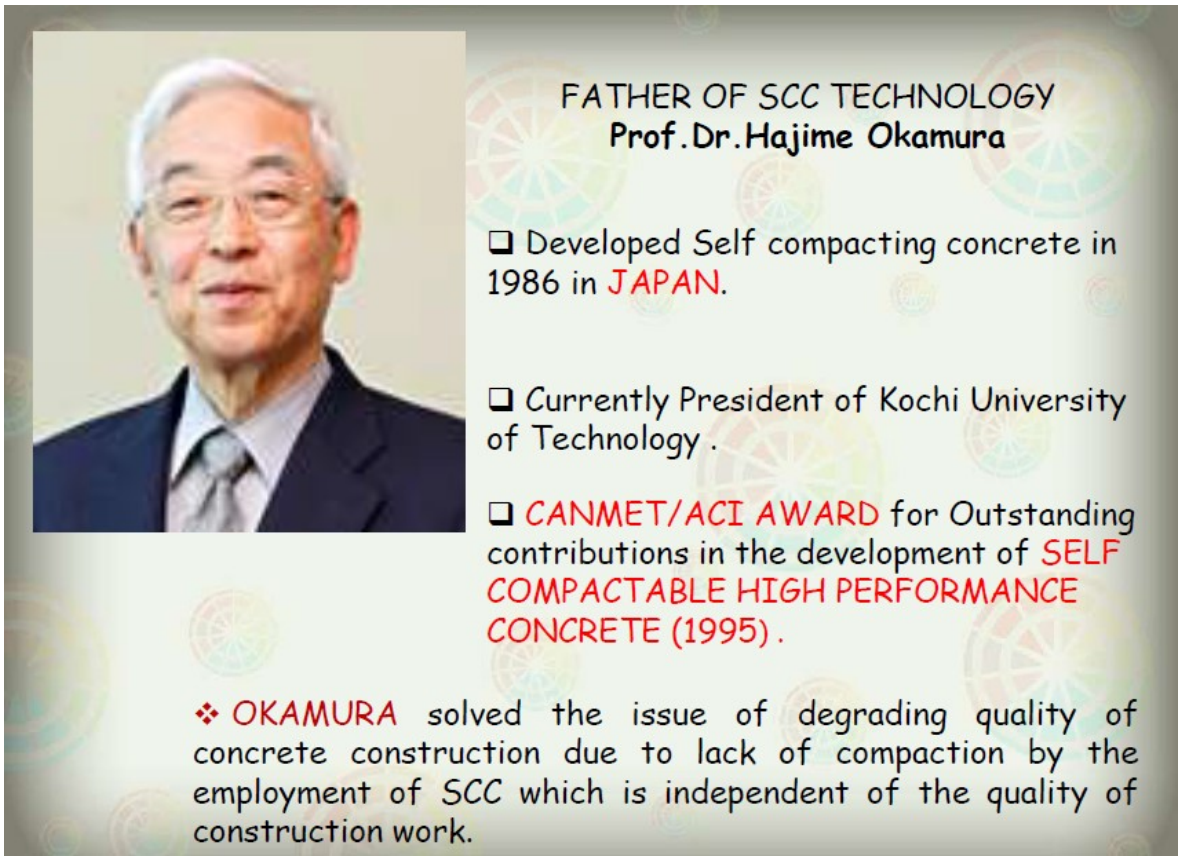
1. The usage of Rheometers to attain the data regarding the flow behavior of cement paste, cement mortar and concrete,
2. The SCC mix proportioning methods,
3. The test methods to obtain SCC characteristics,
4. The SCC hardened and durability properties and their comparison with conventional concrete (CC)
5. The construction problems related to SCC

Following are the important questions that require particular attention:

1. The development of SCC mix design guidelines similar to those for conventional concrete (CC)
2. A shift to more 'normal' powder contents in SCC,
3. Understanding the SCC autogenous and plastic shrinkage problems
4. The development of acceptance tests to measure the quality control parameters at the site.

Brief history of SCC

- Sept. 1986: initiation of research by Okamura on "Waiting for Innovation in Concrete Materials".
- Aug. 1988: Production of Prototype concrete No.1 by Ozawa.
- July 1989: demonstration of SCC to the construction industry at the Tokyo University.
- July 1989: publication of first work by Ozawa, Maekawa, and Okamura et al.
- 1990 onwards: application of SCC by construction industries.
- 1995 onwards: spreading of SCC to the world research centers.



Constituent Materials

- Cements and Additive Materials
- Admixtures
- Coarse Aggregates
- Fine Aggregates
- WATER

Mixes of SCC different Categories

Ingredient	Powder Type	VMA Type	Combined Type
Water kg/m^3	175	165	175
Cement kg/m^3	530	220	298
Fly ash kg/m^3	70	0	206
GGBFS kg/m^3	0	220	0
Silica Fume kg/m^3	0	0	0
F.A. kg/m^3	751	870	702
C.A. kg/m^3	789	825	871
High, Range Water reducing admixtures kg/m^3	9.0	4.4	10.6
VMA kg/m^3	0	4.1	0.0875
Slump flow test dia. of spread mm	625	600	660

General

- The constituent materials for SCC are the same as those used in traditional vibrated concrete conforming to EN 206-1. In most cases the requirements for constituents are individually covered by specific European standards. However, in order to be sure of uniform and consistent performance for SCC, additional care is needed in

initial selection and also in the continual monitoring for uniformity of incoming batches.

- To achieve these requirements the control of the constituent materials needs to be increased and the tolerable variations restricted, so that daily production of SCC is within the conformity criteria without the need to test and/or adjust every batch.

Cement

- All cements which conform to EN 197-1 can be used for the production of SCC.
- The correct choice of cement type is normally dictated by the specific requirements of each application or what is currently being used by the producer rather than the specific requirements of SCC.

Additions

- Due to the fresh property requirements of SCC, inert and pozzolanic / hydraulic additions are commonly used to improve and maintain the cohesion and segregation resistance. The addition will also regulate the cement content in order to reduce the heat of hydration and thermal shrinkage.
- The additions are classified according to their reactive capacity with water:

TYPE I	Inert or semi-inert	• Mineral filler (limestone, dolomite etc) • Pigments
TYPE II	Pozzolanic	• Fly ash conforming to EN 450 • Silica fume conforming to EN 13263
	Hydraulic	• Ground granulated blast furnace slag (If not combined in an EN 197-1 cement, national standards may apply until the new EN 15167 standard is published)

Self-compacting concrete is often selected for its high quality finish and good appearance but this may be compromised if the source of the addition does not have good color consistency.

Mineral Fillers

- The particle size distribution, shape and water absorption of mineral fillers may affect the water demand /sensitivity and therefore suitability for use in the manufacture of SCC.
- Calcium carbonate based mineral fillers are widely used and can give excellent rheological properties and a good finish.
- The most advantageous fraction is that smaller than 0.125 mm and in general it is desirable for >70% to pass a 0.063mm sieve.
- Fillers specifically ground for this application offer the advantage of improved batch to batch consistency of particle size distribution, giving improved control over water demand and making them particularly suitable for SCC compared with other available materials.

Fly Ash

- Fly ash has been shown to be an effective addition for SCC providing increased cohesion and reduced sensitivity to changes in water content.
- However, high levels of fly ash may produce a paste fraction which is so cohesive that it can be resistant to flow.

7.3.3 Silica fume

The high level of fineness and practically spherical shape of silica fume results in good cohesion and improved resistance to segregation. However, silica fume is also very effective in reducing or eliminating bleed and this can give rise to problems of rapid surface crusting. This can result in cold joints or surface defects if there are any breaks in concrete delivery and also to difficulty in finishing the top surface.

7.3.4 Ground blastfurnace slag

Ground granulated blast furnace slag (ggbs) provides reactive fines with a low heat of hydration. GGBS is already present in some CEM II or CEM III cements but is also available as an addition in some countries and may be added at the mixer. A high proportion of ggbs may affect stability of SCC resulting in reduced robustness with problems of consistence control while slower setting can also increase the risk of segregation. Ground blast furnace slag is also available in some countries as a type I addition.

7.3.5 Other additions

Metakaolin, natural pozzolana, ground glass, air cooled slag and other fine fillers have also been used or considered as additions for SCC but their effects need to be carefully and individually evaluated for both short and long term effects on the concrete.

7.4 Aggregates

Normal-weight aggregates should conform to EN 12620 and meet the durability requirements of EN 206-1. Lightweight aggregates should conform to EN 13055-1.
NOTE: Aggregate particles smaller than 0,125 mm are deemed to contribute to the powder content of the SCC.

The moisture content, water absorption, grading and variations in fines content of all aggregates should be closely and continuously monitored and must be taken into account in order to produce SCC of constant quality. Using washed aggregates will normally give a more consistent product. Changing the source of supply is likely to make a significant change to the concrete properties and should be carefully and fully evaluated.

The shape and particle size distribution of the aggregate is very important and affects the packing and voids content. Some mix design methods use the voids content of the aggregate in predicting the volumes of paste and of mortar required. Single size aggregates and/or a gap in the grading between coarse and fine aggregates are used in some mix designs.

7.4.1 Coarse aggregate

Coarse aggregates conforming to EN 12620 are appropriate for the production of SCC. Lightweight aggregate has been successfully used for SCC but note that the aggregate may migrate to the surface if the paste viscosity is low and this may not be detected by the sieve segregation resistance test.

The reinforcement spacing is the main factor in determining the maximum aggregate size. Aggregate blocking must be avoided as SCC flows through the reinforcement and the L-box test is indicative of the passing ability of an SCC mix. The maximum aggregate size should generally be limited to 12 – 20 mm, although larger sizes are being used.

The particle size distribution and the shape of coarse aggregate directly influence the flow and passing ability of SCC and its paste demand. The more spherical the aggregate particles the less they are likely to cause blocking and the greater the flow because of reduced internal friction.

Merits and demerits of SCC

1. SCC will typically have a slightly higher compressive strength when compared to a conventional concrete of similar w/cm ratio.
2. Bond to reinforcement – While SCC bond strength is typically assumed to be higher than conventional concrete, this increase in bond is typically not considered in the design of the structure.
3. A slump flow value between 500-800 mm depending upon congestion of reinforcement.
4. The placement rate should be slowed to the point that there is sufficient time for the entrapped air to rise to the concrete surface
5. When placing SCC with a concrete pump the hose of the pump should be placed inside the formwork and under the concrete surface whenever possible. This installation method both reduces the possibility of entrapping additional air within the SCC and eliminates the potential for material segregation due to free-fall around the reinforcing steel and form hardware.
6. Care should be taken to minimize vertical drops to 1.5 meters or less and to minimize horizontal flow to 10 meters or less.
7. Visual Stability Index – The stability of self-consolidating concrete can be assessed by visually evaluating the distribution of the coarse aggregate within the concrete mass after the spreading of the concrete has stopped.
8. T50cm Value – The T50cm value is recorded during the slump flow test by pre-marking a 50cm diameter circle on the non-absorbent rigid surface and using a stopwatch to record the amount of the that is required for the concrete to reach this diameter.

CHAPTER- 4

PILE FOUNDATION

The Pile Foundations were adopted in Bhimavaram and Palakol sites and the execution details are as follows:

Description on piles:

For arriving type of foundation first conducted bore-hole test in Bhimavaram and Palakol project sites randomly in whole site.

Test report gives "N" value on an average of above 50 for Site1 at 19.0m depth, 99 for site2 at 25.0m depth and 27 for site3 at 27.0m depth for Bhimavaram site mostly observed type of soil is greyish brown silty clay which is very stiff.

Test report gives "N" value on an average of above 60 for Site1 & 41 for Site2 at 21.0m depth for Palakol project site mostly observed type of soil is clayey sand which is very dense/Hard.

Based on type of soil and N value at larger depths reports went to piling option for Bhimavaram and Palakol project sites.

Arrived the diameter of pile as 450mm, length(Varies to each site) and no's per each type of 300Sqft, 365Sqft and 430Sqft as 24, 27 and 36 piles respectively based on load of the building.

Each pile carrying capacity is 80T and it is end bearing pile, 30% of load is transferred to soil by friction and 70% of load is transferred by end bearing.

There are 3 types of piles

1. Manual Boring piles
2. DCIS(Driven Cast In situ)
3. BCIS(Bore cast In situ)

Manual boring pile option is not feasible because of large depth and lack of time, so other two options (DCIS & BCIS) are available to proceed for piling in site.

Bhimavaram and Palakol project sites consists of large number of blocks and completion time given is only for 1 year within the short span of time completion of job not feasible with the help of Manual boring pile option so we have gone for DCIS and BCIS piles.

Bhimavaram:

Piling started on 18th Sep 2017 and completion date is 23rd Feb 2018. On an average 2 hours took to complete one pile using DCIS (Mechanical rig) and 3 hour's time taken to complete one pile using BCIS.

Mechanical rig for DCIS in Bhimavaram site

Using BCIS total 2472 numbers has done in site 1 and site 3. By using DCIS total 3570 numbers has done

Tractor rig for BCIS in Bhimavaram site

Palakol:

In Palakol piling started on 27TH Sep and going to complete by March end. On an average 45 minutes took to complete one pile using DCIS (Hydraulic rig) and 3 hours' time taken to complete one pile using BCIS.

Using BCIS total 435 numbers has done in site 1. By using DCIS total 5855 numbers has done.

Hydraulic rig by L&T Geo for DCIS in Palakol

Types of tests on piles:

1. Dynamic Load test
2. Static load test
3. Pile integrity test

1. Dynamic Load Test:

Dynamic load test was done on BCIS pile for initial pile test applied 2.5 times of test load means 200T on one pile in Bhimavaram observed settlement was approximate 3.7 mm. & net Settlement was 1.060 mm, Hence Pile is found good and it can support the structure. Dynamic load test was done on DCIS pile for initial pile test have applied 2.5 times of test load means 200T on three piles in Palakol site observed settlement was approximate 5.575mm, 6.918 and 6.619 and corresponding net Settlement was 1.088mm, 1.05mm & 1.198 respectively. Hence Piles are found good and it can support the super structure.

Dynamic test

3. Pile integrity Test:

There is a chance of collapsing of soil during concreting for BCIS pile to find out voids in the pile we carried out Pile integrity test on BCIS piles of 10% of total number of BCIS piles done in site. With this test we didn't find any voids and cracks, all the piles are found satisfactory in Bhimavaram site.

Pile integrity Test

Advantages of BCIS:

1. Only circular shape is possible
2. 300mm to 2500 mm is possible (In general practise 300,450,500,600,750, 900,1000,1200,1500, 2000,2500 mm piles)
3. Can go length up to 30m
4. Heave does not Occur
5. Can be executed in low head room
6. Can be done in all locations
7. Mobilization of rig is cheaper than DCIS

Disadvantages of BCIS:

1. Site will be messy due to Bentonite Solution
2. It is costlier per pile around 1.083% more than DCIS.
3. Rather Slow (Takes min. 3 hours for completion of 1 pile)

Advantages of DCIS:

1. Both Circular & Square shape is possible
2. 300 mm to 600mm is possible (In general practise 300,400,450,500,600mm piles)
3. Environment is clean
4. Cheaper than Bored piles
5. Quality of concrete will be good
6. Medium Speed (Takes min. 1 hour for completion of 1 pile)
7. Cost per pile is 1.083% lesser than BCIS
8. Casing to be driven to the required depth which it helps for lateral compaction of the soil

Disadvantages of DCIS:

1. Mobilization cost is more than BCIS
2. Length restricted to 24m due to availability of piling rig
3. Heave can occur
4. High head room required
5. Restricted to certain locations due to driving vibration

CHAPTER -5

Quality Assurance plans for materials & Finished Works of PMAY-AHP (Urban) Building Projects.

Quality is conformity to standards and requirements to achieve excellence and is one of the key parameters to access the successful completion of any Project. Quality Assurance (QA) is the planned and systematic actions necessary to provide adequate confidence that the work will satisfy quality requirements. Quality Assurance attempts to improve and stabilise implementation to avoid, or at least minimize, issues which may lead to the defect(s) during construction. Quality Assurance is normally expressed together with Quality Control. Quality Control (QC) is a system of maintaining standards by reviewing, checking, inspecting and testing. Quality control needs to emphasize testing of materials used during implementation.

This chapter provides an overview of control requirements for materials and equipment components, including site testing, manufacturers' certification and third-party inspection.

Control and approval of construction materials and equipment components to be incorporated in the works shall be based on the following:

1. Test reports for materials tested at site, such as cement, sand, water, aggregates, bitumen etc.
2. Manufacturer's certificates and IS mark for manufactured items, such as Doors, Windows, Tiles, water supply & sanitary fittings.
3. Third party inspection for various items as per contract documents

Q A P for Basic Materials

The first step towards ensuring good quality construction is to get good quality basic materials required to be used in the construction activities. These construction materials like Doors, Windows, Tiles, water supply & sanitary fittings Aggregates, Sand, Earth or Water, processed materials like Cement, Bitumen, and Geo textile. Sealant etc. or processed and assembled materials like Doors, Windows, Tiles, water supply & sanitary fittings Bearings and Expansion Joints. This shall also require prior approval of the source or supplier for the individual material or product.

In order to ensure that material used in construction is of high quality and meets the codal requirements of BIS, IRC or MORTH as applicable, a series of tests have to be carried out at regular frequencies. The testing has to be done first at the level of the

supplier *I* manufacturer or the contractor. This forms the first level check. The testing may be done jointly with the client or the client may do the testing independently in the site laboratory. This forms the second level check. The material is also got tested from reputed independent laboratories. This forms the third level check.

FLOORING

Before tiling work is started, all points of level for the finished tile surface shall be marked out. This is particularly necessary in the case of finished staircase landings. Wherever slopes in finished floors are desired points of level and outlets shall be correctly marked and outlet openings made before hand. Where it is feared or suspected that dampness may percolate either from the ground floor or walls, the same shall be damp-proofed or waterproofed.

Spreading of Cement Mortar: The tiles shall be soaked in water for 12 hours before using. The base shall be well compacted and the surface shall be rough to form a suitable key. The base shall be cleaned and wetted without allowing any pools of water on the surface. Cement mortar shall be evenly spread over the base for two rows of tiles and about 3 to 5 m in length with thread level fixed at both ends to act as a guide. The top of the mortar shall be kept rough so that cement slurry can be absorbed. The thickness of bedding shall be not less than 10 mm and not more than 30 mm in any one place.

Tiles which are fixed to the floor adjoining the wall shall go above 10 mm under the plaster, skirting or dado as may be required.

The joints shall be kept as close as possible and in straight lines. The joints between the tiles shall normally be 1.5mm wide.

After fixing the tiles, the floor shall be kept moist and allow to mature for 7 days so that the bedding and joints set properly.

The following tests shall be carried out to check the quality of tiles.

1. Determination of water absorption IS:13630 (Part 2)

2. Determination of modulus of rupture Part 6

3. Determination of linear thermal expansion Part 4

4. Determination of chemical resistance Part 8

5. Determination of resistance to surface abrasion Part 11

6 Determination of Scratch hardness of surface Part 13

7. Sampling and basis for acceptance of ceramic tiles.

PRESSED CERAMIC TILE FLOORING

- Pressed Ceramic Tiles The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630.
- Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.
- The tiles shall be square or rectangular of nominal size. Table 1,3,5, and 7 of IS 15622 give the modular preferred sizes and table 2,4,6 and 8 give the most common non-modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width upto 2mm for uncertified floor tiles and Upto 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tiles shall conform to table10 of IS 15622 with water absorption 3 to 6% (Group BII).
- The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only Upto 50 per cent of the surface area of the edges.
- Colored Tiles Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.
- Decorative Tiles The type and size of the decorative tiles shall be as follows:
  - (i) Decorated white back ground tiles; The size of these tiles shall be as per IS 15622.
  - (ii) Decorated and having coloured back-ground; The sizes of the tiles shall be as per IS 15622.

Preparation of Surface and Laying

- Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10 mm.
- Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.
- Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over an area upto one square metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.
- The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.
- Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.
- After tiles have been laid surplus cement slurry shall be cleaned off.
- Pointing and Finishing The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

PRESSED CERAMIC TILE FLOORING (VITRIFIED TILE FLOORING)

- Operations as described in 11.15.1 to 11.15.6 shall be followed except the tiles shall conform to Table 12 of IS 15622 (Tiles with water absorption E ≤ 0.08 per cent Group BIa) and the joint thickness in flooring shall not be more than 1mm.
- Rate The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

FIXING OF TILE FLOORING WITH CEMENT BASED HIGH POLYMER MODIFIED QUICK SET ADHESIVE (WATER BASED)

- When tile flooring is to be laid over the existing flooring without dismantling old flooring it can be laid with adhesive. The old flooring shall be thoroughly cleaned and checked for undulations, if any shall be rectified with cement mortar 1:3 (1 cement: 3 coarse sand). Old cement concrete surface shall be hacked and cleaned off to have proper bond with the old surface.
- High polymer modified quick set tile adhesive (conforming to IS 15477) shall be thoroughly mixed with water and a paste of zero slump shall be prepared so that it can be used with in 1.5 to 2 hours. It shall be spread over an area not more than one sqm at one time. Average thickness of adhesive shall be 3 mm The adhesive so spreaded shall be combed using suitable trowel. Tiles shall be pressed firmly in to the position with slight twisting action checking it simultaneously to ensure good contact gently being tapped with wooden mallet till it is properly backed with adjoining tiles. The tiles shall be fixed within 20 minutes of application of adhesive. The surplus adhesive from the joints, surface of the tiles shall be immediately cleaned.

- The surface of the flooring shall be frequently checked during laying with straight edge of above 2m long so as to attain a true surface with required slope.

- Where spacer lugs tiles are provided these shall be filled with grout with lugs remaining exposed.

- Where full size tile can not be fixed these shall be cut (sawn) to the required size and edges rubbed smooth to ensure straight and true joints. Tiles which are fixed in floor adjoining to wall shall enter not less than 10 mm under plaster, skirting or dado.

PRESSED CERAMIC TILES IN SKIRTING AND DADO

- The tiles shall be of approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze, however, any glaze if unavoidable shall be permissible on only upto 50 per cent of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawlings or other imperfections detracting from the appearance when viewed from a distance of one metre. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

(a) Dimensions and Tolerances Glazed pressed cramic tiles shall be made square or rectangular in sizes Table 1, 3, 5 & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non-modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with 1 mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified. above.

The thickness of the tiles shall be 5 mm or 6 mm or as specified.

The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs, cronices and capping beads shall be of the shape and dimensions as required and the thickness of fittings shall be the same as the thickness of tiles given above.

Preparation of Surfaces The joints shall be raked out to a depth of at least 15 mm in masonry walls. In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

Laying 12 mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth. Skirting /dado shall not project from the finished "surface of wall" by more than the tile thickness, undulations if any shall be adjusted in wall.

Curing and Finishing The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

DOORS& WINDOWS

Sal Wood (Shoera Robusta) Sal is about 30 per cent heavier than teak, 50 per cent harder, and about 20 to 30 per cent stronger. In shock resistance it is about 45 per cent above teak. Its heart wood is a naturally durable wood, and usually remains immune to attack by white ants and fungi for a long period, while its sapwood is very perishable and should not be used. Well dried sal is not a really easy wood to saw and work. It is a rough constructional wood than a carpentary timber. No individual hard and sound knot shall exceed 25 mm in diameter and the aggregate area of all the knots shall not exceed 1% of the area of the piece.

It can be used for a variety of purposes, such as door frames window frames, rafters, flooring, piles, bridging, tool handles, picker arms and tent pegs, etc.

FLUSH DOOR SHUTTERS

- Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Paintable type as per IS 2202 (Part I). Nominal thickness of shutters may be 25, 30 or 35 mm. Thickness and type of shutters shall be as specified.
- Width and height of the shutters shall be as shown in the drawings or as indicated by the Engineerin-Charge. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 per cent when tested according to IS 1708.
- Core The core of the flush door shutters shall be a block board having wooden strips held in a frame constructed of stiles and rails. Each stile and rail shall be a single piece without any joint. The width of the stiles and rails including lipping, where provided shall not be less than 45 mm and not more than 75 mm. The width of each wooden strip shall not exceed 30 mm. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips shall be parallel to the stiles.

End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be of one species only but it may or may not be of the same species as that of the stiles and rails. Any species of timber may be used for core of flush door. However, any non-coniferous (Hard wood) timber shall be used for stiles, rails and lipping.

- **Face Panel:-** The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0 mm and 3.0 mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.4 mm and 1.0 mm for decorative veneers, provided that the combined thickness of both is not less than 2.2 mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

- **Lipping**:- where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

- Rebating In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type as shown in drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

- Opening for Glazing When required by the purchaser opening for glazing shall be provided and unless otherwise specified the opening for glazing shall be 250 mm in height and 150 mm or 200 mm in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25 mm. Opening for glazing shall be provided where specified or shown in the drawing.

FITTINGS

- Fitting shall be of mild steel brass, aluminium or as specified. Some mild steel fittings may have components of cast iron. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. These shall be of the following types according to the material used.

(a) Mild Steel Fittings: These shall be bright finish black stone enamelled or copper oxidised (black finish), nickel chromium plated or as specified.

(b) Brass Fittings: These shall be finished bright satin finish or nickel chromium plated or copper oxidised or as specified.

(c) Aluminium Fittings: These shall be anodised to natural matt finish or dyed anodic coating not less than grade AC 10 of IS 1868.

The fittings generally used for different type of doors and windows are indicated in Annexure attached. The fittings to be actually provided in a particular work shall, however, be decided by the Engineer-in-Charge.

Screws used for fittings shall be of the same metal, and finish as the fittings. However, chromium plated brass screws or stainless-steel screws shall be used for fixing aluminium fittings. These shall be of the size as indicated in respective figures.

Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in - Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sinking of hinges.

Butt Hinges These shall be of the following types according to the material used.
(a) Mild steel butt hinges (Medium).
(b) Cast brass butt hinges light/ordinary or heavy.
(c) Extruded aluminium alloy butt hinges.

Mild Steel (Medium) :

These shall be medium type manufactured from M.S. sheet. These shall be well made and shall be free from flaws and defects of all kinds. All hinges shall be cut clean and square and all sharp edges and corners shall be removed. These shall generally conform to IS 1341.

PVC DOOR SHUTTERS:

The shutters shall be fabricated at factory as per nomenclature of the item and directions of Engineer-in-Charge. Shutter shall be made of PVC material conforming to IS 10151.

- mm thick PVC Door Shutter
- 30 mm Thick PVC Door Shutters
- Sampling and Criteria for Conformity

General Precautions

- The test specimens shall not have been exposed to a temperature below 40oC for 24 hours immediately preceding the test and shall be free from all visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded.
- If any test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

Sampling

- Sampling criteria for conformity shall be in accordance with IS 4020 (Part –I)

- Lot in any consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to form a lot.

- The number of shutters to be selected at random from a lot shall depend upon its size and shall be in accordance

Criteria for Conformity:

The lot shall be considered conforming to the requirements if the number of samples failing to satisfy the requirements of characteristics does not exceed the permissible number.

Test

- The door shutters shall be subjected to the following tests in accordance with IS 4020 (Part 1 to 16).

(a) **Dimension and Squareness Test :** Door shutters when tested in accordance with IS 4020 (Part 2) the dimensions of nominal width and height will be within a limit of + 5 mm. The door shutter shall not deviate by more than 1 mm on a length of 500 mm. The thickness of the door shutter shall be uniform throughout with the permissible variation of not more than 0.8 mm between any two points. The nominal thickness of the shutter shall be within a limit of + 1.5 mm.

(b) **General Flatness Test :** Door shutter, when tested in accordance with IS 4020 (Part 3) the twist, cupping and warping shall not exceed 6 mm.

(c) **Local Planeness Test :** Door shutters, when tested in accordance with IS 4020 (Part 4), the depth of deviation measured at any point shall not be more than 0.5 mm.

(d) **Impact Indentation Test :** Door shutters, when tested in accordance with IS 4020 (Part 5), shall have no defects such as cracking, tearing or delamination and the depth of indentation shall not be more than 0.2 mm.

(e) **Edge Loading Test :** Door shutters, when tested in accordance with IS 4020 (Part 7) the deflection of the edge at the maximum load shall not be more than 5 mm. On removal of the loads, the residual deflection shall not be more than 0.5 mm, failing which the test may be repeated on the other edge in the reverse direction. Also there shall be no lateral buckling by more than 2 mm during loaded condition and no residual lateral buckling after removal of the load.

(f) **Shock Resistance Test :** Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 8) , there shall be no visible damage in any part of the door after twenty five blows on each end.

(g) **Buckling Test** : Door shutters, when tested in accordance with IS 4020 (Part 9), shall not show any deterioration and any residual deformation more than 5 mm after 15 min. of unloading and the initial deflection also shall not be more than 50 mm.

(h) **Slamming Test :** Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 10), shall not have any damage in any part of the door at the end of successive impacts.

Door shutters, when tested in accordance with 3.1 of IS 4020 (Part 10), shall not have any visible damage in part of the door at the end of 100 successive impacts.

(i) **Misuse Test :** Door shutters, when tested in accordance with IS 4020 (Part 11), there shall not be any permanent deformation of the fixing or any other part of the door set in hindering its normal working after the test.

(j) **Screw Holding Test :** Door shutters, when tested in accordance with IS 4020- Part 16, the load shall not be less than 1000 N.

(k) **End Immersion Test :** Door shutters, when tested in accordance with IS 4020- Part 13, the shutter shall not show any delamination.

(l) **Knife Test :** Door shutter, when tested in accordance with IS 4020 – Part 14, the grading shall be standard & excellent.

(m) **Glue Adhesion Test :** Door shutters shall be tested in accordance with IS 4020 – Part 15. There should be no delamination.

WOOD WORK AND P.V.C. WORK

- Fixing of Shutters PVC door shutter shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel.

- Tolerance The tolerance on the width and the height of the door shall be + 5 mm and the tolerance on the nominal thickness of the door shall be + 2 mm.

- Fittings shall be provided as per schedule of fittings decided by Engineer-in-Charge. In moisture prone areas M.S. fittings and screws should not be used. Hardware such as handles, tower bolt, stopper, buffer etc. should be directly screwed (not pre-drilled) and fitted on the door.

- Measurements Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

- Rate The specified rate include the cost of the door shutter and labour involved in fixing of the shutter. Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.

TESTS FOR FLUSH DOOR SHUTTERS

F-1. **END IMMERSION TEST** Door shutters shall be tested for resistance of their base to immersion in water as follows:

The door shutter shall be immersed vertically to a height of 30 cm in water at room temperature for 24 hours and then allowed to dry for 24 hours at 27 ± 2°C and relative humidity of 65 ± 5 per cent. The cycle shall be repeated eight times. There shall be no delamination at the end of the test.

F-2. **KNIFE TEST** (i) Apparatus : The type of knife required to be used in the test It may be made from a 250 x 25 mm file. The cutting edge should be kept chiselsharp. The test shall be carried out on a stout table to which a wooden batten is screwed against which the edge of test piece is placed. 250 mm (Approx.) 25 cm

KNIFE FOR TESTING PLYWOOD FOR ADHESION OF PLIES

(ii) **Procedure**: The knife is inserted with its cutting edge parallel to the grain of the outer veneer and worked into, or if possible along a glue line and the veneer is prised upwards. A hard and dense specie of plywood requires considerable force to effect entry and to prise and veneer. In a soft timber the knife tends to follow an easy course through the wood and in this case it is essential that the knife be firmly guided along the glue line.

The bond should just pass the requirement, it is judged by the relative amount of wood fibre left on the core veneer, and the area prised off. The grading is assessed chiefly on the appearance of the break. The force needed to effect separation is also an accompanying requirement.

The bond is 'excellent', when it is difficult to find the glue line and impossible to keep the tool within it for more than 6 mm without cutting adjacent wood. On prising upwards, the veneer usually breaks off over a width slightly greater than that of the tool.

The bond is 'poor' when knife meets little opposition in the glue line and the prise results in the easy removal of almost all the veneers from one side of the test piece. The separated veneers are usually almost free from adherent fibre.

(iii) **Reporting of test results:** The results shall be reported as 'pass standard' 'excellent' or 'poor'.

F-3. GLUE ADHESION TEST

Four square sections, 150 x 150 mm shall be cut from the corners of the door. These four corner sections as cut from the door shall be immersed in boiling water for 4 hours, then dried at 27 ± 2°C and relative humidity of 65 ± 5 per cent for 24 hours. At the end of the drying period, the samples shall be examined for delamination. In the case of the glue lines in the plywood, all the four exposed edges of the plywood on both faces of a specimen shall be examined for delamination.

A specimen shall be considered to have passed the test if no delamination has occured in the glue lines in the plywood and if no single delamination more than 50 mm in length and more than 3 mm in depth has occured in the assembly glue lines between the plywood faces and the stile and rail. Delamination at the corner shall be measured continuously around the corner. Delamination at a knot, knot hole, a pitch pocket and worm hole or other permissible wood defects shall not be considered in assessing the sample. A door shall be deemed to have passed this test if three of the four specimens tested pass the test.

TEST FOR MORTICE LOCKS

The finally assembled lock shall withstand the test given as below: The locking bolt shall be first locked in the forward position. A load of 40 kg. shall be applied without shock in the direction perpendicular to securing face as well as on both the locking faces of protruding bolt in turn. Then the load shall be applied by means of a fixed steel board 3 mm thick by rounded edge held in such a position that the centre line is approximately 3 mm from the fore end.

When the spindle with handle is inserted into hole in the follower and turned, the latch bolt shall draw smoothly into the lock body and shall be within one millimetre from the face of the fore end.

When the latch bolt is pressed in to the lock body by pressure, the action shall be smooth and when fully pressed the latch bolt shall not project more than one millimetre from the face of the fore end.

When a key is inserted in key hole from one side of the lock and turned to withdraw the locking bolt the action shall be smooth and without impediment. When the direction of turn is reversed to lock the locking bolt then also the action shall be smooth and without impediment. In the locked position the locking bolt shall project 12 mm from the face of the fore end, although one-millimetre free movement is permissible. In the withdrawn position the locking bolt shall not project more than one millimetre from the face of the fore end. The locking bolt shall be worked by turning key in both the direction 6000 times. At the end of the test, the lock shall continue to work smoothly. The test shall be repeated with the key inserted from the other side of the lock.

Note : The clearance for levers while in the operating condition shall not exceed 0.25 mm. When the key is turned to lock the locking bolt at the same time applying a reasonable pressure by finger on it, after completion of the key rotation the locking bolt shall be positively locked in the forward position. This test shall be repeated with the key inserted from the other side of the lock.

SCHEDULE OF FITTING FOR DOORS AND WINDOWS

A : Door Shutters

1. Door of room adjoining the verandah, corridor, lobby or hall, shall be considered as external door.
2. Where the height of the door leaf exceeds 2.15 metres above the floor level, one extra hinge shall be provided for every additional height of 0.50 metre, or part thereof and the length of top bolts shall be increased by the height of the leaf above 2.15 metres from floor level. Single leaf door shutters of more than 0.80 m in width shall be provided with one extra hinge.
3. Fan light shutters of more than 0.80 metre width shall be provided with one extra hinge and extra quadrant stay.
4. In double leaf shutters of doors, two door bolts shall be fixed to the first shutter and one to the closing shutter at the top.
5. In case of single leaf inter communicating, panelled, glazed or paneled door shutter for bath and w.c. one tower bolts will be replaced by a bathroom latch.
6. For shutter exceeding 40 mm thickness, heavy type M.S. butt hinges of 125 x 90 x 4 mm shall be used.
7. In case of external door shutters, instead of sliding door ball mortice lock can be provided where specified.
8. Cupboard and wardrobe shutters will have ball catches where specified.
9. Finger plates shall be provided in case of bath and wc shutters in office buildings.

B : Window Shutters

10. In case of windows with double shutters, two tower bolts shall be fixed to the closing shutters and one tower bolt to the first shutter at the top.
11. In case of window shutters, hooks and eyes may be provided in lieu of casement stays where specified.
12. Where the height of window shutter exceeds 1.20 metres one extra hinge shall be provided and length of top bolts shall be increased by height of the leaf above 2.15 metres from the floor level.
13. Window shutter with steel frames shall be provided with six hinges in case of double leaf shutters and three hinges in case of single leaf shutters, irrespective of height and width of shutters.

C : Fanlight and Clerestory Window or Ventilator

14. Centrally hung and bottom hung CS windows and fan lights, will be provided with chain and hook bamboo pole with hook for opening ventilators shall be provided for each residence or for set of 4 rooms in case of office building.
16. Centrally hung clerestory windows or fan lights will have fan light pivots in lieu of hinges.

METHOD OF TEST FOR EDGE STRAIGHTNESS AND SQUARENESS OF PLYWOO

PROCEDURE FOR EDGE STRAIGHTNESS

- The straightness of the edge and ends of plywood shall be verified against a straight edge not less than the full length of the plywood. If the edge on the end of the plywood is convex, it shall be held against the straight edge in such a way as to give approximately equal gap at each end. The largest gap between the straight edge and the edge shall be measured to the nearest millimeter and recorded.

PROCEDURE FOR SQUARENESS

- The squareness of plywood shall be checked with a 1200 mm x 1200 mm square by applying one arm of the square to the plywood. The maximum width of the gap shall be recorded.

M.S. HOLLOW RECTANGULAR DOOR FRAMES

- Materials Steel door frames shall be manufactured from commercial mild steel sheet of 1.60 mm thickness, conforming to IS 2062 and 4351. Steel door frames shall be made in the profiles as per drawings and/or as directed by the Engineer in-charge.

- Construction Each door frame shall consist of hinge jamb, lock jamb, head and if required angle threshold. These shall be welded or rigidly fixed together by mechanical means. Where no angle threshold is required, temporary base tie shall be screwed to the feet of frames in order to form a rigid unit. Where so specified base ties shall be pressed mild steel 1.60 mm thick adjustable to suit floor thickness of 35 or 40 mm and removable, or alternatively, threshold of mild steel angle of section 50 x 25 mm, minimum shall be provided for external doors frames.

- Fabrication The M.S hollow rectangular steel door frames shall be got fabricated in an approved workshop as approved by the Chief Engineer.

Fixing Lugs :

There shall be three adjustable lugs with split end tail to each jamb.

The head of the fixing lug shall be 120 mm long and made up flat steel strip 25 mm wide and 1.60 mm thick.

- Hinges 100 mm mild steel butt hinges shall be used. Floor door frames 80 cm wide and under, three hinges shall be rigidly fixed to one jamb and for frames of door above 80 cm wide, four higes shall be rigidly fixed to one jamb, if it is single shutter. Where the height of door shutter exceeds 2.15 metres, one additional hinge shall be provided for every 0.5 mm or part thereof of the additional height.

- In all cases the hinges shall be so fixed that the distance from the inside of the head rebate to the top of the upper hinge is 20 cm and the distance from the bottom of the door frame to the bottom of the bottom hinge is also kept about 200 mm. The middle hinges shall be at equal distance from lower and upper hinges or as agreed to between the purchaser and the supplier. Hinges shall be made of steel 2.5 mm thick with zinc coated removable pin of 6 mm diameter. The space between the two leaves of the hinge when closed shall be 3 mm and the leaf that is not welded to the frame shall have four counter sunk holes to take Number-10 cross recessed head wood screws.

- Aldrops, Sliding Bolts and Tower Bolts : Provisions shall be made for aldrops, sliding bolts and tower bolts in the frames as per the positions given by the purchaser. Necessary mortar guards/metallic or nylon bushes shall be provided inside the frames for aldrops, sliding bolts and tower bolts.

Lock Strike Plate : Provision shall be made to fix lock stricke plates of mortise locks or latches, complying with the relevant Indian Standards. A slot suitable for lock stricke plate shall be pierced into the rebate of the frame and necessary fixing arrangement and mortar guard from the inside of the frame shall be provided.

Shock Absorbers : For side-hung door there shall be not less than three buffers of rubber or other suitable material inserted in holes in the rebate and one shall be located at the centre of the lock jamb of frame and other two shall be 300 mm from top and bottom of the frame. For double leaf doors two buffers shall be provided.

- Finishing The surface of door frame shall be thoroughly cleaned, free of rust, mill – scale dirt, oil etc. either by mechanical means, for example sand or shot blasting or by chemical means such as picking. After pretreatment of the surface one coat of approved primer i.e. red oxide zinc chrome primer conforming to IS 2074. Two coats of paints as directed by the Engineer-in-Charge shall be applied to the exposed surface.

- Fixing Frames shall be fixed up right in plumb and plane. To avoid sag or bow in width during fixing or during construction phase, temporary struts across the width preventing sides bulging inwards may be rovided. Wall shall be built solid on each side and grouted at each course to ensure solid contact with frame leaving no voids behind the frame.

Three lugs shall be provided on each jamb with spacing not more than 75 cm the temporary struts should not be removed till the masonry behind the frame is set. In case screwed base tie is provided, this should be left in position till the flooring is laid when it can be removed.

After pretreatment of the surface one coat of steel primer and two coats, of paint, as directed by Engineer-in-charge shall be applied to the exposed surface.

FACTORY MADE GLAZED STEEL DOORS, WINDOWS AND VENTILATORS

- Specifications for this item to be same as for standard steel glazed doors, windows and ventilators as mentioned the above para except that Doors, windows and ventilators to be manufactured in a workshop, approved by the Chief engineer. Also owner of the workshop shall have a valid ISI license for manufacture of doors, windows and ventilators.

- STEEL WORK WELDED IN BUILT-UP SECTIONS USING STRUCTURAL STEEL (A) In Stringers, Treads, Landing etc. of Stair cases including use of Chequred Plate wherever required (B) In Grating, Frames, Guard Bar, Ladder, Railings, Brackete, Gates and similar work.

- General specifications for these items to be same as for steel work welded in built-up sections as mentioned in the para except that steel used for fabrication of these items to be of type used for structural use/purposes.

- Steel members used for fabricating these items to be designed structurally to withstanding the all loads to be carried out by the members during erection, fixing and functional use in designed life. Work to be executed as per structural drawings.

STEEL WORK WELDED IN BUILT-UP SECTIONS FOR HAND RAIL USING M.S. TUBULAR/ERW TUBULAR PIPES AND G.I. PIPES

- General specifications to be same as for steel work welded in built- up section as mentioned in para 10.4.

- Hot finished welded (HFW) Hot finished seamless (HFS) and electric resistance welded tube shall conform to IS 1161.

- G.I. pipes used for Hand rail to be conforming to IS 1239-Part I for medium grade. GI pipes to be screwed and socketed type and of required nominal bore.

- Galvanising of GI pipes shall conform to IS 4736.

- All screwed tubes and socket of GI pipes shall have pipe threads conforming to the requirements of IS 554.

- The fittings for GI pipes to be conforming to IS 1239 (Part-II).

TESTS TO BE CONDUCTED FOR FLUSH DOOR SHUTTERS.

Measurement of dimensions and square ness

IS: 4020

Impact Test

Flexture Test

Shock resistance

Slamming test

End immersion test

Knife test

Glue adhesion test

Screw with drawl resistance

PAINTING

OBJECTIVES:

The various objectives of painting on the different surfaces are as follows:

1. To protect the surface from weathering effects of the atmosphere.
2. To protect the decay of wood and corrosion of metals.
3. To provide a decorative finish to obtain a clean colourful and pleasing surface.

CHARACTERISTICS OF A GOOD PAINT:

1) A paint should possess good spreading or covering power.

2) The paint should have such a consistency that it can be applied easily and freely on the Surface with a brush or spray.

3) The paint should be such that it dries within 24 hrs. to a hard dry condition but not too rapidly.

4) The paint should not be affected by weathering agencies, i.e., rain, heat, wind etc.

5) The paint colour should afford a clean, attractive and pleasing appearance of the surface.

6) The paint colour should neither fade nor change by atmosphere influences.

7) It should offer a surface which is durable and strong enough to resist moisture penetration.

TYPES:

The following are some of the types of Paints

ALUMINIUM PAINT:

Aluminium paint is widely used for painting metal roofs, gas tanks, oil storage tanks, silos, electric and telegraphic poles, hot water pipes, machinery, radiators etc. It consists of finely ground aluminium suspended in either quick-drying spirit varnish or slow drying oil varnish as per the requirements. Due to silvery shining texture, it is visible even in darkness and possesses high spreading power.

EMULSION PAINT:

This paint consists of a vehicle such as polyvinyl acetate, synthetic resins (usually chlorinated rubber) as the main constituent. It has the qualities of quick drying, good workability and high durability. This paint is recommended for use on stucco, bricks and masonry surfaces which contains free alkali. The surfaces to be painted should be washed with zinc sulphate solution so as to reduce alkalinity.

ENAMEL PAINT:

The paint consists of metallic oxide ground with a small quantity of oil and mixed with petroleum spirit holding resinous matter in solutions. The enamel paints are generally used for painting porches, stairs, decks, concrete surface etc. This paint is available in market in ready-made form in variety of colours.

PAINTING IRON WORK:

Quality of paint required for primer coats and other coats is about same where red-oxide paints are used.

FOR NEW WOOD WORK:

Before painting, wooden surfaces shall be well cleared with soap dissolved in water. The washing shall be done by means of large white wash

brushes. After soap and water have been used, the surface shall be well washed down with clean water, and painter's hands must on no account touch the surface. The surface must be dry before the application of paint. All projections, glue or whiting spots, all tool marks and other irregularities, shall be carefully removed with stopping knife and duster and smoothed off and all heads of screws and nails set ½" below the surface.

After the surface has been prepared, the primary coat shall be applied. The primary coat shall consist of one part while lead to eight of whiting, ground and mixed together with four parts of twice boiled linseed oil.

After the primary coat has dried, all nail and screw holes and cracks shall be filled with putty and irregularities reduced with sand paper and pumice stone. Priming coat is applied before the wood work is fixed in place.

FOR OLD WOOD WORK:

In case removal of the oil paint is found to be unnecessary, the old painted surface will be rubbed down with sand paper if it is rough, and then washed down with soap and water. If the old painted surface is blistered or flaked, it is necessary to remove the old paint before repainting.

Old paint shall be removed by burning with an ordinary painter's blowlamp, or by covering the surface with kerosene oil or other paint remover and then burning afterwards scrapping off the paint.

When the paint has been thoroughly removed, the surface shall be washed, rubbed down, and holes etc., sealed as specified above for new wood works.

FOR NEW IRON & STEEL WORK: The surface shall be thoroughly scraped, well brushed and cleaned free of rust, scale and dirt. The primary coat shall consist of red lead and boiled linseed oil.

APPLICATION:

Painting wood work will only be done in dry weather, when the wood work is perfectly dry. Painting to unseasoned wood will do more harm than good and will only induce dry rot, and also result in the paint blistering. Similarly surfaces of all descriptions to be painted-iron, plaster, etc. must be thoroughly cleaned before application of the paint. Paint brushes shall be of best quality manufacture. Only skilled painters shall be employed on painting, varnishing etc.

When thinning of paint is required to produce the required consistency, it shall be done with the following mixture:

Boiled linseed oil - 14 parts Spirits of turpentine - 1 part

The paint shall be laid on evenly and properly by means of crossing and laying off the later in the direction the grain for wood work and care shall be taken that the paint is of such consistency that it runs easily from the brush. The paint must not be allowed to settle in the cans. To prevent this, each painter shall have in his paint can a small smooth stick with which the paint shall be carefully stirred before the paint is used.

Successive coats of colour shall be applied after the previous coats are thoroughly dried and inspected by the in-charge. Such coat, except the last coat, shall be slightly rubbed down with sand paper or fine pumice stone and cleaned of dust before the next coat is laid. No hair marks from the brush or clogging of paint shall be left on the work.

In painting (or varnishing) doors and windows, the putty round the glass shall also be painted but the glass must not be smeared. Stains of paint in glass panel etc. shall be carefully removed by applying a little turpentine and the whole work left in a clear condition.

HOUSE WIRING:

Conduit pipe system of wiring is the best and it is protected well from mechanical damages. This system is also fire proof and to an extent fire resistant. Therefore, for all buildings this system may be adopted. Planning and Designing:

General:

The design and planning of an electrical installation shall take into account all the prevailing conditions which may include some or all the following:

a) Type of supply

b) Envisaged load having regard to the requirements of the owner or occupier.

c) The probable modifications and future extensions.

d) The degree of electrical and mechanical protection necessary.

e) The probable operation and maintenance cost taking into account the electricity supply tariffs available.

f) The relative cost of various alternative methods, and

g) The need for radio and telecommunication interference abatement.

It is recommended that advice of a competent electrical engineer be sought at the planning stage with a view to providing an installation that will prove adequate for its intended purpose and safe and efficient in its use.

Layout and Installation Drawing:

The electrical layout should be considered after proper locations of all outlets for lamps, fans, appliance both fixed and transportable, motors, etc., have been selected and best methods of wiring determined.

Al runs of wiring and the exact positions of all points of switch-boxes and other outlets shall be first marked on the plans of the building and approved by the engineer-in-charge or the owner before actual commencement of the work.

The design of the wiring system and the size of the cables should be decided taking into account two factors.

a) **Voltage Drop**: this should be kept as low as economy permits to ensure proper functioning of all electrical appliances and equipment including motors.

b) First cost against operating losses.

VOLTAGE AND FREQUENCY OF SUPPLY

It should be ensured that all equipment connected to the system including any appliances to be used on it are suitable for the voltage and frequency of supply of the system. The nominal values of low and medium voltage systems in India are 240 V and 415 V ac respectively and the frequency 50 Hz.

RATINGS:

The current-carrying capacity of different types of cables shall be chose in accordance with good practice.

The current ratings of switches for domestic and similar purposes are 5 A and 15 A.

The current ratings of isolators and normal duty switches and composite units of switches and fuses shall be selected from one of the following values:

16, 25, 32, 63, 100, 160, 200, 320, 400, 500, 800, 1000 and 1250 A.

The ratings of rewireable and HRC fuses shall be in accordance with good practice.

The current rating of the distribution fuse board shall be selected from one of the following values:

6, 16, 25, 32, 63 and 100 A.

Note: The above ratings are for each fuse way of the distribution fuse- board.

LIGHTING AND LEVELS OF ILLUMINATION:

General: - Lighting installation shall take into consideration the many factors on which the quality and quantity of artificial lighting depends. The modern concept is to provide illumination with the help of a large number of light sources not of higher illumination level. Also much higher levels of illumination are called for than in the past, often necessitating the use of fluorescent lighting suitably supplemented with incandescent fittings, where required.

FUTURE DEMAND:

However, if for financial reasons, it is not possible to provide a lighting installation to give their commended illumination levels, the wiring installation at least should be so designed that at a later date, it will permit the provision for additional lighting fittings or conversion from incandescent to fluorescent lighting fittings to bring the installation to the required standard. It is essential that adequate provisions should be made for all the electrical services which may be required immediately and during he intended useful life for the building.

Principles of Lighting:

When considering the function of artificial lighting, attention shall be given to the following principal characteristics before designing an installation.

b) Illumination and its uniformity.

c) Special distribution of light. This includes a reference to the composition of diffused and directional light, direction of incidence, the distribution of luminance's and the degree of glare; and

d) Colour of the light and colour rendition.

The variety of purpose which have to be kept in mind while planning the lighting installation could be broadly grouped as:

a) industrial buildings and processes.

b) Offices, schools and public buildings;

c) Surgeries and hospitals, and

d) Hostels, restaurants, shops and homes.

It is important that appropriate levels of illumination for these in accordance are provided and the types and positions of fittings determined to suit the task and the disposition of the working places.

For specific requirements for lighting of special occupancies, reference shall be made to good practice.

FANNAGE:

Where ceilings fans are provided, the bay sizes of a building which control fan point locations, play an important part. Fans normally cover an area of 9 cm2 to 10 m2 and therefore in general purpose of the buildings, for every part of a bay to be served by the ceiling fans, it is necessary that the bays shall be so designed that full number of fans could be suitably located for the bay, otherwise it will result in ill-ventilated pockets, in general, fans in long halls may be spaced at 3 m to 3.5 m in both the directions. If building modules do not lend themselves for proper positioning of the required number of ceiling fans, other types of fans, such as air circulators or bracket fans, would have to be employed for the areas uncovered by the ceiling, fans. For this, suitable electrical outlets shall be provided although result will be disproportionate to cost on account of fans.

Proper air circulations could be achieved either by larger number of smaller fans or smaller number of larger fans. The economics of the system as a whole should be a guiding factor is choosing the number and type of fans and their locations.

Exhaust fans are necessary for spaces, such as community toilets, kitchens and canteens and godowns to provide the required number of air changes. Since the exhaust fans are located generally on the outer walls of a room,

appropriate openings in such walls shall be provided for in the planning stage.

Positioning of fans and light fittings shall be chosen to make these effective without causing shadows on the working planes.

Reception and Distribution of Main Supply:

Central at point of commencement of supply:

There shall be a circuit breaker or miniature circuit breakers or a linker switch on each live conductor of the supply mains at the point of entry. The wiring throughout the installation shall be such that there is no break in the neutral wire in the form of switch or fuse unit. The neutral shall also be distinctly marked in this connection. Rule 32 (2) of Indian electricity Rules, 1956 shall also be referred.

The main switch shall be easily accessible and situated as near as practicable to the termination of service line.

On the main switch, where the conductors include an earthed conductor of a two-wire system or an earthed neutral conductor of a multi-wire system of a conductor which is to be connected thereto an indication of a permanent nature shall be provided to identity the earthed neutral conductor. In this connection rule 32(1) of the Indian Electricity Rules, 1956 shall be referred.

Main Switches and Switchboard:

All main switches or miniature circuit-breakers shall be either of metal-clad enclosed pattern or of any insulated enclosed pattern which shall be fixed at close proximity to the point of entry of supply.

Location:

Open type switch boards shall be placed only in dry and ventilated rooms and they shall not be placed in the vicinity of storage batteries or exposed to chemical fumes.

In damp and dusty situation the switch-board shall be totally enclosed in accordance with accepted standards.

Switch boards shall not be erected above gas stoves or sinks, or within 2.5 m of any washing unit in the washing rooms of laundries or in bathrooms, lavatories or toilets or kitchens.

The location of switchboards shall be so chosen as to facilitate easy attendance to maintenance such as replacement of fuses, clearing etc.

Metal-clad switchgear shall preferably be mounted on any of the following types of boards.

a) Hinged-Type Metal Boards:

These shall consist of a box made of sheet metal not less than 2 mm thick and shall be provided with a hinged cover. The joints shall be welded to a wooden board protected on both sides with insulating varnish and of not less than 6.5 mm thickness, shall be provided at the back. There shall be a clear distance of not less than 2 – 5 cm between the board and the cover, distance being increased for larger boards. Alternatively, hingedtype metal boards shall be made of sheet covering mounted on channel or angle iron frame.

Note: Such type of boards are particularly suitable for small switchboards for mounting metal-clad switchgear connected to supply at low voltages.

b) Fixed-Type Metal Boards:

These shall consist of an angle or channel iron frame fixed on the wall or on the floor and supported on the wall at the top, if necessary. There shall be a clear distance of 1 m in front of the switchboard. If there are any attachments of bare connections at the back of the switchboard, Rule 51 (1) © of Indian Electricity Rules 1956 shall apply.

Note: Such type of boards are particularly suitable for large switchboards or higher capacity metal-clad switchgear or both.

c) **Wood Boards**:

For small installations connected to a single-phase 240 volts supply, these boards may be used as main boards or sub-boards. These shall be of seasoned and durable wood with solid back impregnated with vanish with all joints dove-tailed.

In large size medium voltage installations, before proceeding with the actual construction of the boards, a proper drawing showing the detailed dimensions and design including the disposition of the mountings which shall be symmetrically and neatly arranged for arriving at the overall dimensions shall be prepared and approved by the engineer-in-charge.

Recessing of Boards

Where so required the switch, boards shall be recessed in the wall. The depth of recess provided at the back for connection and the space at the front between the switchgear mountings shall be adequate.

Arrangement of Mountings:

a) Mounting which is on the front of a switchboard shall be so arrange that inadvertent personal contact with live parts is unlikely during the manipulation of switches, charging of fuses or like operation.

b) No mounting shall be mounted within 2.5 cm of any edge of the panel and no hole other than the holes by means of which the panel is fixed shall be drilled closer than 1.3 cm form any edge of the panel.

c) The various live parts, unless they are effectively screened by substantial barriers of non-hydroscopic, non-inflammable insulating material, shall be so spaced that are cannot maintain between such parts and earth.

d) The arrangement of the gear shall be such that they shall be readily accessible and their connections to all instruments and apparatus shall also be easily traceable.

e) In every case in which switches and fuses are fitted on the same pole, these fuses shall be so arranged that the fuses are not alive when their respective switches are in the off position.

f) No fuses other than fuses in instrument circuit shall be fixed on the back of or behind a switchboard panel of frame.

Main and Branch Distribution Boards:

Main and branch distribution boards shall be of any type mentioned in the above paras

Main distribution boards shall be provided with a switch or circuit-breaker on each pole of each circuit, fuse on the phase or live conductor and a link on the neutral or earthed conductor of each circuit. The switches shall always be linked.

Branch Distribution Boards:

Branch Distribution Boards shall be provided with a fuse or a miniature circuit – breaker or both of adequate rating/setting on the life conductor each circuit and the earthed neutral conductor shall be connected to a common link and the capable of being disconnected individually for testing purposes. At least one spare circuit of the same capacity shall be provided on each branch distribution board.

In residential installations lights and fans may be wired on a common circuit. Such sub-circuit shall not have more than a total of ten points of lights, fans and socket outlets.

The load of such circuit shall be restricted to 800 watts. If a separate fan circuit is provided, the number of fans in the circuit shall not exceed ten. Power sub-circuits shall be designed according to the load but in no case shall there be more than two outlets on each-circuit.

In wiring installations at construction sites, stadium shipyards, etc., where large number of high wattage lamps may be required, there shall be no restriction offload on any circuit but conductors used in such circuits shall be of adequate size for the load and proper circuit protection shall be provided.

Installation of Distribution Board:

The distribution fuse-boards shall be located as near as possible to the centre of the load they are intended to control.

These shall be fixed on suitable sanction or wall and shall be accessible for replacement of fuses.

These shall be of either metal-clad type or all-insulated type. But if exposed to weather or damp situations, they shall be totally enclosed in accordance with accepted standards.

Where apparatus is to be operated at medium voltage or where medium voltage exists between two or more adjacent low-voltage circuits all terminals or other fixed line parts not permanently shrouded in insulating material shall either be installed so as to be accessible only to authorized personnel or shall be enclosed in earthed metal or non-combustible insulating material and the distribution boards shall be fixed not less than 2 m. apart.

All circuits shall be marked distinctly on distribution boards as lighting or 'power' as the case may be and also marked with the voltage and number of phases of the supply. Each board shall be provided with a circuit list giving details of each circuit which it controls and the current rating of the circuit and size of fuse-element.

Wiring of Distribution Board:

In wiring a branch distribution board, total load of the consuming devices shall be distributed, as far as possible evenly between the number of ways of the boards, leaving the spare circuit for future extension. Spare circuits on branch distribution boards shall be at least 10 percent of the number of ways of the board subject to a minimum of 1 in 6 way board and above.

All connections between placed of apparatus or between apparatus and terminals on a board shall be neatly arranged in a definite sequence, following the arrangements of the apparatus mounted thereon, avoiding unnecessary crossings.

Cables shall be connected to a terminal only by soldered or welded lugs, unless the terminal is of such a form that it is possible to securely clamp them without cutting away of the cable strands. Aluminium conductors should be tinned before insertion in clamps.

If required, a pilot lamp shall be fixed and connected through an independent single pole switch and fuse to the bus-bars of the board.

In a hinged type board, the in-coming and outgoing cables shall be fixed at one or more points according to the number of cables on the back of the board leaving suitable space in between cables, and shall also, if possible, be fixed at the corresponding points on the switchboard panel. The cables between these points shall be arranged to form a 'U' or 'S' shaped loop which shall be of such length as to allow the switchboard panel to swing through an angle of not less than 90.

Protection of Circuits:

a) Appropriate protection shall be provided at switch boards and distribution boards for all circuits and sub-circuits against over current and earth faults, and the protective apparatus shall be capable of interrupting any fault current that any occur, without danger. The ratings and settings of fuses and the protective devices shall be coordinated so as to afford selectivity in operation where necessary.

b) Where circuit breakers are used for protection of a main circuit and of the sub-circuits derived there from discrimination in operation may be achieved by adjusting the protective devices of the sub-main circuit breakers to operate at lower current settings and shorter time lag than the main circuit breaker.

c) Where HRC type fuses are used for back-up protection of circuit breakers, or where HRC fuses are used for protection of main circuits, and circuit breakers for the protection of sub-circuits derived there from, in the event of short-circuits exceeding the breaking capacity of the circuit breakers, but for smaller overloads within the braking capacity of the circuit-breakers, the circuit-breakers shall operate earlier than the HRC fuse blows.

d) If rewirable type fuses are used to protect sub-circuits derived from a main circuit protected by HRC type fuses, the main circuit fuse shall normally blow in the event of a short circuit or earth fault occurring on a sub-circuit, although currents. The use of

rewirable fuses is restricted to the circuits with short circuit level of 4 KA, for higher level either cartridge or HRC fuses shall be used.

e) A fuse carrier shall not be fitted with a fuse-element larger than that for which the carrier is designed.

f) The current rating of a fuse shall not exceed the current rating of the smallest cable in the circuit protected by the fuse.

g) Every fuse shall have its own case or cover for the protection of the circuit and an indelible indication of its appropriate current rating in an adjacent conspicuous position.

h) For detailed information regarding selection, installation and maintenance of fuses, reference may be made to good practice.

Branch Switches:

Where the supply is derived from a three-wire or four-wire source, and distribution is done on the two-wire system, all branch switches shall be placed in the outer or live Conductor of the circuit and no single-phase switch or fuse shall be inserted in the middle wire, earth or earthed neutral conductor of the circuit. Single-pole switches (other than for multiple control) carrying not more than 15 amperes may be of tumbler type which shall be 'on' when the handle or knob is down.

Wiring

Provision for Maximum Load:

All conductors, switches and accessories shall be of such size as to be capable of carrying, without their respective ratings being exceeded, the maximum current which will normally flow through them.

Estimation of Load Requirements:

In estimating the current to be carried by any Conductor the following ratings shall be taken, unless the actual values are known or specified for these elements:

Element Rating in Watts.

Incandescent lamps 60 Ceiling fans Table fans 60 Ordinary socket outlet points

Fluorescent tubes Length: 600 mm 25 1200 mm 50 1500 mm 90
Power socket - outlet 1000

Selection of Size of Conductor:

The size of conductors of circuits shall be so selected that the drop in voltage from consumer's terminals in a public supply (or from the bus-bars of the main switchboard controlling the various circuits in a private generating plant) to any and every point on the installation does not exceed three percent of the voltage at the consumer's terminals (or at the bus-bars as the case may be) when the conductors are carrying the maximum current under the normal conditions of service.

If the cable size is increased to avoid voltage drop in the circuit, the rating of the cable shall be the current which the circuit is designed to carry. In each circuit or sub-circuit every cable shall have a current rating not less than that of the fuse which protects the circuit or sub-circuit, respectively.

Conductors:

All conductors shall be of copper or aluminium. Conductors for power and lighting circuits shall be of adequate size to carry the designed circuit Load without exceeding the permissible thermal limits for the insulation. The conductor for final sub-circuit for fan and light wiring shall have a normal cross sectional area not less than 1.00 mm2 copper and 1.50 mm2 aluminium. The cross sectional area of conductor for power wiring shall be not less than 1.50 mm2 copper and 2.5mm2 aluminium. The minimum cross sectional area of conductor of flexible cord shall be 0.50mm2 copper.

Flexible Cables and Flexible Cords:

Unless cables and cords are protected by flexible conduits or tough rubber or PVC sheath, they shall not be sued in places where they are liable to be subjected to mechanical damage.

Stranded conductors having a nominal cross sectional area exceeding 6.0 mm2 shall always be provided with soldered terminals.

When a standard conductor having a nominal cross sectional area less than 6.0 mm2 is not provided with cable sockets, all strands at the exposed end of the cable shall be soldered together. 'No-oxide' grease shall be proved on the exposed end of the conductor after soldering.

Passing Through Walls and Floors:

Where conductors pass through walls, one of the following methods shall be employed, care shall be taken to see that wires pass freely through protective pipe or box and that the wires pass through in a straight line without any twist or cross in wires on either ends of such holes.

a) A wooden box extending through the whole thickness of the wall shall be buried in the wall and casing or conductors shall be carried so as to allow 1.3cm. air space on three sides of the casing or conductor.

b) The conductor shall be carried either in a rigid steel conduit conforming to accepted standards or a rigid non metallic conduit confirming to accepted, standards or in a percellin tube of such a size which permits easy drawing in.

c) Insulated conductors while passing through floors shall be protected from mechanical injury by means of rigid steel conduit to a height not less than 1.5m above the floors and flush with the ceiling below. This steel conduit shall be earthed and securely bushed.

Where a wall tube passes outside a building so as to be exposed to weather, the outer end shall be bell mouthed and turned downwards and properly bushed on the open end.

Fixing to Walls and Ceilings:

Plugs for ordinary walls or ceilings shall be of seasonal wood not less than 5cm long and 2.5 cm square on the outer end. They shall be cemented into walls to within 6.5 mm of the surface, the remainder being finished according to the nature of the surface with plaster or lime punning.

Where owing to irregular coursing or other reasons the plugging of the walls or ceilings with wood plugs presents difficulties, the wood casing, wood batten, metal conduit or cleat (as the case may be) shall be attached to the wall or ceiling in an approved manner in the case of new buildings, wherever possible, wooden plugs shall be fixed in the walls before they are plastered, keeping in mind the thickness of plaster to obtain a flush surface.

To achieve neatness, plugging of walls or ceilings may be done by an approved type of asbestos metallic or a fibre fixing plug (rawl plugs).

Fittings and Accessories

Ceiling Roses and Similar Attachments:

A ceiling rose or any other similar attachment shall not be used on a circuit the voltage of which normally exceeds 250 volts.

Normally only one flexible cord shall be attached to a ceiling rose. Specially designed ceiling roses shall be used for multiple pendants.

A ceiling rose shall not embody fuse terminal as an integral part of it.

Earthing: The object of earthing is to drain away any leakage of current due to poor insulation.

DESIGN OF WATER SUPPLY DISTRIBUTION SYSTEM

General: - Design of distribution system inside building involves

(a) estimation of water requirement,

(b) determination of the size of the distribution pipes and

(c) design of pipe layout according to certain basic principles.

Water Requirement: - (IS: 1172 – 1983): The National Building code (SP:7 – 1983) of India recommends that water requirement of 135 liters per head per day may be adopted in the design of water supply system for residential buildings with full flushing system. For residential buildings, the population may be calculated on the basis of five members per family and the number of dwelling units in the building.

Design of the pipe layout: The following broad principles should be borne in mind:

a) Plumbing fixtures and devices shall be as per IS: Codes.

b) It must be ensured that there is no risk of contamination of water supply provided for drinking and culinary purposes. There shall, therefore, be no cross connection whatsoever between a pipe or fitting conveying potable supply and pipe or fitting containing impure or waste water.

c) There shall be no back flow from any cistern or appliance towards the source of supply.

d) All pipe work shall be planned so that the piping is accessible for inspection, replacement and repairs.

e) No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cisterns which shall be supplied from storage tanks.

CAPACITY OF OVERHEAD STORAGE TANK:-

• All the mains should be laid preferably with D.I pipes preferably. • As thee system is proposed to be maintained by concerned municipality / PH/HMWW&SS it is appropriate to consult them and propose the distribution system.

• Sufficient No. of air valves shall be provided in elevated zones for maintaining uniform pressure of supply. • Scorer valves shall be provided at the lowest points to collect the mud and impurities. • As per HMWW 40% of total demand may be considered for design of ELSR capacity. The ELSR shall be located in the highest point of the layout. • The ELSR stagning shall be designed keeping the residual head of 6 m to 7.5 mts for providing of water supply with good pressure.

Storage of water for fire fighting purposes (IS: 9668 – 1980)

• For building not greater than 15 m in height, no separate provision is necessary for fire fighting purposes except that an underground static tank of capacity 50,000 liters shall be provided.

• The Ground level Reservator:- 60% of the total demand may be considered for designing the storage of water in GLSR.

Galvanized Iron (GI) Pipes (IS : 1239, Part 1 – 1990):

GI pipes are made from hot coils of specified thickness. They are available in light, medium and heavy grades depending on the thickness of the sheet used. The thickness of 15 mm GI pipe of light, medium and heavy grade is 2.00, 2.65, and 3.25 mm respectively and the corresponding weight per meter is 1.00, 1.28 and 1.50 kg.

The pipes and sockets should be cleanly finished, well galvanized in and out and free from cracks, surface flaws and laminations. All screw threads shall be clean and well cut.

GI Pipe Fittings (IS 1239, Part 2 – 1990): GI Pipe fittings commonly used in plumbing systems are socket, elbow, tee, union, nipple, reducing socket/ elbow / tee, etc. These are manufactured from GI pipe with parallel threaded connections. The fittings are designated by the respective nominal bore of the pipes for which they are intended.

Laying And Jointing GI Pipes: For internal work, the GI pipes and fittings shall run on the surface of the walls or the ceiling (not in chase) unless otherwise specified. When it is found necessary to conceal the pipes, chasing may be adopted provided there is sufficient space to work on the pipes with the usual tools. Before embedding the pipe in the walls or floors, it should be painted with anticorrosive bitumastic paints of approved quality. The pipe shall not come in contact shall be filled with lime mortar or lime concrete as the pipe is affected by lime. The chases shall be filled with mortar as described.

Threading: The ends of the pipe to be rethreaded shall be carefully filed out to provide chamfer and to ensure that no obstruction to bore is offered. The ends of the pipe shall be carefully threaded with pipe threading dies, pipe vice, etc. in such a manner that there shall be no slackness when the two pipes are screwed together. The screw threads of the pipe and fitting shall be protected from damage until they are fitted.

Jointing: The pipes shall be cleaned and cleared of foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead; a few turns of spun yarn shall be wrapped round the screwed end of the pipe. The end shall then be screwed in the socket, tee, etc. with the pipe wrench. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent ingress of water, soil or any other foreign matter.

Care shall be taken that all pipes and fittings are properly jointed so as to make them completely watertight.

Fixing: All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts, keeping the pipes about 1.5 cm clear of the wall.

The Specials shall be confirmed to IS code.

Stop Valve (IS: 781 – 1984):

Bib Valve (IS: 781 – 1984)

Gate Valve (IS: 9763 –84)

Ball Valve (IS: 1703 – 1989)

Pillar Tap (IS:1795 – 1982)

Fire Hydrant, Landing Valves For Nozzles, etc: Hydrants are invariably used for fire fighting purposes to derive water from the street mains. These shall be of spindle type with 65 mm outlet combined with sluice valve conforming to IS: 780. The hydrants could be of the stand post type or the underground type. The size is 80 mm in case of single outlet and 100 mm in case of double outlets. A duck foot bend is used below the standpipe. The hydrant incorporates a 65 mm male coupling instantaneous pattern to which a standpipe could be attached and cast iron cap permanently secured to duck foot bend. (IS: 908 – 1975 & 5714 – 1981).

DRAINAGE & SANITATION :

Two – Pipe System: In this system of plumbing, the soil and the waste pipes are distinct and separate. The soil pipes are connected to the building sewer direct. Waste pipes are connected to the building sewer through a trapped gully. The gully trap forms a barrier to the passage of foul air from the sewer into the waste pipe.

All traps of soil appliances are completely ventilated through separate ventilating pipes. Likewise traps all waste appliances are also completely ventilated through a separate ventilating pipe. Thus this system of plumbing contains and soil pipe, one waste pipe and two ventilating pipes.

Single Pipe System :- One Pipe System(Fully Ventilated):- The system of plumbing in which the waste connections from sinks, baths and washbasins and the soil pipe branches from water closets are all collected into one main pipe, which is connected, directly to the drainage system. Gully traps and pipes are dispensed with but all traps of water closets, basins etc., are completely ventilated to preserve the water seal.

PLANNING AND DESIGN OF BUILDING DRAINAGE (IS: 1742 – 1983)

The drainage system commences within the building premises at the plumbing fixtures, where the water that is supplied to them, is used or washed and is then drained into the drainage pipes and finally into the public sewer or an individual waste disposal system (septic tank, etc.) The flow in a sewer system is by gravity and not under pressure as in the case of water supply pipes. House drainage consists of the following three sub-systems.

Soil Appliances: The soil appliances (WC, urinal, etc.), which collect and discharge excretory matter, discharge through traps into a soil pipe. The soil pipes discharge into a building (drain) sewer.

Waste Appliances: The waste appliances (wash basin, sinks, shower, etc.) collect and discharge wastewater through traps into waste pipes. The waste pipes discharge into a building sewer directly or through a trapped gully.

Rainwater Systems: The rainwater collected within the premises is carried down the rainwater gutters and pipes. In a partially separate system, where a portion of the rainwater is mixed with the sewage, the building sewer carries rainwater also.

Self-cleansing Velocity: It is the velocity of flow in a conduit at which the grit and other solids remain in a state of suspension and keep flowing. It is necessary to ensure a minimum velocity in a sewer to prevent deposition of suspended solids and blocking of the drainage system. A velocity of 0.75 m/s for at design peak flow is recommended subject to a minimum velocity of 0.6 m/s for present peak flows. The maximum velocity should not exceed 3 m/s to avoid erosion due to sand and other gritty material carried in the sewer.

Depth Of Flow: From consideration of ventilation, sewers should not be designed to full. Up to 400 mm diameter, sewers may be designed to run at half depth; 400 to 900 mm at two-thirds depth and larger sewers at three-fourth depth at ultimate peak flows.

Gradient of the Sewer Line: Normally, the sewer shall be designed for discharging three times the dry weather flow flowing half-full with a minimum self-cleansing velocity of 0.75 m per second. The approximate gradients, which give this velocity for the sizes of sewer pipes commonly used in the buildings, are given in the Table.

Minimum Gradient

Diameter mm Gradient Discharge (cum./min.) 100 1 in 57 0.18 150 1 in 100 0.42 200 1 in 145 0.73 230 1 in 175 0.93 250 1 in 195 1.10 300 1 in 250 1.70

When it is not practicable to provide minimum gradients indicated in Table, a flatter gradient may be adopted but the minimum velocity in such cases should not be less than 0.6 meter per second.

Guidelines For Execution Of Pipe Work: The following precautions may be kept in view while designing and executing sanitary pipe layout for building drainage.

a) The pipe work in branch connections should always be arranged to allow free drainage of the system. Connections to main or branch pipes should be so arranged as to prevent cross flow from one appliance to another. Connections should be made with an easy sweep in the direction of flow particularly in connections in the single stack system.

b) Branch connections should be of large radius along the invert. The connections are not desirable.

c) The minimum diameter of soil and waste stacks shall be 100 and 75 mm respectively.

d) When the pipes are concealed, inaccessible or laid exposed along the internal face of the walls, they should preferably be of cast iron. In the ground floor, all the pipes including those laid on the external face of the wall should be of cast iron.

e) Ample provision should be made for access to all pipe work and the embedding of joints in walls should be avoided as far as possible. f) All appliances directly connected to stack are trapped.

g) It must be ensured that the soil, waste and building sewer pipes are not reduced in diameter in the direction of flow.

h) Cast iron fittings and branches for waste pipes shall be of the same quality as for soil pipe and all waste pipe shall be made gas tight.

General Specifications: The pipes and fittings shall be free from cracks, laps, pinholes and other imperfections and should be neatly dressed and carefully fettled. All pipes and fittings should be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. All CI pipes and fittings are hot dip coated inside and out with a composition having tar or other suitable base. The coating material shall have good adherence and shall not scale off. The coating of tar shall be smooth and tenacious and hard enough not to flow when exposed to temperature of 77°C but not so brittle at a temperature of 0°C as to chip off when scribed lightly with a pen knife.

Cement Mortar Jointing Of CI Pipes: Before jointing, the interior of the socket and the exterior of the spigot should be thoroughly cleaned and dried. The spigot end is inserted into the socket right up to the back of the socket and carefully centered such that there is uniform annular space for filling with a few turns of spun yarn formed into ropes of uniform thickness soaked in neat cement slurry. These shall be pressed home (rammed) into the socket by means of a caulking tool. No piece of rope should be shorter than the circumference of the pipe. More skins of yarns shall be wrapped if necessary and shall be rammed home. The joint shall then be filled with stiff cement mortar 1:2 (1 cement: 2 fine sand) well pressed with caulking tool and finished smooth at top at an angle of 45° sloping up.

The joint must be kept wet for not less than 7 days by tying a piece of gunny bag, four fold, to the pipe and keeping it moist constantly.

Lead Jointing Of CI Pipes: For all the concealed pipes in sunken slabs etc shall be treated with lead. The interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of treated spun yarn, twisted into ropes of uniform thickness, well packed into the back of the socket leaving 25 mm from the lip of the socket for the lead. The jointed pipeline shall be at required levels and alignment.

The lead shall be melted so as to be thoroughly fluid and each joint shall be filled in one pouring. The following precautions shall be taken for melting lead:

a) The pot and the ladle in which lead shall be put shall be clean and dry.

b) Sufficient quantity of lead shall be melted.

c) Any scum or dross, which may appear on the surface of the lead during melting, shall be skimmed off.

d) Lead shall not be overheated.

Fixing Of CI Pipe And Fittings: The pipes are either fixed on face of wall or embedded in masonry. Pipes (without ears) and fittings should be secured to the walls at all joints with MS or CI holder bat clamps. The pipes shall be fixed perfectly vertical unless otherwise specified. Wooden cleats shall be fixed so that the pipes are kept at a distance of 25 – 30 mm from the wall to facilitate cleaning, painting, etc.

General Specifications: The pipes and fittings should be free from any visible defects, such as fire cracks, hair cracks etc. The glaze of the pipe should be free from crazing. The pipe should give a sharp clear tone when struck with a light hammer. There should not be any broken blisters.

Jointing of Pipes: For jointing the pipes, a gasket of unwoven yarn soaked in thick cement slurry is placed around the spigot of each pipe and the spigot is then slipped well into the socket of the pipe previously laid. The pipe is adjusted and placed in the correct position and the gasket is rammed tightly home so as to fill about 1/4th of the total depth of the socket. The remainder of the socket is filled with stiff mixture of cement mortar in the proportion of 1:1 (1 cement: 1 fine sand). When the socket is filled, a fillet is formed around the joint with a trowel to form an angle of 45° with the barrel of the pipe. As the

joint is rigid, it has to be ensured that undue settlement of the underground sewer line does not taken place.

Laying Of SW Pipes (IS : 4127 – 1983):

Trenches: The trenches shall be so dug that the pipe can be laid to the required alignment at the required depth. When the pipe line is under a roadway, a minimum cover of 90 cm is recommended for adoption. The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any shall be properly filled with earth and consolidated in 20 cm layes.

If the trench bottom is extremely hard or rocky, the trench shall be excavated at least 15 cm below the trench grade. Rocks, stones or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand and compacted so as to provide smooth bedding for the pipe.

Laying: The pipe shall be carefully laid to the required alignment, levels and gradients. Great care shall be taken to prevent sand, etc. from entering the pipe. The pipes between two manholes shall be laid truly in a straight line without vertical or horizontal undulations. The pipes shall be laid with socket up the gradient. It may be necessary to support or surround pipe sewers by means of concrete in certain circumstances.

Testing Of Joints: Stoneware pipes used for sewer shall be subjected to a test pressure of 2.5 m head of water at the highest point of the section under test. The test shall be carried out by suitably plugging the lower end of the sewer and the ends of the branch connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required head. Any joint found leaking or sweating, shall be rectified or embedded into 15 cm layer of cement concrete (1:2:4) 30 cm in length and the section retested.

SMOKE TEST:- All soil pipes, waste pipes and vent pipes and other pipes above ground shall be approved gas-tight by a smoke test conducted under a pressure of 25 mm of water and maintain for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oiled waste or tat paper or similar material in the combustion chamber of a smoke machine.

Back-filling: In cases where pipes are not bedded on concrete special care shall be taken in refilling the trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and danger to foundations etc. The backfilling material shall be packed by hand under and around the pipe. No tamping should be done within 15 cm of the top of the pipe.

The refilling shall rise evenly on both sides of the pipe, continued up to 60 cm above the top of the pipe so as not to disturb the pipe.

Check Lists for finished works (Items to be Checked)

TILE FLOORING AND DADO

1) Layout of floor checked and proper slopes for draining water are maintained specially in bath room and toilet.

2) Thickness bases at GL checked of different floor

3) Check for proper back filling under floor done

4) Metal/glass strips laid properly in IPS flooring

5) Curing of IPS Flooring done as per requirements

6) Dado provided as per required height

7) Cleaning and finishing done

PLUMBING & WATER SUPPLY

1) UPVC/SWR pipes etc. confirms to relevant IS codes

2) Pipes of required diameter and their fittings used

3) Plumbing and Water Supply work carried out through a licensed plumber

4) Works done as per specification

5) Plumbing and Water Supply works tested on completion

6) Defects rectified

INTERNAL ELECTRICAL WORKS

A. GENERAL

1) Layout plans: showing the position of L.T Panels/ distribution board, lighting fixtures, lighting distribution, scheme, receptacles, etc available before commencement of work

2) All the following items are as per specification and of approved makes

a) L T Panels/ Distribution Boards

b) Lighting Fixtures

C) Conduits, including accessories

d) Receptacles

e) Junction Boxes

f) Cables/Wires

g) Any other item

SURFACE CONDUIT WIRING / CONCEALED CONDUIT WIRING

1. Conduit and accessories are of specified make, gauge and diameter

2. Proper installation of all conduit wiring and concealed wiring.

- **C. CHECK LIST FOR EARTHING**

1) Earth electrode provided as specified.

2) Types and size of main/sub main and circuit earthing conductors provided as specified

- **D. MAIN AND DISTRIBUTION BOARDS**

1) Main switch board is fabricated based on approved shop drawings and the entire material used is as per BIS Code.

2) Make of switches and other items as specified.

DRAINAGE WORKS

1) Excavation for drains carried out as per the approved lay-out

2) Bed Concrete laid as per specifications with proper slopes and cuttings

3) All pipes procured and laid as per requirement

4) Jointing of pipes done as per specifications

5) Manholes provided as per design

6) Materials for construction of manhole as specified

7) End of the pipes plugged

8) Drainage line tested before putting to use

CHAPTER -6

Approvals and check list

The following approvals are required and the contractor shall satisfy the items shown in the check list vide Annexure -IX

The Contractor Shall Submit Quality Management Plan (QMP) duly indicating the test procedures, frequency of testing and formats for recording test results, and get approval for QMP before proceeding with execution of the project.

The contractor shall submit the detailed designs, all drawing and get approval from the competent authority and based on the above the contractor shall submit the detailed estimate with BOQ (Bill of Quantise) which will be basis for making payments.

MEP systems must satisfy multiple objectives and criteria for design, installation, commissioning, operation, and maintenance. Different types of specialty contractors (e-g., process piping, HVAC piping, WAC ductwork, plumbing, electrical, fire protection, controls) are responsible for these systems. Example of diverse criteria for system design include spatial (avoiding interferences), functional within a system (flow or gravity drainage), adjacency or segregation, system installation (layout dimensions, space and access for installation productivity), and testing (ability to isolate).

For electrical system designers, the design parameters are set in accordance with the National Electric Code (NEC). These are the minimum requirements that must be met. Electrical system designers must also adhere to NFPA 13, and the UBC for requirements beyond the minimum set forth by the NEC. The major categories of the electrical system are supply, distribution, and lighting.

Plumbing system: The plumbing system consists of three major categories - gravity drained waste systems, pressure driven systems, and pumped waste. Plumbing design must meet the Uniform Plumbing Code (LPC). The gravity drain systems include sloped lines which must have a natural grade line. In addition, the gravity drained systems require vent lines for the entire system, to allow for open channel flow in the drainage network. The pressure driven systems include hot and cold water supply lines the various locations in the building.

The following QC Testing & essentials are very much essential to give approvals for materials and workman ship

1) Ponding tests are required to be conducted for toilets and terrace.

2) 10% of the Quality control test are required to be conducted at the external labs approved by NABL..

3) Complete specification for finishing items were required to be finalized and approvals shall be obtained.

4) Approvals to use the materials on the work shall be accorded.

5) Curing is required to be supervised properly and records are to be maintained.

6) Filling in basement shall be compacted properly as per APDSS.

7) Honeycombs and shrinkage cracks shall be properly filled up before applying putty.

8) If the steel used is underweight compared to standard weight and the actual coefficient shall be taken in to account for arriving steel quantity.
9) The SBC shall be verified at the foundation level and approval to commence the foundation is shall be granted.
10) Mix design approvals shall be granted before use the ordinary grade concrete and SCC.in the work.

The Essential Certificates

1. **Foundation and Basement filling Certificate**

It is certified that filling in the above work is done with useful excavated earth (exuding rock)/Carted earth/Gavel/Sand in trenches, sides of foundations and basement in layers not exceeding 150 mm thick, consolidating each deposited layer duly watering and ramming as per Agreement and APSS No.309 & 310.

2. **No Cracks Certificate**

This is to certify that no cracks were seen in the walls and slab for the above work.

3. **No Dampness Certificate**

It is certified that ponding test is conducted as per agreement and there is no dampness /leakages observed either on walls or cellings for the above work.

4. **Wood Certificate**

It is certified that wood used for doors / windows / ventilators / cub boards etc, for the above work is well seasoned and as per agreement specification.

5. **Certificate on Maintenance of Registers**

It is certified that site Order Book, Daily Event Register, Field tests Registers and Lab test reports for the above work are maintained as per agreement conditions

CHECKLISTS

There shall be a quality verification of the work at the time of submission of each bill by the Contractor. For this, checklists are to be filled up by the Engineer-In charge concerned during the execution. It shall be verified and attested by the Dy. Technical Officer and reviewed by the Technical Officer before submission to the Dy. Chief Technical Officer along with the bill for payment. Specimen checklists for quality assurance are given in Appendices of this Manual.

Format–A : Inspection checklists for Tiles		
Layout of floor checked and proper slopes for draining water are maintained specially in bath room and toilet.		
Thickness bases at GL checked of different floor		
Check for proper back filling under floor done		
Metal/glass strips laid properly in IPS flooring		
Curing of IPS Flooring done as per requirements		
Dado provided as per required height		
Cleaning and finishing done		

Format–B : Inspection checklists for Water Supply

Sl.No.	Item to be checked	Remarks by Implementation agency / Authorised representative	Compliance by Contractor
1	Is the construction as per approved construction drawings?		
2	Is the trench to proper i) alignment? ii) depth conforming to minimum cover, and iii) width?		
3	Is proper bedding provided under (& around if necessary) the pipe with granular material like sand or crusher dust?		
4	Are the manufacturer's test certificates for raw material made available? Has the pipe testing been witnessed by Engineer – in -charge? Do the results satisfy the requirements of IS: 4984? Is the % of reprocessed HDPE material maintained less than 10%?		
5	Are there any cracks in the DI/CI in the pipes or the lining?		
6	Whether specials like bends, tees etc. conform to the material and pressure of the relevant pipe line?		
7	Is the jointing of pipes good, particularly at junctions and while giving house service connections? Have good quality jointing materials (like solvent cement for PVC; butt welding using welding machine for HDPE; Jiffy joints with Rubber rings and gaskets for DI/CI been used? Are the rubber rings and gaskets field tested and are positioned properly with jointing material?		
8	Are thrust blocks provided at bends as per requirements of BIS?		
9	Is the backfilling done properly by watering and ramming in layers duly removing boulders etc. and slightly higher than GL?		
10	Are the house connections of GI or MDPE? Is the quality of GI/MDPE pipes as per standards?		

Sl.No.	Item to be checked	Remarks by Implementation agency / Authorised representative	Compliance by Contractor
11	Are the i) valves, ii) valve chambers, covers and iii) specials of good quality? iv) are they properly and safety located to prevent their breaking due to traffic? v) do they conform to the relevant pipe line requirements?		
12	Whether air valves conform to the pipe line requirements?		
13	Whether non-return valves conform to the pipe line requirements?		
14	Whether pressure release valves conform to the pipe line requirements?		
15	Are horizontal stretches in the pipe line avoided to prevent air accumulation?		
16	Have proper Arrangements for Interconnection with Source of supply done? Are concrete / RCC thrust blocks provided at bends as applicable?		
17	Has the Hydraulic test on pipeline/s been conducted? Is it witnessed by the Engineer – in -charge & community?		
18	Is the test pressure adequate and as per specifications?		
19	Is there any leaks/cracks/damages observed in the pipes or joints?		
20	Have all Households taken House Service Connections?		
21	Are the pressures adequate? Have all pit taps, if any, been removed after laying new distribution lines/ replacing old lines?		
22	Are there any un served Households?		
23	Is there any pollution or scope for pollution of drinking water? If so, are necessary precautions taken **or** planned?		
24	Is water **actually** reaching the consumer's house with adequate pressure?		

Sl.No.	Item to be checked	Remarks by Implementation agency / Authorised representative	Compliance by Contractor
25	**PUMP SETS:** **i)** Are the pumps procured as per specifications of duty and head? Has testing of pump set been conducted in the presence of Engineer – in -charge? ii) Have the pump sets passed the tests and satisfy the duty and head requirements? iii) Have all accessories like panel board, switch gear of the pump sets been supplied and are they suitable and satisfy the quality requirements? iv) Is the starter provided appropriate to the KW of the pump set? iv) Has Trial run been conducted and is it successful? v) Have single phasing preventor, over load relay & capacitors been provided?		
26	Are the cable sizes provided as per design and operating conditions?		
27	Is positive suction condition ensured for centrifugal pump sets?		
28	Has an eccentric taper been provided on the suction side?		
29	Have the required sluice valves and non-return valve on delivery side been provided? Is the piping devoid of unnecessary bends etc. to reduce friction losses?		
30	Have proper earthing, lightning arrestors and safety controls been provided?		
31	Have dismantling joints been provided for the valves at the pump house?		
32	Has the electrical connection been given to the pump sets?		
33	Has the correct Contracted Maximum Demand (CMD) been agreed with the State Electricity Board ?		
34	For a tube well, has the capacity (KW) of the submersible pump set been fixed based on the depth and yield of water after conducting yield test?		
35	**SUMP / OHSR / GLSR** Is the safe bearing capacity (SBC) of soil for foundation of Sump / OHSR been tested?		

Sl.No.	Item to be checked	Remarks by Implementation agency / Authorised representative	Compliance by Contractor
36	Does the design of foundation for the Sump / OHSR need any revision based on the SBC?		
37	Have necessary strengthening of foundation done for poor soils like BC soil and / or high water table, if met?		
38	Has the reinforcement assembly at each stage been checked by the Engineer – in - charge?		
39	Is the form work for floor slab/ roof slab / dome adequate and safe?		
40	Is the steel being used comply with the relevant specifications? Are the manufacturer's test certificates available on site?		
41	Has the steel been tested for tensile strength, % elongation and rebend test? If so, do the results satisfy the requirements of the code?		
42	Has the minimum cover in accordance with IS: 3370 provided for RCC water retaining structures?		
43	Is the detailing at joints properly done as per SP: 34?		
44	Have puddle pipes been provided in the floor slab of OHSR?		
45	Has the SUMP / OHSR /GLSR been tested for water tightness in accordance with IS: 3370?		
46	Is there any leakage through the Sump / OHSR / GLSR?		
47	Is the scour of OHSR/GLSR connected to natural drain?		
48	Have the inlet and outlet been inter connected (bye pass)?		
49	Has the overflow pipe been connected to the outlet pipe?		
50	Have proper lightning arrestor, water level indicators, ventilators, ~~phenial~~, ladders, staircase, railing been provided?		
51	Has the ground below the ELSR been raised to prevent stagnation of water?		

Format– C : Inspection checklists for Sewerage

Sl.No.	Item to be checked	Remarks by Implementation agency / Authorised representative	Compliance by Contractor
1	Is the sewer construction done from the downstream (D/S) end considering the Invert Levels of Manhole (MH)on out fall sewer / Inlet of Septic Tank?		
2	Has TBM been established in the poor settlement and have the invert levels been established based on this TBM from the d/s end?		
3	Have the invert levels been checked through the LF book by the Engineer – in - Charge?		
4	Are sight rails and boning rods used in aligning and fixing the invert levels of sewer?		
5	Are the i) Invert Levels of inlet and outlet of septic tank and ii) invert levels of sewers fixed as per construction (working) drawings?		
6	Is the sewer construction done from the d/s end? Is the direction of socket facing the upstream end?		
7	Is proper granular bedding provided under the sewer for the required depth?		
8	Is the sewer jointing done properly using solvent cement for UPVC pipes and Hessian/jute yarn soaked in cement mortar 1:1 ½ and cocked with a cocking tool into the socket end?		
9	Are the manufacturer's test certificates available at the site? Have the pipe testing been witnessed by Engineer – in –charge ? Do the test results satisfy the requirements?		
10	Is the sewer trench to proper i) Alignment? ii) Gradient? iii) Depth? and iv) Width?		
11	Is the sewer jointing properly done as per specification?		
12	Is the backfilling done properly by watering and ramming in layers, removing boulders etc. and slightly higher than GL?		

Sl.No.	Item to be checked	Remarks by Implementation agency / Authorised representative	Compliance by Contractor
13	Are the 'Y's & 'Tee's of good quality?		
14	Is the connection to trunk main/septic tank properly planned /given?		
15	If the main sewer is to be joined to the outfall (trunk) sewer, is the crown level of the main sewer higher than the crown level of the outfall (trunk) sewer to prevent back flow?		
16	Has the Hydraulic Testing of sewer lines witnessed by the, Engineer & the community? If there is any leakage etc., has it been rectified?		
17	Have all Households taken House Connections?		
18	Are the Manholes (MH) properly constructed as per design and drawings and to proper spacing, to the correct invert level using first class bricks? Are they properly cured? Are the sewers properly aligned and joined at the MH? -		
19	Are the top of Man Holes provided flush with the road level?		
20	Are Man Hole frames and covers of appropriate strength provided i.e., LD / MD / HD / EHD considering the type of traffic to take care of traffic loads? Are they of good quality?		
21	Has proper channelling (benching) been provided at the invert of the Man Hole?		
22	Are there any un-served Households?		
23	**SEPTIC TANK:** Has the effect of GWT been considered in the design of floor slab? Has necessary strengthening of foundation done for poor soils like BC soil, if met with?		
24	Have the baffle walls been provided properly at the right place?		
25	Have the Invert Levels for inlet and outlet properly adhered to and the influent enters the septic tank and leaves it satisfactorily?		
26	Has free board of 0.30 m been provided for the septic tank?		

Sl.No.	Item to be checked	Remarks by Implementation agency / Authorised represen- tative	Compliance by Contractor
27	Has slope towards the inlet been given at the bottom to enable proper sludge removal?		
28	Is the septic tank outlet properly connected to either dispersion trenches or to storm water drain?		
29	Has the reinforcement assembly at each stage been checked by the Engineer – in - charge?		
30	Is the form work for floor slab/ roof slab / dome adequate and safe?		
31	Is the steel being used comply with the relevant specifications? Are the manufacturer's test certificates available on site?		
32	Has the steel been tested for tensile strength, % elongation and rebend test? If so, do the results satisfy the requirements of the code?		
33	Has the minimum cover in accordance with IS: 3370 provided for RCC water retaining structures?		
34	Is the detailing at joints properly done as per SP: 34?		
	Have man holes been provided at the inlet and outlet?		
35	Has the septic tank been tested for water tightness in accordance with IS: 3370?		
36	Is there any leakage through the septic tank?		

Format– D: Inspection checklists for Drains

Sl.No.	Item to be checked	Remarks by Implementation agency / Authorised representative	Compliance by Contractor
1.	Is the construction as per approved construction drawings?		
2.	Are the Drain Top Levels below the Road Edge Levels and Courtyard Levels for onsite drains?		
3.	Is Proper alignment and gradient maintained for the drains?		
4.	Are the dimensions correct?		
5.	Is proper granular bedding provided under the bed concrete after removing loose, slushy soil? Is the bed concrete of Good quality?		
6.	Is the construction done to the required gradient?		
7.	Are the CA, FA and water of good quality & free from deleterious material?		
8.	Are the concrete cube samples taken by Engineer – in -charge and tested? If so, do they satisfy compressive strength requirements?		
9.	Is Vibrator being used?		
10.	Is Curing done properly for the specified period?		
11.	Is the internal drainage properly connected to the outfall drain?		
12.	Are the Road side drain walls raised to just below road level? Are the dimensions of these walls adequate?		
13.	Is the finishing of the drain good?		
14.	Are the culverts adequate to discharge the drainage? If not, do they need widening?		
15.	Are the water pipe lines across the drain or beside the drain being shifted /realigned/encased to prevent pollution of water?		
16.	Is there any need to rehabilitate existing damaged drain section if any, which inhibits the efficiency of functioning of the drain?		

Format– E: Inspection checklists for Water Proofing

1	Surface for waterproofing has been prepared and cleaned		
2	Safety measures/ precautions taken before commencement of works		
3	Specified type of water proofing used		
4	Specified material used for waterproofing		
5	The material used was as per specification		
6	Work has been carried out as per specifications by the department/ specialized agency		

Format– F: Inspection checklists for Plumbing & Water Supply

GI/CI/HDPE pipes etc. confirms to relevant IS codes		
Pipes of required diameter and their fittings used		
Plumbing and Water Supply work carried out through a licensed plumber		
Works done as per specification		
Plumbing and Water Supply works tested on completion -		
Defects rectified		

G) INTERNAL ELECTRICAL WORKS			
A.GENERAL			
1	Layout plans: showing the position of L.T Panels/ distribution board, lighting fixtures, lighting distribution, scheme, receptacles, etc available before commencement of work		
2	All the following items are as per specification and of approved makes L T Panels/ Distribution Boards Lighting Fixtures Conduits, including accessories Receptacles Junction Boxes Cables/Wires Any other item		
B SURFACE CONDUIT WIRING / CONCEALED CONDUIT WIRING			
1	Conduit and accessories are of specified make, gauge and diameter		
2	Proper installation of all conduit wiring and concealed wiring.		
C. CHECK LIST FOR EARTHING			
1	Earth electrode provided as specified.		

Sr. No.	Items	Remarks by Implementation agency / Authorised representative	Compliance by Contractor
2	Types and size of main/sub main and circuit earthing conductors provided as specified		
D. MAIN AND DISTRIBUTION BOARDS			
1	Main switch board is fabricated based on approved shop drawings and the entire material used is as per BIS Code.		
2	Make of switches and other items as specified.		
	CHECK LIST FOR EXTERNAL ELECTRICAL WORKS		
A. CHECK LIST FOR O.H. LINES			
1	Poles used are of approved make as specified and conform to relevant BIS codes.		
2	Test certificate as applicable.		
3	Pole embedded below ground level as specified.		
4	Metallic poles are adequately earthed with specified size of earth conductor.		
5	Strays struts, insulators, conductors used conform to relevant BIS Code.,		
6	Earth wire conductor used as specified.		
7	Lightning arrestors used as specified		

Sr. No.	Items	Remarks by Implement	Compliance by Contractor
8	Spacing of poles, spans and clearance between, conductors and, surroundings kept as specified.		
9	Insulators used for specified grade.		
B. CABLE LAYING			
1	Trenches of specified dimensions excavated and prepared		
2	Required quantity of sand cushioning provided; cable laid; another layer of sand and brick protective covering provided. Refilling done earth ramming and dressing done.		
3	Cables entry point in building or crossing roads path protected by providing Hume pipes or PVC pipe		
4	Cable tested before and after laying and before emerging		
C. CHECK LIST FOR EARTHING			
1	Earth electrode provided as specified		
2	Types and size of main/ sub main and circuit earthing conductors provided as specified.		

H. IPS/TILE FLOORING AND DADO			
Layout of floor checked and proper slopes for draining water are maintained specially in bath room and toilet.			
Thickness bases at GL checked of different floor			
Check for proper back filling under floor done			
Metal/glass strips laid properly in IPS flooring			
Curing of IPS Flooring done as per requirements			
Dado provided as per required height			
Cleaning and finishing done			

CHAPTER VII

Concrete during atmosphere at temperate above 40^0 c

EXTRACTS OF IS 7861-1: CODE OF PRACTICE FOR EXTREAM WEATHER CONCRET

2.1 Hot Weather Concreting -

Any operation of concreting done at atmospheric temperatures above 40°C or any operation of concreting (other than steam curing) where the temperature of concrete at time of its placement is expected to be beyond 40°C.

3. EFFECTS OF HOT WEATHER ON CONCRET

3.1 Effects of hot weather on concrete, in the absence of special precautions, may be briefly described as follows:

a) Accelerated Setting - High temperature increases the rate or setting of the concrete. The duration of time during which the concrete can be handled is reduced.

b) Reduction in Strength - High temperature results in the increase of the quantity of mixing water to maintain the workability with consequent reduction in strength.

c) Increased tendency to crack - Either before or after hardening plastic shrinkage cracks may form in the partially hardened concrete due to rapid evaporation of water. Cracks may be developed in hardened concrete either by increased drying shrinkage resulting from greater mixing water used or by cooling of the concrete from its elevated initial temperature.

d) Rapid Evaporation of Water During curing period - It is difficult to retain moisture for hydration and maintain reasonably uniform temperature conditions during the curing period.

e) Difficulty in Control of Air content in Air-Entrained Concrete -It is more difficult to control air content in air-entrained concrete. This adds to the difficulty of controlling workability. For a given amount of air-entraining agent, hot concrete will entrain less air than concrete at normal temperatures.

4. TEMPERATURE CONTROL OF CONCRETE INGREDIENTS

4.1 The most direct approach to keep concrete temperature down is by controlling the temperature of its ingredients. The contribution of each ingredient to the temperature of concrete is a function of the temperature, specific heat, and quantity used of that ingredient. The aggregate, and mixing water exert the most pronounced effect on temperature of concrete. Thus, in hot weather all available means shall be used for maintaining these materials at as low temperatures as practicable.

4.2 Aggregates - Anyone of the procedures or a combination of the procedures given in 4.2.1 to 4.2.3 may be used for lowering the temperature or at least for preventing excessive heating of aggregates.

4.2.1 Shading stockpiles from direct rays of the sun.

4.2.2 Sprinkling the stockpiles of coarse aggregate with water and keeping them moist. This results in cooling by evaporation, and this procedure is especially effective when relative humidity is low. Such sprinkling should not be done haphazardly because it leads to excessive variation in surface moisture and thereby impairs uniformity of workability.

4.2.2.1 When coarse aggregates are stockpiled during hot weather, successive layers should be sprinkled as the stockpile is built up.

4.2.2.2 If cold water is available, heavy spraying of coarse aggregate immediately before use may also be done to have a direct cooling action.

4.2.3 Coarse aggregates may also be cooled by methods, such as inundating them in cold water or by circulating refrigerated air through pipes or by other suitable methods.

4.3 Water- The mixing water has the greatest effect on temperature of concrete, since it has a specific heat of about 4.5 to 5 times that of cement or aggregate. The temperature of water is easier to control than that of other ingredients and, even though water is used in smaller quantities than the other ingredients. the use of cold mixing water will affect a moderate reduction in concrete placing temperatures

4.3.1 Efforts shall be made to obtain cold water, and to keep it cold by protecting pipes, water storage tanks, etc.

4.4 Cement - The temperature has a direct effect on the rate of hydration of cement. High concrete temperature increases the rate of hydration, the rate of stiffening and generally results in increased water demand thus contributing to reduced strength and to plastic shrinkage. Temperature has a definite effect on setting time, and the magnitude of the effect varies with the cement composition when a set-controlling admixture is used. The change in temperature of cement produces significantly less change in the temperature of fresh concrete than the other ingredients. However, it does exert an effect and it is considered prudent to place a maximum limit on temperature of cement as it enters the concrete. Cement shall preferably not be used at temperatures in excess of about 77°C.

5. PROPORTIONING OF CONCRETE MIX MATERIALS AND CONCRETE MIX DESIGN

5.1 The quantity of cement used in the mix affects the rate of increase in temperature. As such, the mix should be designed to have minimum cement content consistent with other functional requirements. As much as possible, cements with lower heat of hydration shall be preferred instead of cements having greater fineness and high heat of hydration.

5.2 In hot weather, hydration of cement is accelerated by high temperature and this acceleration is generally considered responsible for the increase in water requirement of concrete. When the temperature is such as to increase

mixing water demand or reduce workability significantly, water reducing and set-retarding admixtures may be used to offset the accelerating effects of high temperatures and to lessen the need for increase in mixing water.

6. TEMPERATUR OF CONCRETE AS PLACED

6.1 In hot weather, wherever necessary, the ingredients of concrete should be cooled to the extent necessary to maintain the temperature at the time of placing below 40 ^{0}C.

7. PRODUCTION AND DELIVERY

7.1 Temperatures of aggregates water, and cement shall be maintained at the lowest practical levels so that the temperature of the concrete is below 40°C at the time of placement.

7.2 Mixing time shall he held to the minimum which will ensure adequate quality and uniformity, because the concrete is warmed from the work of mixing, from the air, and from the Sun. The effect of mixture surface exposed to the hot sun should be minimized by painting and keeping the mixer drum yellow or white and spraying with cool water.

7.3 Cement hydration, temperature, loss of workability, and loss of entrained air, increase with passage of time after mixing. Thus, the period between mixing and delivery shall be kept to an absolute minimum. Attention shall be given to coordinating the delivery of concrete with the rate of placement to avoid delays in delivery.

8. PLACEMENT, PROTECTION AND CURING

8.1 Placement and finishing: Forms, reinforcement, and subgrade shall be sprinkled with cool water just prior to placement of concrete. The area around the work shall be kept wet to the extent possible to cool the surrounding air and increase its humidity, thereby reducing temperature rise and evaporation from the concrete. When temperature conditions are critical. concrete

placement may be restricted to the evening or night when temperatures are lower and evaporation is less.

8.1.1 Speed of placement and finishing helps to minimize problems in hot weather concreting. Delays contribute to loss of workability and lead to use of additional mixing water to offset such loss.

8.1.2 Concrete shall be placed in layers thin enough and in area small enough that the time interval between consecutive placement is reduced and vibration or other working of the concrete will ensure complete union of adjacent portion. If cold joints tend to form or if surfaces set and dry too rapidly, or if plastic shrinkage cracks tend to appear, the concrete shall be kept moist by means of fog sprays, wet burlap, cotton mats, or other means. Fog sprays applied shortly after placement and before finishing, have been found to be particularly effective in preventing plastic shrinkage cracks when other means have failed.

8.1.3 All placement procedures shall be directed to keep the concrete as cool as practicable and to ensure its setting and hardening, under temperature condition which are reasonably uniform and, under moisture condition, which will minimize drying.

8.2 Protection and curing -Since hot weather leads to rapid drying of concrete, protection and curing are far more critical than during cold weather. Particular attention shall be paid to having all surfaces protected from drying. Immediately after consolidation and surface finish, concrete shall be protected from evaporation of moisture, without letting increase of external water, by means of wet (not dripping) gunny bags, regain cloth etc. Once the concrete has attained some degree of hardening sufficient to withstand surface damage (approximately 12 hour- after mixing). moist curing shall commence. The actual duration of curing shall depend upon the mix proportion, size of the member as well as the environmental condition. however, in any case it shall not be less than 10 days. Continuous curing is

important, because volume changes due to alternate wetting and drying promote the development of surface cracking.

8.2.1 If possible, water shall be applied to formed surfaces while forms are still in place and unformed surfaces shall be kept moist by wet curing. The covering material shall be kept soaked by spraying. Steeply sloping and vertical formed surfaces shall be kept completely and continuously moist prior to and during form removal by applying water to top surfaces so that it will pass down between the form and the concrete.

8.2.2 On exposed unformed concrete surfaces, such as pavement slabs, wind is an important factor in the drying rate of concrete.

8.2.3 On hardened concrete and on flat surfaces in particular curing water shall not be much cooler than the concrete because of the possibilities of thermal stresses and resultant cracking. At the termination of curing with water, an effort shall be made to reduce the rate of drying by avoiding air circulation. This can be accomplished by delay in removal of wet cover until they are dry.