
UNIT 16

STEEL WORK, UTILITIES, FINISHING ITEMS ETC.

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16.0 INTRODUCTION

You have already studied about the supervision checks required to be carried out for various materials, types of concretes and different parts of the building. We now focus attention on structural steel work and various finishes and services provided in a building which ultimately come in contact with day to day usage by the occupant. These activities include flooring, plastering, white washing painting, wood work, water proofing, walling, roofing, water supply and electric supply.

16.0 OBJECTIVES

After studying this unit, you should be able to:

- understand the checks required to be observed during finishing items like flooring, plastering, white washing, painting, wood work etc.,
- distinguish between checks required for services like water supply, electric supply and HVAC works etc., and
- understand the checks required for other items like structural steel work, walling water proofing, roofing and ceiling etc.

16.2 STRUCTURAL STEEL WORK

The checks to be observed during supervision of structural steel work are:

- a. Ensure that all steel brought to site is of specified category, grade and quality and where welding is specified, it is of the appropriate grade.
- b. Check that weights and dimensions are correct.
- c. Check that first coat of protective paint has been applied where specified. Take particular care of portions which will not be accessible after fitting/hoisting.
- d. See that contractor has proper tools for drilling, shearing, sawing, gas cutting, welding, grinding and riveting.
- e. See that all the material is free from bends, twists and waviness. Where necessary, get it straightened or flattened by pressure.
- f. Cutting should be effected by shearing, sawing or gas cutting. Protrusions if any should be rectified by grinding edges.
- g. Holes should be drilled and not punched. Before drilling, ensure that all the members are clamped. If this is not practicable, prepare a template so that the position of the holes is correctly marked. Before riveting/bolting, make sure that the holes are concentric.
- h. The hole shall be 1.5 mm larger in case of the diameter of the rivet/holt being 25 mm or less and 2 mm larger in case of the diameter of the rivet/holt exceeding 25 mm.
- i. The component parts shall be assembled in such a way that they are neither twisted nor damaged in handling.
- j. Rivets shall be of proper quality and shall be heated uniformly without burning or excessive scaling.
- k. See that rivet heads are neatly finished. For multiple rivetted section, service bolts should be provided in every third or fourth hole.
- l. The threaded portion of each bolt should project through the nut at least two threads.
- m. See that washers are provided on bolt heads and nuts.

- n. See that heel plates of trusses are slotted at one end to allow for expansion where specified and that dimensions of steel trusses are correct.
- o. Where welding is specified, study the Indian Standard Codes on the subject for achieving best workmanship.
- p. In steel fabrication, mistakes once made cannot be rectified easily. Hence great care must be taken that due allowance has been made in the components of particularly large span framed girders while fabricating on ground, so that the deflection due to dead weight does not create any problem while fixing such girders on supports.

(Note: Useful Indian Standards are IS: 226, 277, 278, 280, 412, 432, 800, 805, 806, 808, 816, 818, 819, 1148, 1173, 1323, 1977 and 2062 as amended).

16.3 FLOORING

16.3.1 Cement Concrete Floor

- i. Check that formation is properly compacted with water, and that thickness of base concrete and the topping is as specified.
- ii. See that proper slope has been given to the floors where necessary to allow for cleaning and washing.
- iii. See that the work is done in panels not exceeding 2 meters square laid alternately with dividing glass strips on all the four sides. The top edge of the glass strip should be flush with the concrete surface and should not be proud of the surrounding surface or lower.
- iv. See that the water cement ratio is properly controlled. Excessive water decreases the strength and does not allow proper bond for the smoothing layer and result in stripping of surface mortar. Smoothing of the floor should be completed within 30 minutes of laying concrete.
- v. See that the concrete is properly compacted but not overdone to an extent which brings excess of water and matrix to the top.
- vi. Mix the entire quantity of dry cement for floor in one room and keep it separately as cement from different stocks gives varying color to the floor.
- vii. See that curing is done for at least 10 days.

16.3.2 Terrazzo Flooring

- i. Entire quantity of cement, pigment and marble chips for floor in one room should be mixed before starting the work on flooring. A small quantity of material for top filling grout should be kept separately for use during grinding.
- ii. See that marble chips are of correct type and grade and that pigments are of good quality to give permanent color.
- iii. Do not heap up the mix of cement, pigment and aggregate so that bigger aggregate falls to the bottom.
- iv. The floor should be laid in panels not exceeding 2 meters square. See that joints in terrazzo floor are over the corresponding joints in the structural slab and glass or aluminum strips are used for them.
- v. Terrazzo topping should be laid when the under layer is reasonably hard but still plastic. Normally the period is 18 to 24 hours. Provide a layer of cement slurry before laying topping.

- vi. Avoid excessive troweling and ramming of topping and see that proper anchorage has been provided for the dividing strips.
- vii. Study the Indian Standard Code of practice and apply carefully for the specified finish. Cutting of floor by grinding machine as per IS code must be followed.

16.3.3 Other Types of Floor

For terrazzo tiles and other types, such as glazed tiles, linoleum, rubber floors carry out the work as specified. Study Indian Standards and manufacturer's instructions for taking appropriate precautions.

(Note: Useful Indian Standards are IS: 653, 777, 809, 1196, 1197, 1198, 1237, 1443, 1478, 2114, 2571, and 2690 as amended)

16.4 PLASTERING AND POINTING

- a. See that all joints are thoroughly raked out before work commences except where pointing is in the same mortar as the masonry when joints should be struck as masonry proceeds. Insist on a whole wall being treated at one time, i.e., the joints from top to bottom in the whole length should be raked out. Where cement mortar is used in the masonry and joints are not to be struck along with work insist on joints being raked out every evening after the day's work, as otherwise the mortar will set hard and have to be cut out, damaging the edges of the bricks. See that joints are washed and well wetted before commencement of work.
- b. See that the correct type of pointing as specified is done. All the pointing should be as per the sample already approved.
- c. Take great care in mixing mortar for plaster and pointing. Ensure that mixing is in accordance with specifications.
- d. Plastering must not commence till all the internal plumbing and conduits for electrification have been laid and covered.
- e. In plastering see that laths are used to show thickness of coat required at not more than 1.5 m spacing.
- f. In two-coat work never allow first coat to exceed 10 mm or as specified and see that it is kept wet for 7 days before second coat is applied.
- g. Check plaster to see that it is in plumb.
- h. Reject any plaster which 'blows'. Insist on careful slaking of lime to guard against this in lime or lime gauged plaster except where hydrated bagged lime is used.
- i. Avoid excessive troweling.
- j. Plastered and pointed surfaces should be kept wet for 10 days after completion.

(Note: Useful Indian Standards are IS: 1542, 1661 and 2402 as amended.)

16.5 WHITE WASHING, DISTEMPER, PAINTING AND GLAZING

16.5.1 White Wash and Distemper

- a. See that lime in un-slaked is brought to site.
- b. See that lime is properly slaked and adequate quantity of gum solution is added.

- c. In case of color wash, apply a small sample and let it dry to ensure that uniform and correct color has been obtained.
- d. See that white/color wash is of proper creamy consistency and not too thin.
- e. See that nail holes and patches in walls are repaired before applying white/color wash.
- f. See that proper hair brushes are used for internal white/color washing if spray machines are not available.
- g. Remove all loops in layers of white/color wash before applying fresh coats.
- h. Rub surface to see that wash is reasonably fast, the color is even and reject any surface that 'blows'.
- i. Pass each coat separately before next coat is applied and record in the works-passing-register.
- j. See that the white/color wash splashes have been removed from glass, joinery, dado, skirting, floors, sanitary fittings and electric fittings and so on before the buildings are taken over. Splashes should be removed immediately otherwise it becomes harder to do so.
- k. Distemper/cement-based paint will not be applied over lime washed surfaces.
- l. In case of non-washable distemper see that the various ingredients are correctly mixed as specified. Ready mixed distemper is preferable.
- m. In case of washable distemper, ensure that the material is obtained in sealed containers from approved manufacturer licensed by ISI and that manufacturer's instructions are followed in the preparation and application.
- n. Distemper shall be applied with hair brushes.
- o. In case where other decorative finishes like water proof cement paint, oil bound paint and such other similar finishes are specified, carry out the work as per manufacturer's instructions and as specified.

(Note: Useful Indian Standards are IS: 427 and 428 as amended).

16.5.2 Painting and Glazing

- a. See that all the paint required for the primer, undercoat and finishing coat is from the same manufacturer obtained in sealed containers and opened in presence of authorities.
- b. See that surface is properly cleaned and stopped before priming coat is applied. Commercial plywood must have a filler coat before priming coat is applied.
- c. Where two or more coats are to be applied see that each coat is of a slightly different tint, starting with a lighter shade of the color with which you are to finish. Insist on passing each coat when it is completed and record this fact in the works-passing-register. See that each undercoat is properly rubbed before the next coat is applied.
- d. Do not use thinner to dilute the paint unless you are satisfied that the paint supplied is too thick. In such event thinner recommended by manufacturer should only be used and in the presence of Engineer-in-Charge.
- e. Insist on the use of proper brushes. Workmen prefer to use rag or cotton waste. This must not be permitted on any account.
- f. Never allow any painting to be done on damp surfaces.
- g. See that paint is always well stirred before and during use.
- h. See that the timber to be painted has not more than the optimum moisture content as determined by a moisture meter. Painting shall not be done when it is humid or there is dusty wind. Morning hours are generally more suitable.

- i. Knots in coniferous wood which exude resin should either be removed or replaced or two coats of knotting solution consisting of 0.25 kg. of shellac in a liter of methylated spirit applied to the portions.
- j. After priming coat is dry but not too hard, fill with putty all cracks and nail holes.
- k. See that all inaccessible portions like the top and bottom of doors, windows and CSWs are painted in advance.
- l. See that floors, window cills and fittings on joinery are protected from paint. If required, clean all fittings and hardware with paint remover as the painting progresses. Paint once dried and set is difficult to remove.
- m. When plastic emulsion paint is specified, carefully study manufacturer's instructions and follow precisely. This is a new type of paint and is expensive and any mistake in its application would result in a bad surface.
- n. Check thickness of glass and verify that the standard specified is being used. See that the glass is free from air holes and other defects.
- o. See that panes are sprigged and back puttied and that brads and not tracks are used. Panes must be cleaned before the building is taken over.
- p. See that the putty is made to the correct specifications. The putty in case of steel joinery is of different composition. Ensure that only correct putty is used.

(Note: Useful Indian Standards are IS: 101, 337, 340, 401, 420 and 1477 as amended)

16.6 WATER PROOFING

Check levels/slope of finished slabs, fill up local depressions and correct level/slope as necessary. Ensure that drainage outlets are adequate and are appropriately located in relation to quick drainage of the water.

If the R C slab has been left unprotected for some time, resulting in cracks, these should be carefully sealed before laying water proofing treatment.

16.6.1 Mud Phuska

- a. Check the quality of soil and the maturity of mud phuska. The chopped straw should be intimately mixed with the mortar.
- b. See that the mud phuska is not allowed to *dry* out fully before brick tiles are laid.
- c. Ensure that brick tiles are laid on a wet surface. Excessive water should not, however, be permitted. Tiles should be *dry* at the time of laying over mud mortar.

16.6.2 Lime Concrete in Terracing

- a. Take precautions as dealt under 'concrete in foundation'.
- b. Check local depressions, scrape up old and hardened surface and fill with fresh concrete.
- c. See that the lime concrete has properly hardened and thapies rebound. Mechanical tampers should be used in large scale construction. A well compacted treatment should not show any significant depression by a free fall of a brick from 1.5-meter height.

16.6.3 Tar/Bitumen Felt/Polyethylene Film Treatment

- a. Study carefully details of laying given in Indian Standards Codes and also manufacturer's instructions and follow them precisely.

- b. Ensure that the surface on which water proofing treatment is to be laid is smooth and does not have protrusions which could damage the felt/film.
- c. Mark out the position of layers on roof to ensure adequate overlap. Cut the roll in necessary lengths and flatten them out completely and remove adhering mica in felt with a brush.
- d. See that the treatment is completed quickly so that no moisture finds its way under the felt/film.
- e. See that the felt/film is tacked in parapets or walls where necessary and that sharp corners at junctions are rounded with 7.5 cm diameter cement fillets before laying the felt/film.

16.6.4 Under-lays

- a. See that the bitumen is of correct grade, is heated to correct temperature and that right quantity is used. Industrial blown type bitumen is usually specified.
- b. Provide a protective ring at outlets to prevent melted bitumen choking up the outlets.

(Note: Useful reference is in NBO's/CBRI's publications, manufacturer's technical publications and IS: 73, 459, 654, 702, 730, 1322, 1346, 1464, and 1626 as amended).

16.7 TIMBER JOINERY, DOORS, BUILDER'S HARDWARE

Besides ventilation, lighting and other utilities, doors and windows play an important part towards security and privacy of occupants. Space occupied by the rotation of the shutters, out of the room area causing inconvenience is another important factor whether or not a particular shutter should open inward or outward. From user's point of view ease with which the shutters could be closed or opened has a strong bearing on the position of handles, bolts and similar fittings. Some points to look for are given below:

- i. Open and close all doors and windows and check hinges, locks and bolts. Also check that the correct number of screws has been provided and in correct positions and that the doors and windows work properly, affording maximum convenience.
- ii. See that frames are correctly fixed with their heads horizontal and jambs vertical.
- iii. See that plaster grooves, where specified, are correctly made to accommodate plastering only on the sides.
- iv. See that all doors and windows fittings are clean and free from paint marks.

16.7.1 Timber Joinery

Timber should be of quality viz. 1st class hard/wood soft wood or 2nd class hard wood soft wood/and of correct species as specified. This requires knowledge of timber anatomy to some extent and ability to distinguish between different species, if necessary, with the help of a hand lens, magnifying 10 to 12 times and a sharp knife to make fresh cuts at ends of samples. Usual method is to compare pores/texture/pattern of known samples with that required to be identified. Forest Research Institute and College, Dehra Dun has published literature on the subject which may be studied for the purpose. Indian Standards should also be studied when published. Apart from the species, timber must be sound, of uniform color and texture, seasoned and free from knots, incipient decay and un-warped. Timber should be stored in dry and well-ventilated condition away from contact of damp wall/earth. Additional points are as under:

- i. See that the timber used is of correct species, matured growth, properly seasoned and according to specification. Check the moisture content with a moisture meter.
- ii. Watch that joints are properly made. This is extremely important as few of the carpenters employed on joinery are really 'skilled' labor.

- iii. See that adequate quantity of white lead/resin glue has been provided in the joints.
- iv. Check and get joinery passed by your superior officer to ensure that the finish of the work is good and that the dimensions of various components are correct.
- v. Ensure that door frames are protected from falling bricks/stones during construction.
- vi. See that doors with diagonal braces are properly hung so that the brace is in compression.
- vii. Ensure that the door stoppers are fixed in line with the middle hinge: both of which should be of the full thickness of the shutters.

16.7.2 Flush Doors

- i. Check that the doors are as specified in respect of core, veneer, lipping and grade.
- ii. Ensure that flush door shutters conform to tests prescribed in IS: 2202 (as revised) and related other Indian Standards, particularly in respect of 'Boiling water proof conditions.
- iii. Check that all faces of the shutters are given a coat of primer before being hung. Inaccessible faces should be finally painted.
- iv. See that the door is hung with the correct side up.

(Note: Useful Indian Standards are IS: 287, 303, 401, 883, 1038, 1081, 1141, 1328, 1659, and 2202 as amended).

16.7.3 Steel/Non-ferrous Metal Joinery

- i. Ensure that the joinery conforms to approved samples.
- ii. See that the section of components conforms to Standards specified.
- iii. See that the joinery is fixed only after it has been given a metallic paint primer coat and masonry work is completed. It is important to align the frame and shutters because these are light and may bend if not fixed with great care.
- iv. Get the door frames properly fixed as specified with cement mortar/mastic.
- v. See that special putty and glazing clips are used for fixing glass panes.

16.7.4 Builder's Hardware and other Fittings

- i. See that guard bars/grills are correctly fixed keeping in view position of builder's hardware to be fixed and utilized.
- ii. See that bars are truly horizontal/vertical and welding/riveting with flat iron is sound and neat.
- iii. See that dimensions, weight, finishes and quality of builder's hardware are in accordance with Indian Standards Specification and approved samples.
- iv. See that correct type and number of screws/bolts and nuts to match with the fittings are used. Screw holes should be drilled and screws not hammered but driven.
- v. Operate locks, bolts and other fittings to see that they work properly and that they are fixed in the correct position so as to afford maximum convenience to occupants.

(Note: Useful Indian Standards are IS: 204, 205, 206, 207, 208, 281, 362, 363, 364, 451, 452, 453, 723, 724, 725, 729, 868, 1019, 1341, 1823, 1837, 2209, and 2681 as amended)

16.8 WALL

16.8.1 Brick Masonry Wall

Bricks should be of standard dimensions, sound, well-burnt and free from defects, ringing clearly when struck with a trowel and as per approved sample. The bond used should be English with frog upwards. (No frog is provided in machine made bricks). At all corners alternate courses of brick work should be headers and stretchers respectively for effective bonding of the two walls.

Excepting for the closer, no half bricks bats must be allowed. Bricks used for face work are to be uniform in color and of the best shape. Verticality of the walls, corners and jambs should be frequently checked with plumb bob. PCC bed blocks should be provided and properly cured where RCC beams/steel girders trusses rest on walls. Lintels should have sufficient bearing on either side.

Good liaison must be maintained between B/Rand E/M staff so that cable conduit holes and chases for electrical/water supply/sanitary fittings are placed in correct position as the masonry proceeds. It is undesirable to make holes or damage walls later on after brick work is completed. Chases in brick work should be cut with a sharp chisel not less than 14 days after the brick work is completed.

Further points to observe are given as under:

- a. See that the bricks are up to standard. Bats and rejected bricks should be removed from the site of the work.
- b. See that bricks are well soaked in water before use in all works (except masonry in mud mortar).
- c. Get to know all the details of the bond required and see that correct bond is used and that bricks with frogs are placed with frog upwards.
- d. Check frequently for
 - (i) Thickness of masonry,
 - (ii) verticality of walls,
 - (iii) verticality of comers,
 - (iv) horizontality of courses and
 - (v) Breaking of joints.
- e. See that the joints are of correct thickness, thick joints are wasteful of mortar and a sign of slip-shod work.
- f. Insist that proper brick enclosures are made for mixing mortar. The enclosures should be of small size keeping in view the quantity of mortar that is to be mixed at one time for use by masons within about half an hour in case of cement mortar and two hours in case of lime-cement mortar and one working day in case of lime mortar.

Insist on mortar being properly proportioned. Labor invariably prefers to mix mortar to approximate proportion only and this always means lessening of the quantity of cement or lime and on increase in the quantity of sand or surkhi used. Weigh the cement and mix with measured quantities of sand and or sand and lime. A convenient quantity of mortar to mix at one time is 100 liters. Depending on the specification of mortar in use decide on whether one bag or ½ bag mixes are required and use measuring boxes of suitable size (40 x 35 x 25 cm) for measuring sand and other constituents. One 50 kg cement bag may be taken equal to 35 liters.

- a. In using cement mortar, insist on the minimum quantity of water necessary to obtain a workable mortar being used. See that water is added slowly after thorough dry mixing. In using lime mortar ensure that lime is first thoroughly slaked unless the lime used is hydrated bagged lime.
- b. See that joints are correctly tilled. All brick-layers prefer to lay bricks dry and fill mortar from the top. Do not allow this in any circumstances. Have sample of masonry made in your presence and insist on all masonry being in accordance with these samples. Any masonry found being done by the wrong method should be rejected and dismantled in your presence.
- c. See that water arrangements for tops of walls at close of work are made where required.
- d. Where pointing is in the same mortar as for the brick work it is usual to specify that joints are struck as the work proceeds. If additional pointing or plastering is required, rake the joints up to 10 mm soon after the mortar has become slightly stiff and before the close of the work.
- e. Watch that put-log holes do not damage the stability of masonry.
- f. See all holdfasts and holding down bolts before they are put in, to ensure that they are in accordance with specification and treated with preservative against rust as specified. Always have them put into the work in your presence and ensure that they are properly surrounded with mortar or concrete as specified. Where bricks are laid in mud or lime mortar, masonry round the hold fasts should be in cement mortar.
- g. See that temporary battens are provided at the bottom of door frames where cills do not exist. Provide temporary diagonal battens where openings are large.
- h. See that no woodwork comes within 20 cm of flues.
- i. Check sizes of all rooms as soon as work starts on superstructure.
- j. It is comparatively easy to supervise masonry work when this is below eye level. When the work gets above eye level it is much more necessary, but not so easy. Insist, therefore, on good ladders and good scaffolding being provided so that you can get about and watch the masonry being done and examine it thoroughly.
- k. See that frames are set forward to the thickness of plaster when required to be flush with plastered surface.
- l. See that all hidden faces of woodwork are treated with preservative as specified before being placed in position. Contractors are particularly inclined to give such surfaces a nominal coating only, insist on the whole surface being properly treated.
- m. Work should proceed at one level. Where, for any reason, it becomes essential to leave any portion of work and proceed with that on either side of it, see that work is stepped back and not merely “toothed”. It is important to ensure that cross walls, returns, buttresses are built up course by course and carefully bonded with the main walls.
- n. All masons are careless about making sides of door and window openings truly vertical. Check these frequently as work goes up. Also see that lintels are horizontal and provided with adequate bearing.

(Note: Useful Indian Standards are IS: 1077, 1625, 1905, 2116, 2212, 2250, 2691, and 3102 as amended).

16.8.2 Stone Masonry Wall

Stones should be hard and of approved quality and color and free from defects. Tests for quality may be studied from ARE: 1122 to 1127. Crushing strength should satisfy requirement of IS: 1905. Stones should be carefully laid and solidly bedded in mortar, tailing back and well bonded into the backing. Face stones from opposite faces should bond together and for thicker walls backing should bond well with the facing. Masons should never be allowed to make two faces of wall say 15 cm to 20 cm thick and fill the intervening space with spalls and smaller stones. Size of stone, natural bed on which to be laid, dressing of face, bed and joints should conform to contract specification and approved samples. In the hearing, plum stones should be left to slightly project above the height of course. Quoins should be laid alternately in stretcher and header. Cross walls, buttresses and returns should be built simultaneously with interconnected bonds. Other salient points are as under:

- a. See that stone used is the best available as per approved sample and that the walls do not consist of facings of good stone with the intervening portion filled with small pieces and rubbish. The ideal to be aimed at is a maximum of large stones and a minimum of mortar.
- b. Avoid laminated stone.
- c. See that all bond stones are marked with white washed crossed by contractor. Occasionally uncover stones so marked to check that they are, in fact, bond stones.
- d. See that bringing up to courses has been done as specified and that face and bed are squared back as required.
- e. See that the requirement of height/depth ratio of the stone is maintained as specified.
- f. See that no stone shall pass through a circular ring of 15 cm inner diameter and that the thickness of the stone in any direction is not less than 10 cm.
- g. See that no stone tapers to a point.
- h. Check all verticals and jambs of openings for positions and sizes. Check walls for plumb.

(Note: Some Useful Indian Standards are IS: 1121 to 1127, 1129, 1597, 1805, 1905 and 2395 as amended).

16.9 ROOFING AND CEILING

10.9.1 Roofing

a) General

- i. See that timber is of correct species, of natural growth properly seasoned and of correct dimensions. Check moisture content.
- ii. Check the assembled truss and its joints in detail before hoisting. See that proper contact surfaces are provided for supports. It is impossible to examine trusses after erection. A single bad joint in a truss is sufficient to cause failure of a roof and may result in a serious accident. Trusses passed should be marked so that it can be checked even after erection.
- iii. See that holding down bolts are in position and are properly fixed and that trusses are properly secured to them.
- iv. Check if wedges and cotters have been provided so as to allow possible adjustment later and that the truss has adequate camber.

b) CGI/CI Sheets

- i. See that corroded sheets are not used.
- ii. See that proper galvanized hook bolts, coach screws and washers are provided and that these are set in white lead.
- iii. Holes must be made in the ridges and not in the valleys of the corrugations. These holes must be punched from the underside or drilled.
- iv. The side overlap must not be less than 1% corrugation. The end overlap must not be less than 15 cm.
- v. See that sheets are correctly aligned so that the ridges and valleys of the corrugations of the sheets are in straight lines.
- vi. See that stitch bolts are provided where specified.
- vii. Ensure that the portions of CI sheets covered by the laps are painted before the sheets are assembled and fixed.
- viii. Lay the sheets starting from the side opposite to that of the prevalent monsoon wind and ensure proper flashing of ridge caps, aprons and louvers.

c) AC Sheets

- i. See that no broken or cracked sheets are used.
- ii. Study carefully the chart issued by ACC sheet manufacturers showing the number and position of hook bolts, the correct method of fixing and fitting AC sheets. See that these instructions are carefully followed and bitumen and diamond washers are used as specified. Try to arrange sheets so that where corners have to be cut, sheets with damaged corners are used first. Where sheets have to be cut, use cracked sheets so as to obtain the maximum salvage value from damaged sheets.
- iii. Warn all concerned before laying AC sheets that sheets are not to be screwed or bolted down too tightly. If they are too tight, breakages are bound to occur in the hot weather on expansion of the sheets.
- iv. See that all holes are drilled on the ridge and that the diameter of the hole is 3 mm larger than the diameter of the hook bolt, coach screw.
- v. Ensure that the length of the hook bolt/coach screw is adequate in relation to the depth of purlins and situation of the sheets as intermediate sheets or corner sheets.
- vi. Ensure that where four corners are coming at point, two sheets are mitred.
- vii. See that the end lap between the sheets is at least 15 cm.
- viii. See that the sheets are correctly aligned with reference to purlins so that the hole in the sheet is 7.5 cm from the edge and that purlins are straight.
- ix. See that hook bolts/screws are staggered in the semi-corrugated sheets for the intermediate corrugation.
- x. See that cat ladder or roof board is used by workman working on the roof to avoid damage to sheets.

d) Tiles

- i. See that no broken or cracked tiles are used.
- ii. See that nibs or lugs rest fully on the supporting batten at lower level of tiles.
- iii. See that all tiles fit closely to adjacent ones and that overlapping is to the full depth.
- iv. See that rows are even, straight and parallel to the ridge.

- v. Where tiles are required to be pointed, plastered, set in lime or cement mortar or require filling of ends, these shall be soaked in water for two hours before use and cured subsequently.

e) Flat Roofs

- i. See that correct slope is given in the slab and padding concrete as per drawings and specification.
- ii. See that smooth surface or paper is provided under the ends of slab.

16.9.2 Ceiling

- i. Ensure that the material is of the correct type as per approved sample.
- ii. Common types are AC building board, fiber hardboard wood particle board, veneered particle board, block board, teak planking, acoustic board or cement/concrete lime plaster.
- iii. Check that fixing of the frame supporting the ceiling is adequately done with screws.
- iv. Check spacing and size of ceiling joints.
- v. See that joints in the planking are neat and close and fixed with counter sunk screws.
- vi. AC board/hard board/fiber board/block boards are not to be tightly butted against each other; a space of 3 mm should be left between edges.
- vii. When joints are covered with fillets or moldings, these should be painted as specified before fillets/moldings are fixed.
- viii. Ensure that the ceiling does not give any undulating appearance.
- ix. In the case of acoustics board ensure that the distempering is by spray painting or by dusting as specified and that there is no bridging of the gap which would affect acoustics effect. Oil paint or oil bound distemper should not be used for acoustics board.

(Note: Some Useful Indian Standards are IS: 703, **883, 1328, 1414, 1658, 1659, 1651, 1946, 2098, 2441, 3087 and 3097** as amended).

16.10 WATER SUPPLY, PLUMBING

Water Supply

Remember that a Water Supply Scheme must be progressed as a whole e.g. the source, pumping plant, and treatment, pipeline and distribution system. Delay in any of these stages will render the execution ineffective. Work out a coordinated plan for timely completion of all items.

16.10.1 Sources

Rivers

- a. While laying intake pipe ensure that its inlet is protected by a suitable manhole of honey comb construction.
- b. In case of infiltration gallery, ensure that while embedding slotted pipes, the slotted half of the pipe circumference is facing downward.
- c. In order to cater for variation in the water level, the intake pipes and the infiltration galleries should be laid at different levels.
- d. Ensure that inlet to the jackwell is provided with requisite number of valves to control the flow:
- e. The jackwell should be constructed in compartments to facilitate maintenance.

Springs

- a. Ensure all loose soil is removed from near the spring to lay bare firm ground or bed rock for flow of water.
- b. The outlet from spring must be properly protected against pollution.

Tube-wells

- a. Before undertaking well boring, obtain geologist's recommendations in regard to the exact location.
- b. Based on the likely strata, choose the proper type of rig. Rotary machine is better for alluvial strata while percussion machine is more dependable for rocky strata.
- c. Before starting the well boring operation ensures all administrative requirements like supply of water for drilling, supply of fuel and lubricants and adequate cover for day to day repair and maintenance is available at site.
- d. While the drilling is in progress keep carefully samples of the various strata in the sample box.
- e. Keep record of the depths at each change of strata. This will ensure that at later stage slotted pipes are located at the right depth to tap water. Check that the bore is in plumb. A crooked bore will make the installation of pump difficult.
- f. While installing the tubewell pipe, ensure solid and slotted pipes are at correct depths. Keep record of the composition of entire length of pipe.
- g. Carry out proper development of the well and test its yield.
- h. While finishing the well ensure gravel packing is provided around the pipe.
- i. Top of the well must be protected against pollution from surface water, Provide adequate PCC floor around the pipe.

Shallow Wells

- a. While digging shallow wells ensure that springs in the wells are not choked up by masonry lining.
- b. Steining of sound design should be provided where required. Take help of a designer to check it if necessary.
- c. Make provision of platform for installation of pumps while constructing masonry well.

16.10.2 Pumping

Installation of Pumps

- a. Ensure that the pumping set, received is of the correct type, capacity, complete with Prime Mover, valves (foot valve and reflux valve), gauges, spare parts, tools, suction and delivery flanges, foundation bolts, manufacturer's instructions book and catalogue, as specified.
- b. Before commencing the work of installation, ensure that the layout has been approved. The layout should be such as to provide the most direct connection between the suction and delivery flanges of the pumps and the suction and delivery pipes, with the minimum number of bends. Avoid sharp bends especially near the pump, where their effect is greatest.

- c. See that concrete foundations are made as per maker's foundation drawing. If none exists, prepare one yourself and have it approved. Special care should be taken in grouting the proper and correct size of foundation bolts.
- d. Ensure that the foundation has properly set, before the pump set is actually installed.
- e. See that the alignment is correct. Although the coupling may be flexible, it allows only for very small errors.
- f. Care must be taken to support both the suction and delivery piping so that no stress is put on the pump either from weight or expansion.
- g. See that all joints in the suction piping are made absolutely air tight. This is particularly important with centrifugal pumps.
- h. See that the strainer and foot valve are well submerged below water level at all times.
- i. See that necessary arrangements are made to drain the pipe in frosty weather.
- j. When two or more pumps are installed together supplying into the same delivery main, each set should have its own delivery sluice valve and reflux valve.
- k. When pumps have flooded suction, ensure that an isolating sluice valve is provided on suction side of each pump.
- l. Ensure that the work of installation of deep well pumps is carried out strictly in accordance with manufacturer's instructions and catalogue.
- m. While installing deep well pumps and pipe work in bore holes, great care is to be taken to avoid dropping them in.
- n. Where deep well turbine pumps are to be installed in tube wells, it should be ensured that the tube wells are bored true, straight and vertical.
- o. Check that the casing pipe is of adequate diameter to provide proper clearance, so that the pump hangs free in plumb.
- p. Ensure that deep well pumps are placed at such a depth in the bore hole that at least the 1st stage always remains submerged at the lowest water level.
- q. In case of an engine driven pumping sets see that special attention is paid to ventilation, cooling system and fixing of exhaust pipe which must always be taken outside the building sufficiently above ground level.

Testing of Pumps

Before carrying out the testing check the following:

- a. The installation has been properly completed and sufficient water is available for testing.
- b. The alignment is correct and the foundation bolts are properly tight.
- c. All the valves, gauges, and controls have been properly fixed adjusted and are functioning satisfactorily.
- d. Glands are suitably packed and not leaking.
- e. Bearing/bushes are properly lubricated.
- f. Power supply is available and connection properly made.
- g. Sufficient quantity of POL is available.
- h. Testing instruments e.g. speedometer, suction and delivery gauges, water meter, volt and ammeters, megger thermometer, feeler gauges and spirit level are available.
- i. See that the testing is carried out as specified and test results recorded on the proper testing sheet and signed by the contractor/supplying firm and Engineer-in-Charge/GE.
- j. Ensure that the defects noticed during testing are rectified by the contractor/firm.

- k. See that the plant is not taken into use till such time; the performance test is satisfactory and passed by the Inspector.

16.10.3 Treatment Plants

Study the flow-through diagrams of the treatment plant carefully and understand the function of each unit/fitting. As these are normally designed and executed by specialist firms, the firm's specific instructions regarding the maintenance and operation should be strictly followed.

The water treatment plant works should be well maintained with the grounds attractively landscaped. Visitors, not acquainted with the technicalities of water treatment, are likely to judge the quality of water as much from the appearance of plant, both inside and out, as from the appearance and taste of water.

16.10.4 Sedimentation Tanks

- a. Ensure that the rate of flow in the tank is correctly maintained.
- b. See that the tank is cleaned at proper intervals by scrubbing and/or hydraulic flushing.
- c. Where coagulation is done ensure that -
 - i. the correct dosage of chemical is used - weighing equipment for this purpose should be properly maintained;
 - ii. adequate storage arrangements for coagulants are made e.g. bags of aluminum sulphate and ferrous sulphate being hygroscopic should be stored in wooden bins. Ferric chloride, being corrosive should be stored inside rubber lined bags;
 - iii. adequate reserve of coagulants is kept;
 - iv. the operating staff are provided with suitable protection against hazards due to storage, conveyance, feeding or handling of chemicals.

16.10.5 Filtration Plants

- a. Check that the correct grade and size of sand and gravel are laid, as specified.
- b. Ensure that the rate of filtration is maintained constant since sudden variation in the rate of filtration may cause water to break through the filtering material without proper treatment.
- c. When the loss of head in the filter has reached the permissible limit see that the filter is washed after putting it out of commission.
- d. Ensure that no coagulants are used preceding filtration by slow sand filters. Coagulants may however be used when filtration is through rapid sand filter or through pressure filters.
- e. For washing slow sand filter, scraper about an inch of sand from the top of the bed, wash it with clean water and return it to the filter.
- f. For backwashing of rapid sand filters, ensure that the quality of water for backwashing is as good as that of the effluent from the filters.
- g. Avoid backwashing the rapid sand filter too vigorously as it would result in the sand entering the wash water through.
- h. When air is used for agitation of sand (while the sand is suspended in rising water) ensure that the air and water are not applied simultaneously, because of the danger of disturbing the gravel.

Chlorination

- a. Ensure that the work of installation of chlorinator is carried out in accordance with manufacturer's instructions and catalogue.
- b. A schematic diagram showing the various parts/operations of the chlorinator should be prominently displayed in the chlorinator room.
- c. Ensure that apparatus for determining dosage of chlorine and the residual chlorine content (ortho-tolidine method, calorimetric method etc.) are maintained properly. As the dosage of chlorine varies according to the quality and temperature of water, tests should be carried out as a matter of routine to determine the correct dosage for the desired residual content.
- d. Ensure that anti corrosive treatment to cylinders and other equipment in the chlorinator room are given periodically.
- e. Ensure that the personnel permitted to handle chlorine cylinders and chlorinating equipment are made aware of the hazards involved, precautions to be observed and the first aid to be rendered in emergencies.
- f. Ensure that cylinders containing chlorine are handled gently and not dropped or rolled on ground and no object is allowed to strike them with force.
- g. See that cylinders are not stored in the open or in damp places but in rooms which are well lighted and ventilated.
- h. In case the valve is found stuck, no attempt should be made to ease the same by hammering as this is very dangerous.
- i. Ensure that rubber gloves, gas masks and aprons are housed in an easily accessible cupboard (unlocked) outside the chlorinator room and the canisters of gas masks are changed at proper intervals. A record of that should be kept.
- j. Check for leaks should be carried out frequently by using a glass rod dipped in a solution of liquid ammonia which produces dense white fumes in the presence of chlorine gas.
- k. Grease should never be used where it can come in contact with chlorine.
- l. In case of injury caused to personnel by leakage of chlorine gas send for the doctor immediately. It is important that no drink of any sort should be given, if the person is unconscious. If breathing has apparently stopped, artificial respiration may be given by the back pressure and arm lift method.
- m. As disinfection is such an important step in water treatment, ensure that the facilities exist for the switch over to the application of bleaching powder during non-availability of liquid chlorine.

16.10.6 Reservoirs

- a. See that WC tanks are not kept empty for long durations as variation in temperatures is liable to produce cracks the availability of adequate water supply for testing and filling purposes should be ensured.
- b. Ensure that all accessories such as over flow, manholes, access ladders, pipe connections, mosquito-proof ventilation and water level indicators are always maintained in perfect condition.
- c. Ensure that the reservoirs are cleaned periodically and a record kept.
- d. Ensure that proper anti-corrosive treatment for the exposed faces of steel-tanks is given periodically.
- e. Lighting conductors should invariably be provided for elevated tanks. Obstruction lights may be provided, for safety against flying hazards where considered necessary.

16.10.7 Pipe Lines

Excavation

- a. Before the excavation for pipe line trenches is commenced, mark the route of pipe lines actually on the ground and get the alignment and exact position for the laying of pipe lines/fittings, valves, valve chambers, washout etc., approved by the Engineer-in-Charge.
- b. Insist on all excavated earth being kept one meter away from the trenches.
- c. Ensure that the trenches are excavated in perfect straight lengths, the angles being formed with square or easy bends. The curve of the bend must be such that pipe does not require the application of undue force to adopt it to the curve.
- d. See that the bottom of trench is smoothly graded to provide support to the pipes.
- e. Before the pipes are lowered into the trench, hollow (grips and pockets) are to be cut in the bed to receive the socket or flanges to allow adequate room for making and caulking of joints.
- f. Get the soft spots in the bed of trench properly rammed, and in case of rock, get the bed leveled with hard moorum as specified.
- g. Have the excavated trenches, checked by the Engineer-in-Charge/and record this fact with date in the Works Diary and the Works Passing Register.
- h. If there are any ordered deviations, those should be measured before starting to lay the pipe line. Get the measurements of trench checked by the Engineer-in-Charge/project Manager.

16.10.8 Laying and Jointing of Pipes

- a. Ensure that all pipes, specials/fittings and jointing materials brought to site are of approved pattern, specified grade/quality and have proper weight and marking. Use IS certified fittings wherever available.
- b. The use of rubber gaskets for jointing of CI pipes is considered to be a satisfactory alternative to the “lead” joint in view of the acute scarcity of “lead” in the country. While jointing pipes with rubber gaskets ensure that the manufacturer’s instructions regarding the jointing methods are strictly followed.
- c. See that contractor has proper tools viz. pipe wrenches, pipes cutters, pipe vices, pipe screwing tackle, fork tool tackle, rack and lever tackle, caulking tools, crow bars, set of spanners, hammers etc.
- d. In case of socketed pipes, the sockets should face the direction of flow of water but on slopes sockets should face “uphill” irrespective of direction of flow to facilitate laying of pipe lines.
- e. Before laying, the pipes and specials/fittings shall be examined that there are no cracks due to handling.
- f. Ensure that all pipes, fittings/specials are cleaned of all dust and dirt, special care being taken to thoroughly clean the extremities to be jointed. This is particularly important in case of jointing CI pipes with rubber gaskets, as rubber joints are only as water tight as they are clean.
- g. See that the CI/AC pipes are lowered into the trench by means of suitable pulley blocks, shear legs, chains, ropes etc., and not rolled and dropped in. Specials or fittings should also be laid in proper positions as stated above.
- h. Examine that CVAC pipes are carefully packed underneath.
- i. Ensure that gravity pipe lines are laid to proper slopes and gradients, as specified.

- j. See that the joints in the pipes are properly laid and correct method of jointing has been used.
- k. Check occasionally that appropriate quantity of lead is used and joints are properly caulked.
- l. See that polythene pipes are not laid in complete straight line but snaked in a trench to allow for contraction and expansion.
- m. Ensure that polythene/PVC pipes are not used for conveying hot water.
- n. In situations where attack from rodents are expected ensure that polythene/PVC pipes are buried at least to a depth of 0.5 meters.
- o. See that at the end of day's work, the last pipe laid has its open end securely closed, so as to avoid dirty rats and other small animals getting in.
- p. Ensure that exposed CI/AC pipes laid either on the ground or across nallahs/culverts are held firmly by adequate supports with an encircling clamp laced near the joint.
- q. Examine that the pipe lengths fixed on walls are in proper straight line and they do not give an ugly appearance. As far as possible carry the pipes on the outside faces of the buildings.
- r. See that CI/MS/Polythene pipes are fixed clear of walls with approved pipe brackets, clips, pipe hooks or holder bats, as specified.
- s. Ensure that proper anchorages (i.e. thrust/anchor blocks) are provided at each bend, on gradient more than 1 in 3 to take tangential thrust/unbalanced pressure.
- t. Take special care to have adequate horizontal and vertical separation between water and sewer mains. The minimum horizontal separation should be 3 meters and the bottom of water main should be at least 0.5 meter above the top of sewer line.
- u. Avoid cross connection between water mains and sanitary plumbing fixtures or sewer appurtenances.
- v. Ensure that number of valves is kept minimum consistent with efficient and utilitarian operation of pipe line system.
- w. See that all water mains are properly disinfected before being put to use and also after every major repair.
- x. See that linings and coatings of the pipe are properly protected against damage during laying.

16.10.9 Filling of Trenches

- a. See that refilling of trenches is not done, until the laying and jointing of pipe line have been passed by the Engineer-in-Charge and the necessary tests have been carried out.
- b. Spoil obtained from excavation of the trenches shall be entirely re-used except vegetable or black cotton soil which is prohibited for refilling. The finest spoil is to be selected and carefully filled in around the pipes, etc., before the man filling is done.
- c. See that the filling of earth/moorum is carried out properly in layers not exceeding 20 cm thick, well-watered and rammed.

Pits

- a. See that masonry pits of proper size with CI manhole covers are built as specified.
- b. Check that CI boxes for valves/meters are of approved type, pattern/design, conforming to IS specifications.
- c. Ensure that CI frames and covers for manholes are of correct type, pattern and weight.
- d. See that manhole covers, frames are given bituminous paint all-over and greased at the seat.

16.10.10 Testing of Pipe Line

- a. Prior to testing any exposed length, ensure that suitable provision to anchor the pipes have been made to overcome the end thrust and to prevent involuntary displacement permitted by the flexibility of joints.
- b. See that sufficient anchorage is provided by filling in with lightly rammed earth around the centre of each pipe laid in the trench.
- c. Ensure that sufficient water is available for testing and necessary arrangements made to fill the pipe line.
- d. Check that the hydraulic pump and pressure gauges are in proper working order.
- e. Examine all the joints for leakage under specified pressure. Get the defects, if any, properly rectified. Repeat the test till all the leakages are stopped and line passed by the Engineer-in-Charge. Record this fact with date in the Work Diary and the Work Passing Register.
- f. Ensure that, after completion of the testing, trenches are re-filled properly, as specified.

16.10.11 Plumbing

- a. See that the pipes are of proper weight and have proper markings.
- b. In case of socketed pipes, the sockets should be on the supply end.
- c. See that the pipes are coated with approved anti-corrosive treatment where specified.
- d. See that the joints are correctly laid and appropriate quantity of lead used.
- e. In case of water supply tubing, see that joints are correctly made and given a coating of lead/cement paint.
- f. See that the rim of the pipe is straight and that surface pipes are at least 25 mm away from the wall.
- g. Try to align pipes on walls so that they do not give an ugly appearance. As far as possible carry the pipes on the outside face.
- h. For concealed plumbing, the chases should be made with a sharp chisel and deep enough so that the pipes are embedded a minimum of 5 mm below the masonry surface. Before covering the pipes with a base coat of plaster, pressure tests should be carried out and leaks rectified. Joints in between elbows/tees/fittings should be avoided.

(Note: Some Useful Indian Standards are IS: 27, 458, 651, 774, 782, 783, 1726, 1729, 1742, and 1834 as amended).

16.11 ELECTRICAL, HVAC WORKS

16.11.1 Internal Electrification

Standard drawings invariably show the exact locations of these points and fittings and no deviations will be made. During construction it should be ensured that these positions are not changed through oversight or negligence. During execution the following points which are common to all types of wiring should be carefully watched:

- a. Ensure that neutral and live wires are correctly marked at point of supply.
- b. Position of lights, fans, switches etc. should be as per drawings and should be marked on the walls and approved before execution.
- c. Schematic diagram and circuit should be made before starting the work and adhered to.

- d. Power circuits should be separate from the lighting circuits.
- e. All channels in walls for conduit wiring should be provided during construction as far as possible. No plastering will be permitted till after conduits and boxes are laid. Similarly, all conduit in RCC roofs, RCC beams and floors etc. must be laid before concreting.
- f. All wiring should be done by looping system.
- g. Ensure that aluminum conductor is connected to switches, plugs, ceiling roses etc. with the recommended jelly to ensure permanent contacts.
- h. While drawing aluminum conductor cables through conduit, ensure that these do not break at any point. Check continuity periodically.
- i. Ensure that there are no kinks in the wires.
- j. Ensure that all crossings through the wall are done either with porcelain tube or conduit where wooden bushes should be provided at the ends.
- k. The specifications for internal wiring as laid down in SSR for MES should be strictly followed.
- l. Main switch should be easily accessible.
- m. Ensure that pole for service connection is so fitted that rain water does not get into the pole.

Following points should be watched during the execution of different types of wiring:

A) TRS Wiring on Teak Wood Battens

- a. Use planes, seasoned, dried and varnished teak wood. The size will depend on the number of wires to be carried on it.
- b. It should be fixed on wall by brass screws and rawl plugs or wooden gutties. The wire should be laid with brass clips and brass nails.
- c. The distance between screws should be (9") 23 cm and nails (6") 15 cm.
- d. Ensure that wooden blocks, boards etc. are of seasoned dried teak wood and are varnished and are fitted flush with the wall surface.
- e. TRS (tough rubber sheathed) cable should be as ISI specification No 434 of 1965 (revised Part I and Part II).

B) Concealed Conduit Wiring

- a. Ensure that correct size of the conduit is used depending upon the size and number of wires.
- b. Ensure that all conduits are electrically connected to earth either by bonding at all joints or by running a continuous earth wire of copper or GI.
- c. Ensure that conduit ends have no sharp burrs as they damage the wires when pulled through with a steel wire.
- d. The boxes for switches, sockets etc. should be fitted flush with the wall.
- e. Ensure that conduit is fixed in the wall chasses with clamps and the chasses then filled with cement mortar before plastering the wall.
- f. The wires through the conduits should be pulled straight and with uniform pull. It should be done with steel flexible wire commonly known as "fish wire".
- g. After laying the conduit at the installation the conduit ends should be sealed against likely entry of water and cement slurry while plastering the wall.

C) Surface Conduit Wiring

- a. Ensure that conduits are fitted properly in clamps and are not subjected to any load.
- b. Earthing should be continuous and properly jointed at the joints.
- c. All conduit boxes should be securely screwed and fitted with check nuts.
- d. Ensure that conduits are laid straight and do not present unsightly appearance.
- e. Surface conduits will be laid where authorized and will not be laid on plastered walls.

Earthing

- a. Ensure that either an earthed terminal is provided by the supplier at the point of supply or the building has its own efficient earth so that all earth connections are connected to it.
- b. Ensure that all non-current carrying metal parts of electrical fittings are connected with continuous earth wire to an independent earth except for those given in IE Rules Para 61 sub para 3 such as isolated wall bracket, switches etc.
- c. Earthing with gas pipes or water pipes is not allowed.
- d. Neutral will never be earthed at the point of supply near the building or at the service connection.
- e. Size of earth wire for internal wiring should not be less than 14 SWG copper or 4 sq. mm of aluminum.
- f. The following points should be kept in mind while providing earth:
 - i. The earthing pit for building earth should not be less than (6 ft.) 1.8 meters deep or up to such depth where moist earth is available.
 - ii. The size of earth plate if it is a cast iron/steel, it should not be less than 60 cm x 60 cm x 6 mm and if it is a copper, it should not be less than 60 cm x 60 cm x 3 mm.
 - iii. The earth plate should be packed all around up to 15 cm with charcoal dust mixed with commercial salt.
 - iv. In rocky areas the earth conductor should be provided with loop earthing.
 - v. In dry areas a pipe should be provided to pour water from the surface.
- g. The main earth wire should never be less than 8 SWG copper or 4 mm diameter aluminum to avoid mechanical damage.
- h. The earth wire should be either in conduit or buried where it is liable to be damaged or cut. Portion of the earth wire which is to be buried should be of copper or GI and not aluminum.
- i. All joints in earth connections if any should be made rigid either by soldering or bolting.
- j. The earth resistance of an independent earth should never exceed 3 ohms except in dry, rocky or sandy area where it may be allowed to 10 ohms.
- k. Earthing should be done as per ISI specification No 3043 of 1966 Code of Practice for earthing.

Testing

Before connecting low tension installation up to 250 volts the following checks/tests will invariably be carried out:

- a. Ensure that all switches are on live line.
- b. All metallic fittings are connected to earth.
- c. Phase and neutral are distinctly marked at the point of supply
- d. No fuse or switch is provided in the neutral

- e. Ensure that leakage of current does not exceed $1/5000$ part of the maximum current supplied to the building.
- f. No building will be connected if the insulation resistance between phase or neutral and earth is less than 3 mega ohms.

Internal wiring must be checked annually for insulation resistance and earth resistance.

16.11.2 HVAC Works

Layout and Site Examination

- a. On the layout plan of the building, mark out the locations and sizes of the important rooms and facilities so that there are no changes during execution. These should include:
 - i. Plant room
 - ii. Weather making room
 - iii. Air handling units
 - iv. Cooling towers and water softening plant if provided. Where possible these should be on top of the plant room.
 - v. Electric substation
 - vi. Water mains
 - vii. Drainage/sewers
 - viii. Standby power house, if any
 - ix. Contractor's fabrication area
- b. Check the sizes of the various plant rooms to ensure that these are adequate to house the plant and leave enough space for maintenance.
- c. Check that available services like water, electricity, sewage are adequate. If not initiate action for their modification.
- d. Check that there will be no hold up during execution due to unforeseen site conditions.

Air-conditioning Layout of Operation Theatre

- a. In an operation theatre, recirculation of air is not permitted. Verify and ensure that proposed layout caters for this.
- b. To ensure that contaminated air does not infiltrate into sterilized zone, check that layout provides for flow of air from operation theatre outwards to non-sterilized zone.

Coordination with Civil Engineering Works

- a. Indicate on a plan the location and sizes of ducts diffusers and return gills. This should be given to the design section for incorporation in the plans.
- b. Finalize the arrangements for fixing ducts so that necessary hooks etc can be left in the roof slabs where necessary.
- c. Ensure that a time table is made out for handing over the various rooms to the air-conditioning contractor for installation of the equipment. Watch that this is adhered to.

CPM Chart

Prepare CPM Chart for the air-conditioning works and get it correlated with the CPM Chart of the building works. Review the chart periodically. Ensure that all activities are commenced and completed as planned.

Construction and Installation of Ducts

- a. Sketch out the supply and return duct system
- b. Indicate various sizes of duct sections, as per design
- c. Fix location of outlet diffusers and return grills.
- d. Check material for duct construction for quality and thickness
- e. Ensure joints are made in accordance with IS: 655-1963 and reinforcement provided for rigidity.
- f. Inspect all branches, elbows etc. before assembling.
- g. After assembling, check seams and corners for air tightness. During construction, ensure that there are no sharp internal edges as these will generate noise.
- h. Ensure that hanging arrangements are rigid and there is no strain on the joints.
- i. Ensure dampers are installed in correct locations
- j. Remember that fan, ducts, dampers, diffusers return grill and return ducts form one correlated system. Change in any of these is likely to upset air balancing of the system.
- k. When crossing walls, ensure that ducts are properly packed with felt/fiberglass to reduce noise and to prevent leakage from the room.
 - i. Ducts which are outside the conditioned space should be adequately insulated. Use vapor barrier to prevent moisture condensation inside the insulation material.
- l. Provide flexible canvas joints to prevent long duct system from vibrating like a string.
- m. After final installation, check for vibration and noise at full design flow of air.
- n. Large ducts should be provided with access doors for cleaning.

Installation of Chilled Water Mains

- a. Ensure thorough internal cleaning of the pipes. Any lapse in this will cause serious damage to the system, as dirt will clog up the orifices,
- b. Check that suspension arrangements are as per design.
- c. While fixing insulation, ensure that there is no moisture on the pipe.
- d. After completing the installation, the following procedure should be gone through:
 - i. Bypass all controls and equipment with small tubes/orifices,
 - ii. Flush the pipeline with clear water till it appears to be clean.
 - iii. Load the system with 1 lb. of tri-sodium phosphate to every 50 lb. of water and circulate this by means of a pump for 8 hours.
 - iv. Then drain and flush with clean water.
 - v. Check with litmus paper the pH value; it should be 7.5. If high repeat the cleaning process and flush.

Check Lid Location of Fresh Air Inlet

- a. While locating the outside air inlet, ensure that surface dirt will not be drawn into the system.
- b. Inlets taken above roof should be high enough to clear parapet walls.
- c. Ensure that inlet is not in line with neighborhood chimneys.
- d. Inlet should not be exposed to prevailing winter wind.
- e. Ensure that proper louvers are provided at the inlet to keep out rain, birds and other objects.

Air Filters

- a. Ducts or apparatus connection to filters should be designed to allow uniform flow over the entire filter area.
- b. Mixing chamber, where return and fresh air are mixed ahead of filter bank should have adequate size to equalize the velocity of air entering the filters.
- c. It is a good practice to provide a draft gauge to indicate pressure drop across the filter bank to give warning for cleaning.
- d. Filters should be located between the pre-heaters and other apparatus to protect cooling coils and fans from accumulation of dust.
- e. Ensure sufficient space is provided for access and inspection of filters.
- f. Lights installed in filter chambers should be of vapor proof type.

Air Handling Units

- a. Provide asbestos cloth or other fire proof types of flexible connection to ducts at the fan inlet and discharge to reduce noise.
- b. Vibration isolation material should be used on the foundation to prevent transmission of vibrations to the building structure.
- c. Ensure that the speed of the fan is not increased beyond designed speed. Although increase in speed will improve the air flow, the power consumption will increase in a much higher ratio. Impulse to increase the fan speed should therefore be restrained.

Diffusion Devices

- a. Check that conditioned air is not directly deflected towards an air return.
- b. See that air flow does not strike walls, beams, or other obstructions.
- c. See that no obstruction is placed in the air return passage.
- d. Check that the adjustment of grill frets does not result in the supply air striking directly the thermostat.
- e. Low side wall or flush floor diffusers should be so adjusted that air is deflected properly upward for cooling and downward for heating.

Heating Furnaces

- a. Check that adequate height of chimney is provided. The end of chimney should be protected by a hood.
- b. Check that all the controls are tested before being installed.
- c. Oil burners are meant to be used with specified oil. Check the specification of the burner being provided. Inspect the test certificate which should normally be with the burner.
- d. Ensure that adequate fuel storage is provided.
- e. See that unit incorporates safety control for temperature, ignition failure and overheating.

Heating Boilers

- a. Check the manufacturer's data and verify that the boilers are according to the laid down specifications.
- b. Ask for manufacturer's test certificate for the boiler working pressure. Boiler should be inspected by own boiler Inspector after the installation is completed and before it is commenced.
- c. Check that Chimney height is adequate to produce the draft as laid down by the makers.

- d. Ensure adequate fuel storage facilities are provided.
- e. Unit should have incorporated safety controls for low water, high pressure, ignition failure and overheating.
- f. While planning the pipeline between the boiler and the heated space, ensure that the outgoing pipeline ditches in the direction of steam flow. The return pipe should ditch towards the condensation pump or the vacuum heating pump.

Installation of Refrigerators

- a. Ensure that shipment boards are removed before switching- on the machine.
- b. Ensure that the machine is properly leveled. It is preferable to keep the machine on a wooden platform to prevent damage by floor moisture.
- c. Check that the machine is not too close to the wall. Ensure proper circulation of cooling air around the unit.
- d. Check the voltage variation and if necessary install a voltage stabilizer.

Window Type Units

- a. These units are easy to install as no special plumbing ducts are required.
- b. These do not give accurate humidity control and have a fixed air quantity.
- c. These should be installed in such a way that these do not interfere with use of window.
- d. Ensure that outside air can freely reach the unit to cool it.
- e. Check that the space between the unit and the frame is properly sealed.
- f. Ensure that condensate is properly guided through down pipe to prevent spoiling of surroundings. Check that the unit is at proper slip to facilitate collection of condensate.
- g. Ensure provision of cooling tank in dry climate cooling the compressor.
- h. Check that socket outlet is of correct capacity and wiring can take additional load.

Packaged Units

- a) These are self-contained units and do not need special foundations.
- b) For absorption of vibration. use 1.25-inch sponge rubber or 0.5-inch fiber glass insulation laid underneath the unit
- c) Water cooled units need provision of water piping, drain piping and cooling towers.
- d) These must be installed in close proximity to the room to be cooled
- e) Long runs of refrigerant piping should be avoided in case of air cooled units.

Check List Automatic Door Closers

- a. Ensure that automatic door closers are provided on the door in constant use.
- b. Any defect in the door closers should be rectified at once as nonfunctioning of these will affect the air-conditioning.
- c. See that door stoppers are not fitted on such doors.

Sealing Doors and Windows

- a. Sealing of windows and doors not in use is essential to reduce infiltration losses.
- b. Felt weather seal should be uniformly nailed down to seal the crevices between the shutters and the frames.
- c. Remember that window sills are the area of most discomfort both in winter and summer. Adequate sealing is therefore necessary to prevent drafts.

Provision of Air Locks

- a. For all large air-conditioned buildings air locks must be provided to reduce infiltration losses.
- b. Size of the air lock should be such that stretcher etc. can be accommodated in it with one side doors open.
- c. Door and hinges should be of heavy pattern. Hinges should be capable of adjustment.
- d. Door fasteners should be capable of operation both from inside and outside.

Electric Supply Switch Gear and Wiring

- a. Check and ensure that voltage of electric supply is within permissible limits. If necessary, a voltage stabilizer may be incorporated.
- b. All electrical switch gear must be in accordance with IS1 specifications.
- c. Wiring should be in conduits to ensure that an accidental short circuit will not set fire to the insulation.
- d. All ends of the conduits should be properly sealed to prevent condensation of moisture.
- e. Installation must conform to Indian Electricity Rules and must be done by a licensed contractor and qualified tradesman.

Heaters

- a. Heaters may be installed either before the filters as pre-heater for the return air, in the ducts after the fan or in the base board heat units.
- b. Heaters equipped with fins dissipate the heat quicker.
- c. When heaters are used in the ducts or in the base board units, it is essential that fan is switched on before the heater is switched on. This is because otherwise the heater may develop excessive temperature and may either burn out or cause fire hazard; sequence controllers should be provided for this.
- d. In case of base-board, heaters should have a capillary tube to detect hot spots and turn off the heaters.
- e. Manual switches should also be provided so that heaters can be switched off when not required.
- f. Low voltage thermostat and relays should be provided for switching off/on the heaters. Direct switching will cause the thermostat to burn off due to heated contacts.
- g. On account of frequent cycling, silent relays of bimetal or mercury switch type are preferable to open contact solenoid type.

Installation of Cooling Towers

- a. Check that foundation is designed to take the load of the tower, its interior fill, basin and its water contents.
- b. Locate the tower in such a way that it will not cause noise nuisance to nearby building. Preferably it should be on top of the plant room.
- c. Check that the prevailing summer wind is in the same direction as the tower discharge air.
- d. Ensure proper discharge connection to drainage to prevent flooding of the surroundings.
- e. To prevent loss of water by flooding of the tower on shut down, the lower should be preferably placed above the condenser. Location on top of plant room will ensure this.
- f. Check that adequate wind bracing is provided.
- g. Drift eliminators should be provided to prevent carryover of entrained moisture.

- h. Ensure that walkway is provided for facilitating maintenance of fan motor.

Water Softening Plant

- a. Get the water tested for hardness. If the solid impurities contained are more than 200 parts per million (ppm.) water softening is necessary.
- b. Ion exchange or acid treatment could be used for softening water. Acid treatment needs careful control to avoid corrosion.
- c. It is best to obtain advice from a specialist when water softening is considered necessary.
- d. Use of hard water will create excessive scaling in the condenser tubes and make these ineffective.

16.12 SUMMARY

In this unit very broadly we have covered the “finishes” aspects of a building together with water, electric and HVAC services.

These constitute an important aspect of supervision. These are the final components with which the user of a building interacts and he formulates his decision about the whole project by the satisfaction level achieved from these finishes and services. Therefore, it is very essential for a supervisor to pay full attention during supervision to these activities.

16.13 KEY WORDS

HVAC	: Heat, Ventilation, Air Conditioning
ISI	: Indian Standard Institution
SSR	: Standard Schedule of Rates
RCC	: Reinforced Cement Concrete
PCC	: Plain Cement Concrete
B/R	: Buildings and Roads
E/M	: Electrical and Mechanical

FURTHER READING

1. Neville, A.M., "Properties of Concrete".
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3. Irwin A.W. and Sibbald, W.I., "Falsework: A Handbook of Design and Practice."
4. IS: 456-1978, "Code of Practice for Plain Reinforced Concrete", Indian Standards Institution, New Delhi.
5. Sikand Dinesh, "Fresh and Hardened Concrete, ET-522, Block 2, Concrete Technology & Construction Techniques", IGNOU, SOET, New Delhi