UNIT 7 FOUNDATIONS

Structure

7.1 INTRODUCTION

In this unit you would be told various practical aspects of construction of foundation work. This would help you to execute the works as per the specifications. Foundation transmits the load of the structure to the ground. It is the first stage of construction. Obviously the safety of the entire structure depends on the foundation. Further it is very difficult to rectify any defect in foundation and the cost involved is too much. It is, therefore, very important that foundation should be constructed with utmost care.

Objectives

This unit will help you to understand how to execute foundation works as per the specification and what aspects are to be checked during execution.

After studying this unit you shall be able to:

- supervise foundation works,
- ensure that finished works conform to the specification, and
- appreciate the points that are to be carefully examined during execution of foundation works.

7.2 SOIL INVESTIGATION

As the load on a structure is ultimately transmitted to the soil, it is essential that the soil where the foundation would be lead is properly investigated. Sometimes for small structures we may rely on investigation reports of adjacent areas having similar soil but for important structures it is essential to have proper soil investigation.

Soil grains consists of inert rock materials (boulders, gravel, sand, silt) often combined with significant amount (say more than 5 per cent) of clay. The behaviour of the foundation soil mostly depends on the size and shape of grains, gradation of grains, minerological composition of grains, arrangement of soil grains in relation to each other, the interparticle forces and someother factors. Soil investigation at the laboratory as well as the field reveals all these properties of the foundation soil and helps us to decide about the most useful type of foundation and also the safe bearing capacity.

A soil may have a high ultimate bearing capacity based on shear strength but the

expected settlement may be more than the permissible settlement for the type of structure to be constructed. In such cases the safe bearing capacity of the foundation soil would be decided by the maximum settlement that can be decided by the maximum settlement that can be allowed for the structure. In such cases the safe bearing capacity would be less than the maximum bearing capacity based on shear strength.

The foundation affects not only the soil immeidately below it but also affects the soil at a lower depth depending on the size of the foundation and the load coming over it. It would be desirable that soil investigation is carried out by experts before the foundation is decided for all important works.

7.3 EXCAVATION

7.3.1 Excavation may be Carried Out in

a) **All Kinds of Soil**

Generally any strata such as sand, gravel, loam, clay, mud black cotton, moorum, lime concrete, mud concrete etc. which can be excavated by manual digging or simple implements like pick axes, shovels, jumpers etc. come under this category.

b) **Ordinary Rock**

Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging etc. for excavation such as lime stone, sand stone, hard laterite, hard conglomerate and unreinforced cement concrete etc.

c) **Hard Rock**

Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete etc. come under the category.

d) **Hard Rock where Blasting is Prohibited**

Hard rock can be excavated by blasting\cheeping and digging to remove In special case blasting is prohibited then soil can be excavated around and cheepedoff with the help of hammer and chisells and removed by digging.

7.3.2 Antiques and Useful Materials

As per the laws any items of archaeological interest such as relics of antiquity, coins, fossils or other articles of value found during excavation shall be the property of the Govt.

Any useful material obtained from the excavation shall be the property of the owner unless otherwise stated in the contract.

7.3.3 Safety Precautions

Secure fencing wherever required shall be provided with proper caution signs during the day and red lights at nights to avoid accidents.

Excavation shall not damage adjoining structures or dislocate the services in any way. It would be useful to have photographs of those structures and records of cracks if any. It may be useful in resolving disputes claims etc. at a later date.

In sandy/alluvial soils, if ground water table is lowered, ground subsidence in the area surrounding the construction site may occur due to consolidation of underlying clay layers. In such a case it may be necessary to provide a water retaining barrier around the site if structures exist adjacent to the excavation. Pumping to dewater may produce 30 to 50 mm settlement within a short time affecting the structure.

When pore water in the soil is just enough to moisture the sand but not saturate it, the surface tension makes it possible to provide shallow excavations with near vertical sides. With confirmed drainage and evaporation or vibration, the sides may collapse. Near vertical excavation in a cohesive soil may collapse due to rainfall softening the

clay and creating excess pore water pressure.

Excavation in sands below the water table may result in slumping of the sides and boiling of the bottom, unless a properly designed ground water lowering system is adopted.

7.3.4 Setting out and Making Profiles

Before starting excavation masonry pillars to serve as bench marks shall be erected at suitable point. Necessary profiles with strings streched on pegs, bamboos or burjis shall be made to indicate the correct formation levels. The bench marks shall be maintained during excavation to check the profiles and recording measurements.

The ground levels shall be taken at 5 to 15 meters intervals in uniformly sloping grounds and at closer intervals where local mounds, pits or undulations are met with. The levels should be recorded in field books and plotted on plan to a scale of 5 metres to one cm or any other suitable scale.

7.3.5 Blasting

It is essential that the executing agency should obtain written approval of the competent authority for resorting to blasting.

The executing agency shall obtain licence from the competent authority for undertaking blasting work as well as for obtaining and storing the explosives as per the Explosive Act, 1884, and the Explosive rules 1983. Explosives, fuses, detonators, etc. shall be purchased only from licenced dealers. Transportation and storage of explosives shall confirm to the aforesaid act. Explosives shall be securely kept and properly accounted. Fuses and detonators shall be stored separately and away from the explosives.

Blasting operation shall be carried out under the supervision of a responsible and competent authorised person during approved specified hours. Red flags shall be prominently displayed around the area where blasting operations are to be carried out. A safety zone of 200 meters shall be created from the blasting site prohibiting entry of non essential personnel. Audio warning by blowing whistle shall be given before igniting the fuse.

7.3.6 Excavation in all Kinds of Soil

All excavation operation shall include excavation and taking out the excavated material and depositing it beyond a specified distance away from the edge of excavation. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

In firm soils the sides of trenches shall be kept vertical upto a depth of 2 meters from the bottom. For greater depths, 50 cm steps on either side for every 2 metres depth shall be provided. Alternatively, the excavation can be done with a slope 1 horizontal to 4 vertical. For soft, lose or slushy soils the width of steps shall be suitably increased or sides sloped or the soil stored up. During excavation the natural drainage of the area shall be maintained.

The excavation shall be done true to levels, slope, shape and pattern indicated in approved drawings. Soft/defective spots at the bed of foundation shall be dug out and suitably filled. Any excess excavation of the foundation bed shall be suitably filled.

7.3.7 Excavation in Ordinary/Hard Rock

All useful excavated material shall be stacked. All other excavated material shall be disposed beyond the specified distance away from the edge of excavation.

During excavation natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or under cutting shall not be done.

Where blasting is restored it shall be done as specified in sub-section 7.3.5.

Chiselling shall be done to obtain correct level, slope, shape and pattern of excavation as per approved drawings.

Where blasting is prohibitted or are not practicable excavation in hard rock shall be done by chiselling.

Any excess excavation in the bed of foundation shall be suitably filled up. Soft/defective spots at the bed of foundation shall be dug out and suitably filled.

Excavation shown in drawings shall be measured and recorded for payment except in case of blasting where excavation shall be measured to actual levels.

7.3.8 Foundation Level

After excavation foundation should be laid over the soil as considered in the design. Any major variation like level of water table, presence of soft, deleterious, black cotton or filled up soil should be brought to the notice of the designers. The existing services like water supply, sewerage, storm water, gas telephone, electric lines etc. should be suitably protected.

Foundation should be laid over dry soil. If the level is below the water table suitable arrangement should be made for dewatering by bailing out or pumping or well point dewatering. Care should be taken so that adjacent structures are not be disturbed.

Over large areas the founding strata may be at different levels. The difference in level should be less than half the clear distance between footings. Over large areas the founding strata may be at different levels. The difference in level should be less than half the clear distance between footings.

After the excavation of soil is complete foundation should be laid at the earliest so that the exposed soil do not get disturbed by accumulation of rain water etc. If necessary the ground water table should be kept lowered till the foundation is cast beyond the water table and the weight of concrete is more than the upward thrust of ground water.

7.3.9 Planking and Strutting

In case the depth of trench in soft/loose soil exceeds 2 metres then we should resort to stepping, sloping and/or planking and strutting of sides. In case of loose and slushy soils the depth at which these precautions are to be taken shall be determined by the Engineer in Charge according to nature of soil.

Planking and strutting shall be 'close' or 'open' depending on the nature of soil and the depth of trench. The type of planking and strutting shall be determined by the Engineer-in-Charge. Guidance can be taken from IS:3764-1966 for designing the shoring and strutting arrangement.

i) Close Planking and Strutting

Close planking and strutting shall be done by completely covering the sides of the trench usually with short upright boards generally of section 250 mm × 38 mm Figure 7.1.

The boards shall generally be placed in position vertically in pairs, one on either side of cutting. These shall be kept apart by horizontal wallings of strong wood at a maximum spacing of 1.2 metres cross strutted with ballies.

Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical wallings which shall be strutted to similar timber pieces on the opposite face of the trench. The lowest boards supporting the sides shall be taken in the ground for a minimum depth of 75mm. No position of the vertical side of the trench shall remain exposed.

The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged while removing the planks.

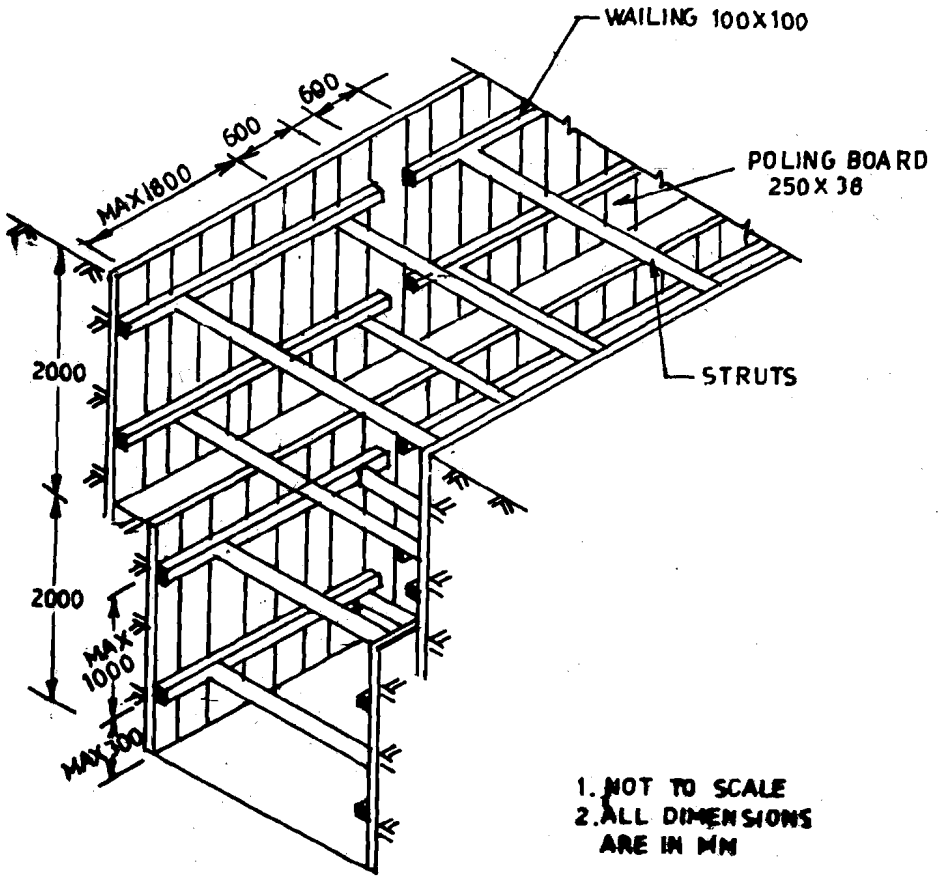

Figure 7.1: Close Planking & Strutting with Vertical Poling Board

ii) Open Planking and Strutting

In case of open planking and strutting the entire surface of the side of the trench is not required to be covered. The vertical boards generally 250 mm wide and 38 mm thick shall be spaced sufficiently apart to leave unsupported strips of 50 cm average width. (Figure 7.2). The detailed arrangement, size of timber and the distance apart shall depend on the nature of the soil. In all other respects, specifications for close planking and strutting shall apply to open planking and strutting.

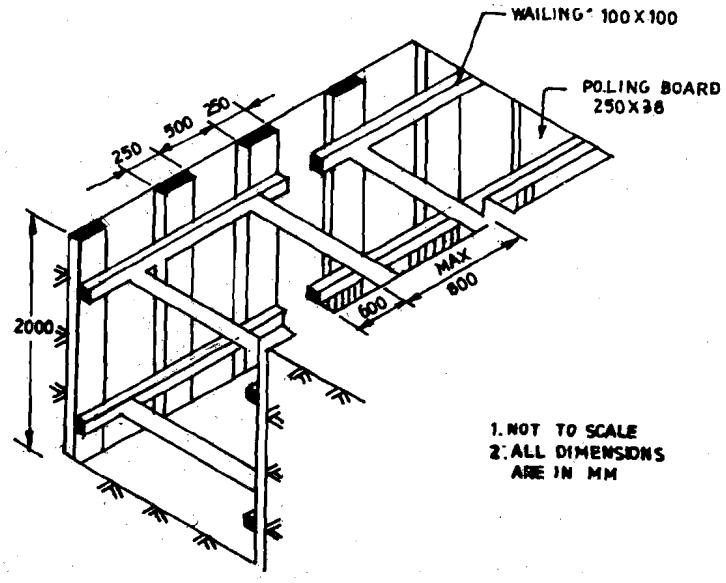

Figure 7.2: Open Planking and Strutting

7.3.10 Defects in Excavation Works

Some of the defects observed in excavation works are as follows:

1) Classification of soil not correctly done with framing the estimate. Bulk of the soil was taken as soft soil. In actual execution most of the soil was found hard soil.
2) The benchmarks left for measurement of excavation was found disturbed.
3) The peace for disposal of excavated was not predetermined.
4) In a project earth from excavation was disposed off to a great distance outside the site after paying lead charges and later earth had to be brought from outside for filling operations

SAQ 1

i) Why classification is necessary for excavation?
ii) Why should excavated material be stacked away from the site of excavation?
iii) What are the precautions to be taken before excavation by blasting?
iv) What will you do if after excavation upto the founding strata you found that there are soft patches?

7.4 FILLING

7.4.1 Filling Requirements

Filling is an important item of work. In case it is not done properly its effect may be felt at a later date when rectification becomes difficult. Settlement beyond permissible limits due to improper filling also causes serious problems. The earth used for filling shall be free from all roots, grass, shrubs, rock vegetation, brushwood, trees, saplings and rubbish.

7.4.2 Filling with Excavated Earth

Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in depth. All lumps and clods exceeding 8 cm shall be broken. Each layer shall be watered and consolidated with steel rammer or 1/2 tonne roller. Where specified every third and top most layer shall be consolidated with power roller of minimum 8 tonnes. The top and sides of the filling shall be neatly dressed. The executing agency shall make good all subsidences and strinkage during execution.

7.4.3 Filling Trenches, Plinth, Floors etc.

Filling in trenches, plinth, under floors shall be commenced soon after the joints and pipes, cables, conduits etc. have been tested and passed. The space around the pipes etc. shall be cleared of all debris, brick bats etc. Where the trenches are excavated in hard/soft soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 20 cm in depth. Each layer shall be watered rammed and consolidated. Ramming shall preferably be done by rammers. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the excavated earth is used for filling. In case of excavation of trenches in ordinary/hard rock, the filling upto a depth of 30 cm above the crown of pipe, cable, conduits etc. shall be done with fine materials like earth, moorum or pulverised decomposed rock according to the availability at site. The remaining filling shall be done with boulders of size not exceeding 15 cm mixed with fine material like decomposed rock, moorum

or earth as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30 cm. Deleterious material shall not be used. Ramming shall be done with iron rammers where feasible. Special care shall be taken to ensure that no damage is caused to the pipes, cables, conduits etc. laid in trenches. In case of filling under floor, the finished level of filling shall be kept to the slope intended to be given to the floor.

7.4.4 Filling at Optimum Moisture Content

Normally excavated earth from the same area shall be used for filling. It should be free from vegetation, boulders greater than 75 mm in any direction, clods exceeding 8 cm and deleterious materials.

The optimum moisture content at which clayee soil can be compacted for maximum density is experimentally found out at the laboratory. The soil suitable for use as fill material is laid in layers. Water is added, if required, to have the optimum moisture content. Rolling as specified is carried out with proper rolling equipment and giving the minimum number of passes. Sample is taken out from the fill and tested to have the required density.

Sand Filling

Sand shall be clean and free from dust, organic and foreign matter and of proper grading. It shall be done in a manner specified in 7.3.3 except that consolidation shall be done by flooding with water. The surface of the consolidated sand filling shall be dressed to the required slope.

7.4.5 Measurements

The length and breadth of excavation or filling shall be measured with a steel tape correct to the nearest cm. The depth of cutting or height of filling shall be measured correct to 5mm, by recording levels before the start of the work and after the completion of the work.

In case of fairly uniform ground the Engineer-in-charge may permit the measurement of depth of cutting or height of filling with steel tape, correct to the nearest cm. Borrow pits, diagonal ridges, cross ridges or deadmen, the position of which shall be fixed by the Engineer-in-Charge, shall be left to permit accurate measurement being taken with steel tape on the completion of the work.

Measurement of the excavation where ordinary rock and hard rock is mixed shall be made in the same way. The two kinds of rock shall be stacked separately, measured and each reduced by 50% to allow for voids to arrive at the quantity payable under hard rock and ordinary rock. The difference between the entire excavation and the sum of the quantities payable under hard rock and ordinary rock shall be paid for as excavation in ordinary soil or hard soil as the case may be.

SAQ 2

i) What is the advantage of filling at optimum moisture content?

ii) What is the difference in technique of consolidation in cohesive and cohesionless soil?

7.5 RAFT FOUNDATIONS

Raft foundation is adopted when isolated footings are not feasible. The whole of foundation area is excavated and RCC raft is placed where the load of the

superstructure is high or the safe bearing capacity of the soil is not adequate raft may be lead over piles driven into the soil over the areas. These piles usually are of shorter length and may be end bearing resting on hard stratum/rock or friction piles.

After excavation is done as given in 7.3 upto the required level the surface should be inspected. If any area has been excavated deeper then it should be filled up to the required level with suitable fill material. If any soft or loose soil is encountered then those areas should be excavated deeper and then suitably filled up as per the advice of the Engineer-in-Charge.

After the excavation is complete a levelling course of lean concrete should be laid and cured. Over this the reinforcement is laid as per the structural drawings. The shuttering of the sides should be suitably propped to the adequately strong to withstand the pressure of green concrete and prevent building. Adequate chairs for supporting top reinforcement should be provided to keep them in position.

Adequate cover should be provided for the reinforcement. Do not provide more cover thickness than specified as it does not increase protection but increases surface crack width. For deep rafts concreting shall be planned carefully to have continuous concreting to the extent possible to avoid weak construction joints. For Raft resting over piles suitable anchorage of the piles inside the raft should be provided.

In general following points should be checked:

1) Quality and size of the coarse aggregate whether under size, over size, or improperly graded and contains disintegrated or soft material, earth and other organic impurities.
2) Sand should be checked for grading, silt content, bulkage and foreign material.
3) Water should be tested for sulphates and chloride and any other impurities.
4) To ensure designed concrete water cement ratio should be as specified.
5) Cover blocks should be of proper size and strength and adequate in numbers.
6) Cement concrete should be as specified.
7) Form work should be as per the drawings.
8) Strength of form work should be adequate to withstand pressure of concrete, workman and machinery during casting. The support frame work should be cross braced. Failure on this account is fairly common.
9) Forms should be easily removable in sections in desired sequence without damaging the concrete.
10) Use of burnt mobile oil on the shuttering surface instead of proper shuttering oil should be avoid as it leaves stain on the concrete surface.
11) Form should be water tight.
12) General quality of line and level should be proper.
13) Adequate arrangement of curring is very important.
14) Mixing arrangement of concrete by mechanical mixutre should be proper.
15) Needle and plate vibraters should be proper and in working condition.
16) Slump of concrete should be as specified to ensure workability and consolidation.
17) Vibration should be properly done. Over or under vibration both are undesirable.
18) Steel reinforcement should be checked for suitability and strength.
19) The length of overlap and its spacing should be adequate. As the force is transmitted by bond with concrete there should be adequate gap between

bars in the lap length. Tying with binders should not be done.

20) Use of proper quality and gauge of binding wire and use in all intersections should be ensured.

21) Reincement details should be such as to permit easy placing and vibration of concrete.

22) Cement should be stored properly.

23) Reinforcement cage should be properly secured by chairs and hangers to prevent dislocation during concreting.

Some of the defects observed in execution of RCC rafts are given below:

1) The storage of cement was not properly done. The principle of 'first in' and 'first out' was not followed. As a result old cement of lesser strength was used occassionally.

2) The water for mixing concrete and curing was not tested periodically. Ground water used contained high quantity of chlorides and sulphates and was not suitable.

3) The water storage tank was used by labourers and contained algae. The water used for concreting was dirty and contained sand.

4) The top reinforcement sagged due to movement of labour while concreting.

5) The cover blocks wire made of weak concrete and gave away easily.

6) Proper cover blocks were not used and many of the blocks were dtached from the steel to which there were tied.

7.6 PILE FOUNDATIONS

Usually piles are adopted for foundations whenever safe bearing capacity of soil does not permit isolated footings or raft foundations. Availability of very hard strata at shallow depths overlead by very weak soil may also make pile foundation economical. The piles can be categorised by the material used such as timber, steel, concrete etc. or by the method of driving piles such as driven cast in situ, bored cast in situ, precast driven, under reamed piles etc.

Piling requires great care during driving. Once driven, a pile can not be corrected. Moreover all operations are supervised at ground levels and the bore remains filled with water or bentonite slurry. Finally the defects in piles remain burried and cannot be easily inspected.

7.6.1 Pile Driving

Following data should be recorded when pile is being driven:-

1) Diameter of the pile.

2) Depth driven.

3) Sequence of driving in a pile group.

4) Set for last ten blows or as specified.

5) The type and size of the hammer and its stroke. In the case of double acting hammer, the number of blows per minute and stroke.

6) Type and condition of the packing on the pile head and of the dolly in the helmet.

7) In case of driven cast in situ pile in variable ground, a record of driving resistance should be recorded.

8) In case of bored pile the boring log should be recorded.

9) In case bentonite slurry is used during driving, the record of density of slurryshould be kept.

Piles foundation should be driven either vertically or in specified inclination as accurately as possible. Any deviation should be reported to the designer for checking and redesigning. Generally the deviation for the pile should not be greater than 7.5 cm at the bottom of the pile cap and inclination of pile should not deviate more than 2% or 10 from the specified inclination.

Specified sequence of driving should be followed in case of grouup piles. For very soft soils piling should proceed from outside to inside and vice versa in case of stiff clay.

Tell-tale mark of sinkage of ground as well as rising of piles should be carefully noted. In case of bored piles soil statum at bottom shall be checked by split spoon sampler or any other method. Before concreting collase of sides shall be checked.

Initial load test shall be carried out on test piles usually at least on two piles. Routine tests as specified, usually 1%, should be carried on working piles to assess settlement corresponding to working load. Lateral load test is also required for inclined or raker piles.

7.6.2 Check List

The following Check List could be adopted

1) Date and time of driving.
2) Date of concreting.
3) Ground water level.
4) Length of pile.
5) Length of permanent casing.
6) Set at intervals during the last 3 metres.
7) Temporary compression of ground.
8) Concrete mix.
9) Details of reinforcement.
10) Volume of concrete supplied vis a vis theoretical quantity.
11) Eccentricity plan.
12) Deviation from verticality.
13) Routine and random check on density of bentonite slurry.
14) Bentonite clay to be checked for liquid limit, plasticity index etc.
15) Initial and routine load tests.
16) The steel reinforcement cage should be properly fabricated. The number and dia of bars and pitch of helical reinforcement should be as per drawing.
17) Lap length should be adequate. Adequate circular cover blocks shall be fixed on the links.
18) The gauge of steel casing should be as per design.
19) Whenever pile is resting over rocks, it should be properly socketed after ascertaining that it has reached the proper strata and not resting on stray boulders or any intervening hard strata. In a group of pile the founding rock level may be different. Test boring details of nearby areas indicate important information.
20) In bored cast in situ piles removable steel casing should be driven ahead of

boring in soft soils, otherwise large voids may form that can cause damage to green concrete as the casing is withdrawn.

21) Reinforcement cage is lowered immediately after bore hole bottom is properly cleared and approved.

22) Spacing of reinforcement should not be closer than 125mm to ensure proper flow of concrete which must have a minum slump of 150-200mm.

23) The tip of the tremie should always remain buried for at least 500 mm in concrete when pile shaft is filled with concrete.

24) Concreting when started shall be completed in one operation and as fast as possible.

25) The temporary casing and the tremie i.e. pipe are sometimes progressively removed for very long piles as the concreting proceeds. These operations require very close monitoring to effect speedy action. If the concrete is stiff or it has set it may arch across the casing and get lifted creating cavities and damaging the pile.

26) In under reamed pile the bulb diameter should be carefully checked immediately before concreting.

7.6.3 Common Defects Occurring in Piling Work

Some of the Common Defects Occuring in Piling Work are as follows:

1) The number of tests stipulated are not carried out.

2) Lateral load tests are not done.

3) Sufficient boring data is not kept. At a later date it could not be checked whether boring was upto the required level or not.

4) No cross check is done between the quantity of concrete consumed and the theoretical quantity.

5) Tilt and shift are not checked before withdrawing casing pipes.

6) The steel reinforcement case are not properly fabricated. The pitch of the helical reinforcement is not kept uniform and proper. The length of overlap is not adequate.

SAQ 3

i) Why it is important to examine the bore before concreting?

ii) Why it is ncesssary to clean the inside of the casing pipe?

iii) Why it is necessary to get the tip of tremie always burried inside green concrete?

7.7 WELL FOUNDATIONS

7.7.1 Construction Aspectes

Well foundation is adopted when appreciable load is coming over soil like bridge piers etc. and when there is appreciable horizontal load like abutments, high mast etc. or when load is to be transmitted to rocky strata available at a shallow depth. You will be surprised to know that Tajmahal was built on well foundation.

In river beds diversions or coffer dams are made to have a working platform for well

sinking. These should be properly designed and strong enough to withstand the high flood level conditions.

The alignment and location of the cutting edge and well kerbs should be carefully checked as these could not be corrected later. It should also be constructed with due care as it bears the brunt of the soil resistance during sinking.

The sinking should be uniform. Records of sinking should be carefully noted. The scooping out of material from the bottom should be in an uniform manner as also the kentledge on the top of the well so that there is no tilting. Tilt and shift of the well shall be continously recorded so that prompt remedial measures could be taken.

Pneumatic well sinking should be done only by expert agencies.

The level of the inside of the well should not be lowered to avoid sand blowing that may cause tilt of the well.

After the well has reached the required depth, the bottom should be excavated to have the bottom plug. The tremie used for concreting shall be securely fixed with arrangement for horizontal movement. The tip of the tremie should be kept burried in concrete while concreting proceeds. Concreting of bottom should be done in one operation.

The shuttering of top plug of wells, which are not filled up with soil, should be strong enough and they usually are not recovered.

7.7.2 Safety Measures

Well foundation is a specialised job. It is necessary that adequate safety measures are adopted on the following categories

1) Proper working and maintenance of tools and plants.
2) Health care of the vorkers.
3) Signalling system.
4) Inspection of works.

1) **Tools and Plants:** Proper Maintenance are tobe done in following way

1) All equipments used for sinking operation should be regularly inspected.
2) Qualified and experienced technical personnel, mechanic or supervisor should always be present at site.
3) Complete tool box and spares and consumables like fan belt, battery, grease gun etc. should be available at site.
4) All machines should be checked for oil, diesel, lubrication, wear and tear of moving parts before starting.
5) The air pipe lines should be checked for leakages.
6) The pressure gauge fitted at air compressor and air storage tank should be calibrated after every 200 hours of work.
7) Regular overhandling of machineries should be carried out at intervals.

2) **Health Care of Workers**

1) Divers should be physically and mentally fit and free from disabling diseases.
2) Adequate supply of air to all the divers should be ensured.
3) A stand by compressor and a pipe line should be kept at site in working condition.

4) The signal man at the top should be competent to direct safely the diver below the water.

5) The airtube for the diver should be kept straight without bend or kink.

6) When more than two divers are working in a well they should be properly guided so that the roaps, air tubes or signal lines are not disturbed.

7) The air compressor should be of adequate capacity and regularly serviced.

8) The pully should be tested for its capacity.

3) **Signalling System**

The engineer, superviser and workers should be familiar with the signalling system.

4) **Inspection of Works**

1) Engineers, supervisors and workers should have a helmet.

2) Standing on ground near well is not safe as blow can occur any time.

3) The wire ropes, clamps and other fastenings should be carefully inspected.

4) Gauge should be provided on all four sides to know depth of sinking.

5) Proper oiling and greasing of equipments should be checked.

6) Health of diver should be observed. More working should be avoided.

7.8 ANTI TERMITE TREATMENT

Anti termite treatment is an important aspect of foundation construction. The termites enter to building through the timber burried in grounds or by means of mud tubes over unprotected foundation. They may cause considerable damage to wooden members of buildings and other households articles. The treatment shall be during construction. However existing building can also be treated.

A chemical barrier is created between the ground and the foundation by treating the soil beneath the building and around the foundation with a suitable insecticide. Care should be taken that the barrier is without any break.

The chemical specified should be tested for its chemical property. Chemical of required concentration shall be procured in sealed original containers directly from reputed and authorised dealers. The quantity of chemical used for unit area should also be checked.

Graduated contains shall be used for dilution of chemicals with water in the required proportions to achieve the desired percentage of concentration. It would be advisable to collect all the required quantity of material at site, mark the containers, and use them in day today work. Empty containers should be taken back.

All chemical used for antitermite treatment are poisons. These chemicals can have an adverse effect upon health when absorbed through the skin, in-haled as vapours or spray mists or swallowed. Children should not have access to the stored chemicals. Workers should be advised about the dangers of skin contact with chemicals. They should wash themselves with soap and water and change dresses after working with the chemicals.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

Treatment shall be got only from approved specialised agencies. Spraying of chemical should be done using hand operated pressure pump.

7.8.1 Treatment for Masonry Foundations and Basements

The bottom surface and the sides upto a height of 300 mm of the excavations made

for masonry foundations and basements shall be treated with the chemical fat the rate of 5 litres per sq. metre surface area (Figure 7.3).

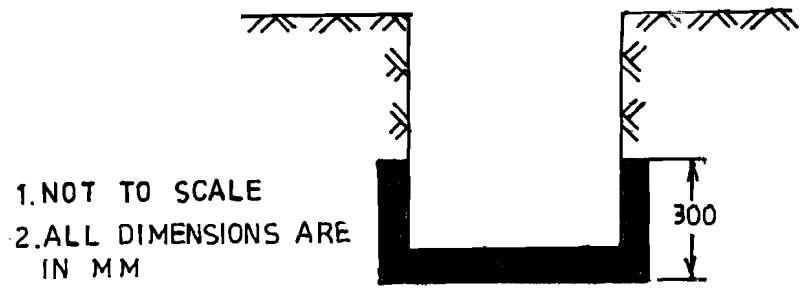

Figure 7.3: Section of Trench Bottom and Sides

After the masonry foundations and the retaining wall of the basements come up, the back fill in the immediate contact with the foundation structure shall be treated at the rate of 7.3 litres per sq. m. of the vertical surface of the substructure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemical with the above dosage. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical(Figure 7.4).

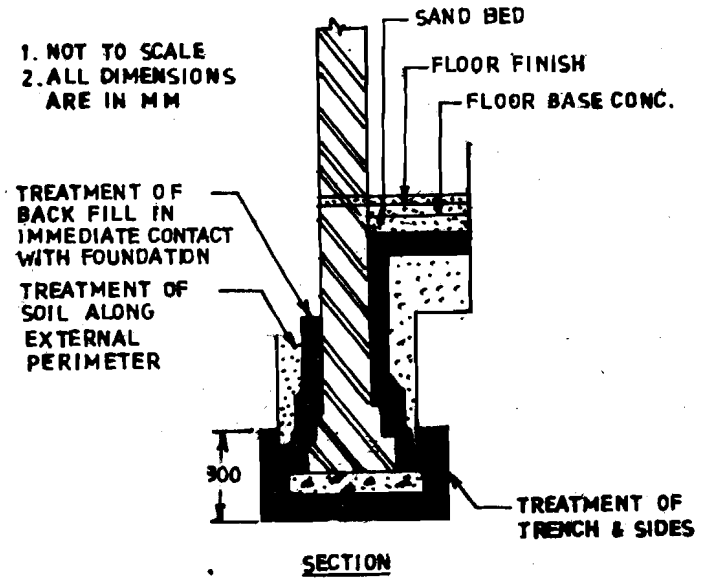

Figure 7.4: Load Bearing Wall Structure

7.8.2 Treatment of RCC Foundations and Basements

In case of RCC foundation the treatment should start at the depth of 500 mm below ground level. The soil in immeidate contacat with the vertical surface of RCC foundation shall be treated at the rate of 7.5 litres per squre metre. The other details of treatment should be as mentioned earlier (Figure 7.5).

7.8.3 Treatment of Surface of Plinth Filling

The top surface of the filled earth within the plinth walls shall be treated with chemical emulsion at the rate of 5 litres per sq. m. of the surface before the sand/subgrade is laid. Holes upto 50 to 75mm deep at 150 mm centres both ways shall be made with crow bars on the surface to facilitate saturation of the soil with chemical emulsion.

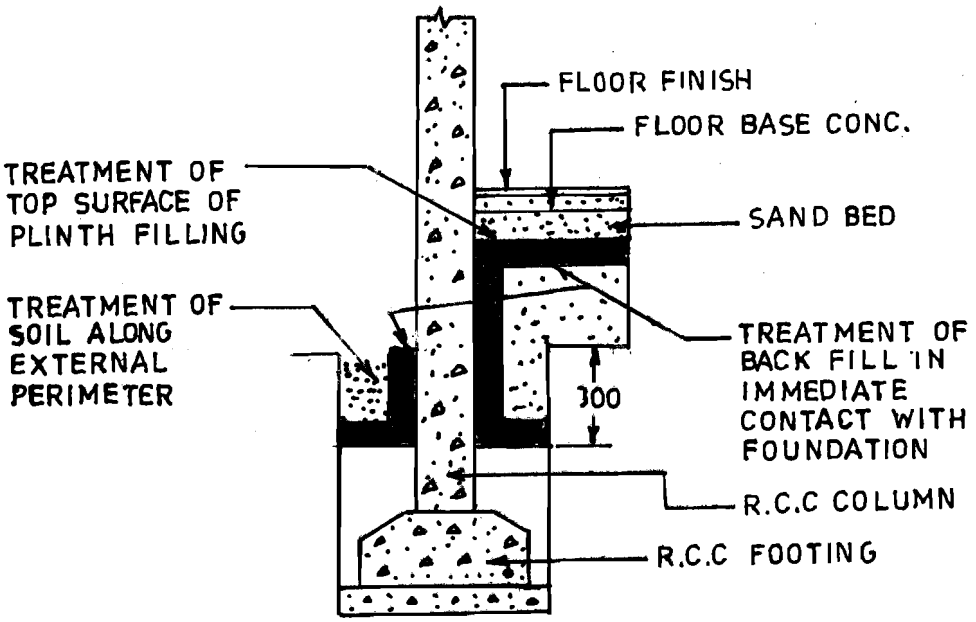

Figure 7.5: R.C. Framed Structure With Column & Plinth Beams

7.8.4 Treatment at Junction of the Walls and the Floor

To achieve continuity of the vertical chemical barrier on inner wall surfaces from the ground level, a small channel 30 × 30 mm should be made at all the junctions of the walls and columns with the floor before laying the subgrade and rod holes made in the channel upto ground level 150 mm apart and the chemical emulsion poured along the channel @ 7.5 litres per sq./m. of the vertical wall or column surface so as to soak the soil upto bottom. The soil shall be tamped back into peace after this operation.

7.8.5 Treatment of Soil along External Perimeter of Building

After the building is complete 300 mm deep holes shall be provided in the soil with iron rods along the external perimeter of the building at the intervals of about 150 mm and these holes shall be filled with chemical emulsion at the rate of 7.5 litres per sq.m. of vertical surfaces. The holes shall extended upto the original ground level if the depth of filling is more than 300 mm.

No treatment should be carried when the soil is wet due to rain or subsoil water.

The treated soil barrier shall not be disturbed. In case of any disturbance the continuity and completeness of the barrier system shall be restored.

Holes for chemicals shall be properly made. For proper penetrations of chemical into the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation.

SAQ 4

i) What is the basic principle of Antitermite treatment?

7.9 SUMMARY

In this unit you have been told how to supervise the work of foundation during execution. Beginning with the excavation, filling and different types of foundation

normally executed have been covered. The antitermite treatment which is an essential aspect of foundation has also been covered. The safety aspect to be looked into during execution has also been covered.

7.10 KEY WORDS

Foundation : The portion of a structure that supports all loads coming on it and transmits the load to the ground.

Specification : It specify the quality and quantity of materials, their proportions, procedure of execution, performance characteristics etc.

Black Cotton Soil : A type of claye soil that expands appreciably in contact with water and shrinks when dried. Usually black in colour.

Bench Marks : Reference points whose location and level is kept unchanged during construction.

Blasting : Breaking rock or masonry with the help of explosives.

Undermining : Excavation done at a depth keeping the upper layers of soil intact.

Planking and Strutting : Supporting soils during excavation with wooden or metallic planks and supporting the planks with bullies or pipes.

Formation or Profile : Final shape of the ground after excavation or filling up.

Optimum Moisture Content : The amount of moisture at which a soil can be consolidated to its densest state.

Raft Foundation : A thick RCC slab or beam and slab system usually extending over the entire plan area of the structure and even beyond for transmitting the load of the structure to the ground.

Pile Foundation : Poles of timber, concrete, steel etc. provided at the foundation for transmitting load of the structure to the soil either by end bearing or by side friction or by both.

Tremie : A tunnel shapped device with an adjustable long stem for concreting under waters.

Anti termite Treatment : Treatment of the soil below and around the foundation to prevent entry of termite in the structure.

7.11 ANSWERS TO SAQs

SAQ 1

i) The efforts and tools and plants needed and time required for excavation in different kinds of soils like ordinary soil, ordinary or hard rock and excavation in hard rock without blasting are different. Accordingly the cost involved and hence the rate payable for excavation in different class of soil are different. Similary, the cost involved and hence rate payable for excavation of soil under water, mud or foul condition are higher than in dry condition.

ii) Stack materials may slip and fill the excavated area. It may also cause subsidence of edges.

iii) The general precautions to be taken for blasting are:

a) The whole operation should be conducted by competent persons.

b) Statutory permissions should be obtained.

c) Proper safety precautions shall be taken to avoid accidents.

d) Blasting materials shall be purchased from authorised dealers.

iv) The area surrounding the soft soil should be excavated for some more depth till uniform soil is avaialble. The extra excavation shall be filled up with sand or moorum and rammed.

SAQ 2

i) The consolidated fill at optimum moisture content ensures the densest state of consolidation. The permeability is also lowest at this condition. The amount of settlement is least in this type of filling.

ii) In cohesionless soil like sand flyash etc. consolidation is achieved by flooding with water. In cohesive soils like silt and clay consolidation is done by laying the fill material in layers and watering and ramming each layer.

SAQ 3

i) Slush and spoils accumulate at the bottom of the boring. The reduces end bearing if not properly cleaned. During boring cavities may form where full casing is not provided. In under reamed piles the diameter of the bulb may not be properly formed. The depth of boring may be inadequate. All these defects can be detected by examining the bore carefully before concreting.

ii) Cleaning of casing reduces the possibility of dragging of concrete and formation of cavities in green concrete during lifting of the casing.

iii) The concrete poured at the start acts as a plug and prevents fresh concrete from mixing with water.

SAQ 4

i) Termite lives in soils. They enter the buildings and cause damages. To prevent their entry to the building a barrier is created by treating the soil with insecticides which the termite cannot penetrate. To be effective the barrier should be without any break and the quantity of specified chemical injected to the soil should be adequate.