UNIT 18 MISCELLANEOUS CONSTRUCTION TECHNIQUES

Structure

18.1 INTRODUCTION

In Units 14 to 17 you have studied about Construction Techniques involving water logged soils, diaphragm wall, piles,caissons, scaffolding, different types of formwork and rapid consolidation of soil etc. In this Unit, we will study about some more construction techniques which deal with vacuum dewatering technique for concrete, precast concrete construction for floor, roof and wall, large panel construction and some anchoring techniques.

Objectives

At the end of this unit, you should be able to :

* describe the vacuum dewatering technique for concrete,
* describe different precast elements for floors and roofs and their suitablility in different situations,
* describe large wall and roof panel construction, and
* describe the anchoring techniques.

18.2 VACUUM DEWATERING SYSTEM FOR CONCRETE

With the industrial revolution in our country and all over the world, the factory floor construction has been one of the serious concerns of architects, engineers and users, and as such the factory floor construction has been a subject of continuous research.

It has been universally recognised that concrete is the material best suited for the construction of industrial floor. It has been realised that the conventional methods of concrete construction of large factory floors when subjected to heavy loads, severe abrasive conditions resulting from mechanical wear & tear, on account of dragging and heavy components like heavy packings, castings, iron tyred trollies, tractors and tanks have not given satisfactory service. Certain admixtures have been added to floors in the past, but these measures have contributed only to a certain extent.

Concrete floor requires a slump of about 2-4 cm for proper compaction. Therefore, to obtain such a workability, a water-cement ratio 0.5 to 0.6 is required depending upon the size of aggregate and richness of mix etc.

It is an accepted fact that an W/C ratio more than about 0.4 would result in weak concrete associated with all other un- desirable qualities in concrete.

A pertinent point to note is that extra water required by plastic concrete for the reason of workability is for the duration of hardly 30 mt. But it causes untold harm to hardened concrete which is supposed to last for ages. Therefore, it is wise to use or manage to use water content in fresh concrete as low as about 0.4 W/C so that the hardened concrete derives maximum alround benefit.

18.2.1 Vacuum Dewatering System

Vaccum dewatering system is used to eliminate the ill effect of using extra water by the concrete in plastic condition (say about 30 mts) so that the subsequent performance of hardened concrete is greatly improved for the rest of the life of factory floor.

Extra wates in concrete is like administering slow poison to human being. Just as the slow poison gets into the human bones and brain and eventually kills the man, this extra water in concrete increases permeability, reduces strengths, increases shrinkage, produces cracks, reduces abrasion resistance and in short causes undue deterioration and eventual, immature failure. Immature failure of industrial floor will present untold difficulties and loss or stopage of productivity. Therefore factory floor must be made as permanent as possible for trouble free service, and better productivity. Vacuum Dewatering System is designed towards better performance of factory floor. It is a modern technology practiced in developed countries for years. This proven technique has now been transferred to Indian Construction Scene.

Vaccum Dewatering System consists of the following components:

a) Double beam screed vibrator.

b) Vacuum pump with hose.

c) Suction mat with cover.

d) Power trowel with blades & Disc.

e) Poker Vibrator.

18.2.2 Steps Involved in Vacuum Dewatering Process

The numerals are shown in Figure 18.1. Vacuum System match with step numbers which are as follow :

Step 1 The construction of any good floor begins with a careful preparation. Before casting, a precast concrete rail acting as a stop end and rail for surface vibrators, is positioned. It is also possible to use older systems with separate stop ends or elevated track rails.

At this stage, the flatness accuracy of the floor is determined.

The most rational way is to use the precast concrete rail which acts as a joint, stop end and screed rail.

Step 2 After placing the concrete it must be poker vibrated. During poker vibration, proper paste compaction of aggregate and paste is obtained. Voids and entrapped air are eliminated.

If you use the Vacuum System, you can work with a wetter concrete i.e. a higher water/cement ratio than what is normally possible. This facilitates placing and compaction.

Step 3 Poker vibration never gives a really level surface, but when this type of vibration is combined with surface vibration, the concrete surface will be level & smooth. Surface vibration ensures a still better overall compaction.

The surface vibrator should be run twice over the concrete surface. The machine can be pulled by two men or with a winch. Surface vibration is particularly advantageous for laying a wear course on old concrete as it ensures good adhesion to the base concrete.

Step 4 Vacuum processing removes the surplus water which is alway present in concrete. This process, which involves the use of suction mat and a vacuum pump, can be started immediately after placing and screeding.

The work is so simple that it does not require specialists. First, two men place the suction mat on the fresh concrete. The mat is then connected to a vacuum pump provided with a suction hose and the pump is started.

A vaccum is immediately created between the concrete and the surface. The surplus water is extracted out of the concrete by the vacuum pump. Vacuum dewatering lowers the water content in the concrete by 15 to 25%, which greatly increases the compressive strength and wear resistance of the concrete.

Vacuum processing takes only 1.5 to 2 minutes per centimetre thickness of the concrete slab. The concrete is dryer and compacted so tightly that a man can walk on the fresh concrete directly after it has been vacuum treated. This means that floating can be started without waiting for more time.

Step 5 The floating operation takes place directly after the vacuum dewatering. An after mixing and grinding of cement takes place. The cement particles are split apart and mixed with the sand particles which gives a very strong and wear-resistant surface. In order to further improve the wear resistance and minmize dusting, the concrete surface is power-trowelled with a skimfloater provided with trowelling blades. In addition to good wear reisistance, the concrete surface gets the final finish through the trowelling operation. Repeated trowelling, minimum two passes, further improves the wear resistance and minimizes dusting.

Step 6 If a further improvement of the wear resistance of the floor is required, a modern topping material be used. The topping material is worked into the concrete with the floating disc while the concrete is still humid i.e. between floating and trowelling. The surface is then power-trowelled in the normal way. The topping material produces a durable wear course and when desired also colours the floor.

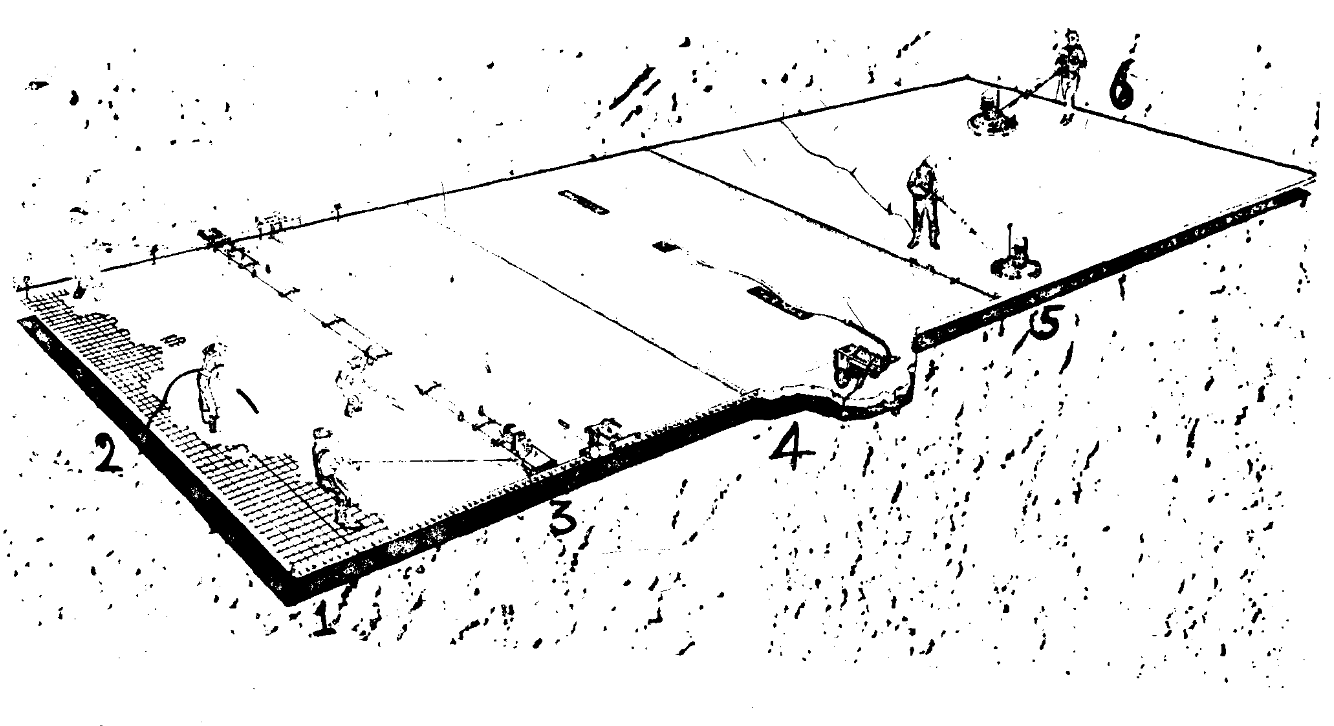


Figure 18.1 : Vacuum System

18.2.3 Advantages

a) **Improved Wear Resistance**

When concrete has been vacuum dewatered, the power-floating with disc can start immediately after the removal of the suction mat. As, at this stage, concrete has not yet hardened, and after mixing of cement and sand particles takes place, which essentially increases the wear resistance of a floor. An improvement of the wear resistance upto 2-3 times can be achieved through floating and repeated power-trowelling as can be seen in Figure 18.2 which shows reduced abrasion for concrete K-35 and K-50 with or without vacuum.

The wear resistance can be improved further by spreading granolithic concrete material on the fresh concrete surface that has been dewatered by vacuum process.

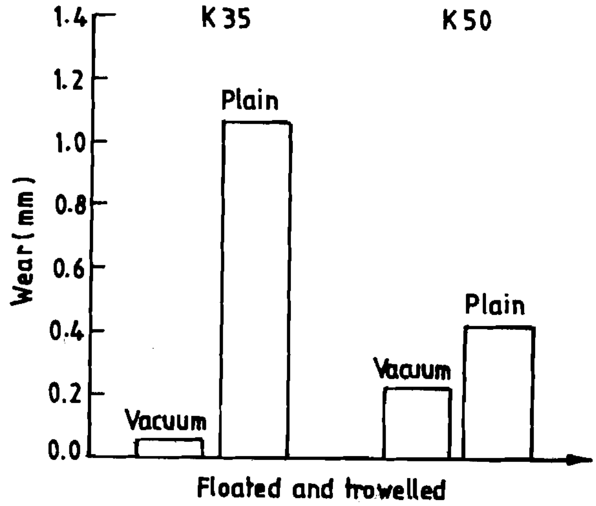


Figure 18.2 : Comparison of Wear Resistant

b) **Elimination of Curling**

A vacuum treated concrete slab shows no curling because shrinkage will be at its lowest on the top part of the slab where the water/cement ratio is lowest. Therefore, the edges will remain in the correct position when the concrete hardens (See Figure 18.3).

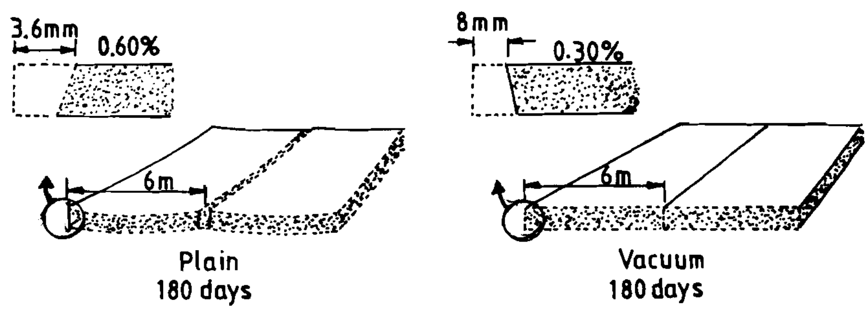


Figure 18.3 : Curling Effects

c) **Compressive Strength**

Tests very clearly show that vacuum processing improves compressive strength and how vacuum affects the top and bottom part of the slab respectively. You may note that already after 7 days, the compressive strength of vacuum dewatered concrete is the same as for normal concrete after 28 days. In addition to this the 24-hour-strength of vacuum dewatered concrete is much higher, which reduces the risk of damage on newly cast floors. The final strength is about 50% higher than that of a conventional concrete floor. It is also important to note that the highest compressive strength values for a vacuum dewatered slab is on the top surface, i.e.

the part of the floor, which is subjected to greater stresses during use (See Figure 18.4).

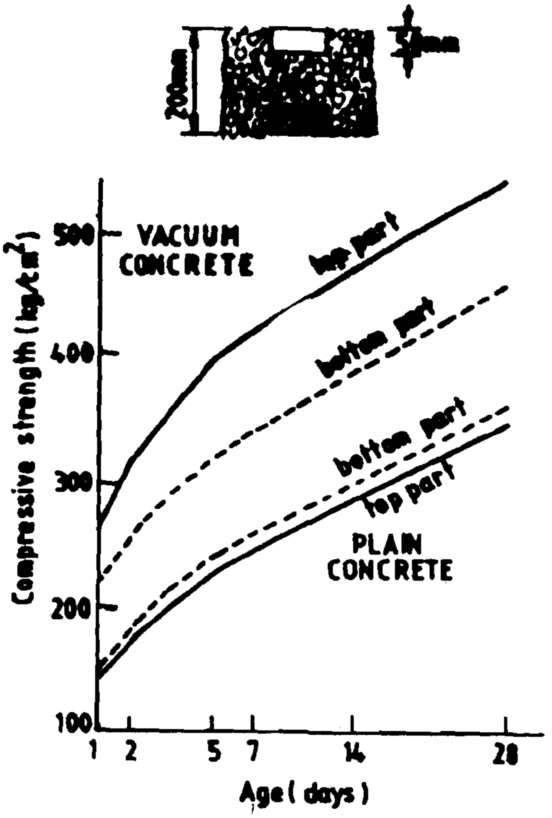


Figure 18.4 : Effect of Vacuum Processed Concrete on Compressive Strength

d) **Reduction in Plastic Shrinkage**

Vacuum dewatering noticeably reduces the risk of cracking due to plastic shrinkage and drying out (see Figure 18.5).

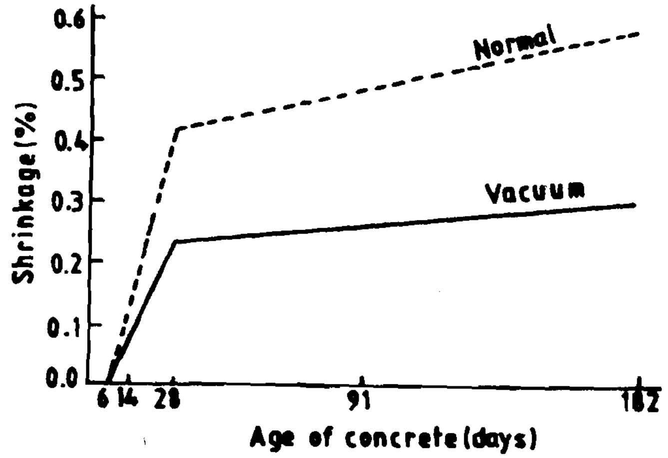


Figure 18.5 : The Shrinkage of the Top Surface is Reduced by 50% Through Vacuum Dewatering

The risk of disturbing crack formation is far less when vacuum dewatering is used than with those manipulated concrete types that are used for casting of floors where quality requirements are high. Slabs that dry out from one side, for example floors on ground, get curling with ensuing edge and joint cracking problems. If vacuum dewatering method is used for repair of old concrete; the difference in shrinkage in the old concrete and the new layer is reduced. The capacity to tolerate tensile stresses in the new layer will improve. The bond to the old concrete will be strong with minimized risk of crack formation.

e) **Permeability** It is a material property that is difficult to measure. It affects e.g. frost and corrosion resistance. Vacuum dewatering reduces the permeability of concrete, (see Figure 18.6).

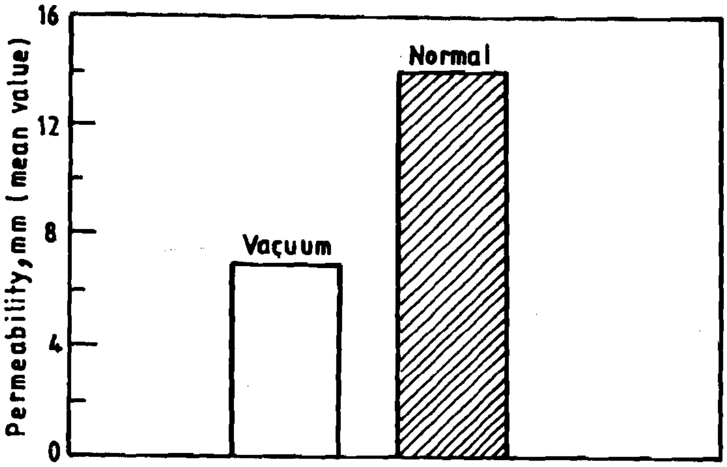


Figure 18.6 : Water Tightness Tests on Drilled out Cylinders

The figure shows a water tightness test according to an ISO-Standard. The test specimens, which are average values of drilled cylinders, are submitted to a pressure of 0.1 M Pa during 48 hours and 0.3 M Pa and 0.7 M Pa respectively during 24 hours each.

f) Mechanical floating and trowelling also have a sealing effect. Frost resistance for example increases because the risk of reaching the critical water saturation degree will reduce. Air entraining agents and vacuum dewatering also positively affects the frost resistance.

g) Durability, functional and asthetic properties are more or less important for different kinds of buildings and constructions (see Table 18.1).

Table 18.1 : Importance of Vaccum System on Different Building

Construction Building / Property Demand	Food/ Chemical Industry	Industry Heavy Store	Bridges Quays, Parking Decks	Office/ Ftals	Wall Panels	Sliding Forms/ Columns
a)Function						
Wear resistance	③	③	③	①	—	—
Compressive strength	③	③	③	②	—	—
Impact resistance	③	③	②	①	1	1
Dust reduction	③	②	①	②	—	—
Non-skid	2	2	2	2	—	—
Flatness	②	③	②	①	②	②
Crack restriction	③	③	③	①	②	③
Electr. or magn. demand	1	2	1	1	1	1
Cleaning possibility	3	2	1	2	1	1
b)Durability						
Permeability–w/c	③	②	③	①	②	③
Frost	②	①	③	①	②	③
Corrosion	②	①	③	①	②	③
Chemicals	3	2	1	1	1	1
c)Aesthetical	1	1	1	2	2	1

1 = Some significance,

2 = Significance,

3 = Great significance

○ =Vacuum System has favourable influence.

The above table shows an over-all evaluation. The circled figures show where the vacuum system has a positive effect in view of meeting quality requirements. It clearly appear that the system has a positive effect on many essential properties and that it is advantageous not only for industrial floors, parking decks and bridges but also for other construction parts like precast wall units and normal suspended floors.

Thus, summarising we can say that Vacuum Dewatering System will bring about the following advantages :

i) The system helps to speed up the floor construction.

ii) The system improves the strength of concrete.

iii) The system helps in producing a non-dusting, crack free durable floor.

iv) It helps to,produce a smooth wear resistant floor.

v) This system helps in reducing the plastic shrinkage.

vi) The vacuum system provides a kind of revibration and segments capillaries, thus reducing permeability.

The vacuum dewatering system thus enables rapid production of strong and durable concrete for industrial floors, parking decks, slabs and precast units, piers, office floors, airports, workshops, bridges etc.

SAQ 1

a) What are the different components of a vacuum dewatering system ?

b) How much time is consumed in vacuum processing?

c) What is the importance of surface vibration?

d) What is the effect of vacuum dewatering on wear resistance, compresive strength, curling and plastic shrinkage?

e) Name a few advantages of vacuum dewatering.

18.3 PRECAST CONCRETE CONSTRUCTION

It is a stupendous task to provide houses to the millions. As per the estimates of the National Building Organisation (NBO) the backlog of housing in the country is in the vicinity of 29.50 million dwelling units. Keeping in view the tight economic position, increasing population and ever growing demand of housing, there is an urgent need to adopt appropriate building technology to achieve maximum economy together with speed in construction. The cost of construction continues to increase rapidly. The exorbitant increase in the cost of land has further aggravated the situation and is responsible for increase in the number of slums, particularly in urban areas.

Prefabrication technology can be adopted to speed up house construction activities and build houses on mass scale. Some indicative studies have shown that construction time of housing could be reduced by about 40 percent by employing complete prefabricated housing technologies, both in walls and floors/roofs. In fact some recommend "Total industrialization of civil engineering" which means that it should be possible to mass-manufacture standardised multi-quality modern building materials and structural components, having high strength to weight ratios, in small, medium and large factories, which should be subject to scientific quality controls as per Bereau of Indian Standard norms. They feel that it is the only solution which has sure potential and capacity to solve country's acute and apalling housing and slum problems. The concept of the Industrialised Building System (IBS) will soon be introduced for the first time in India for housing and commercial constructions. IBS involves 100 percent prefabrication of construction in which the concrete walls, roof and flooring are manufactured in a factory and then transported to the sites of construction for execution as per demand and the design of the building. The entire technology for this project is being provided by CIC, Copenhagen International Consultants of Denmark, who have already supplied this technology to 60 other countries. Some others feel that at the present stage of natural development, partial prefabrication may be the answer to the problem of large scale housing. One of the leading organisation in the country which is working in this field is the National Building Organisation (NBO) which under its Experimental Housing Scheme has undertaken housing projects in the country in which prefab/precast building components have been adopted particularly for roofing/flooring. Among other institutions, some work on precast elements has also been carried out at College of Military Engineering, Pune.

18.3.1 Development of Precast Concrete Components in India

let us now examine as to how developments in India took place regarding precast concrete components :

Stage I

In the early sixties, heavy element handling equipment was available in very limited number and so various components like beams, columns etc developed were also of small and light variety of upto 100 kgs so that they can be handled and erected manually. This resulted in a major disadvantage of too many joints in the structure thus making the structures prone to leakages. A few examples are shown in Figure 18.7.

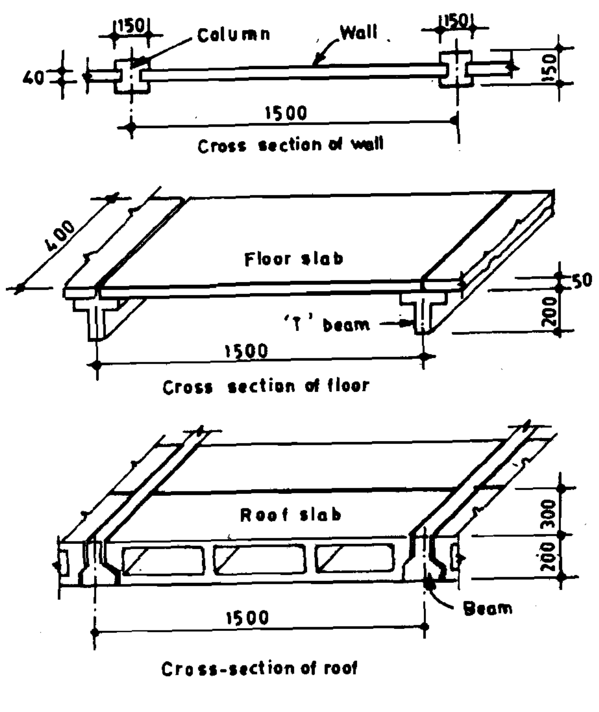


Figure 18.7 : Precast Concrete Sigments of Some Construction

Stage II

However, with advancement and availability of larger handling equipment, larger floor slabs, beams and columns were fabricated with individual element weighing upto 1000 kgs. This resulted in reduction of number of joints and speeded up the construction as compared to the early sixties. Some examples of wall and floor panel are shown in Figure 18.8.

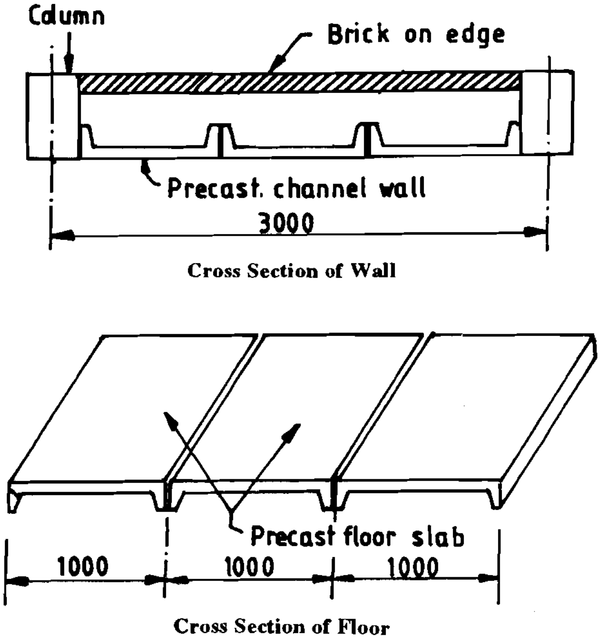


Figure 18.8 : Precast Concrete Sigments

Stage III

The advancements in the field of handling erection and transportation facilities enabled prefabrication of large units weighing upto 10 tonnes. The current practice is to use large prefabricated panels for the walls and floor slabs weighing upto 5 tonnes. This has resulted in further reduction in number of joints and quicker construction. The joints are now located only at the cross walls. This has led to economy in construction when executed on large scale. A few examples are shown in Figure 18.9.

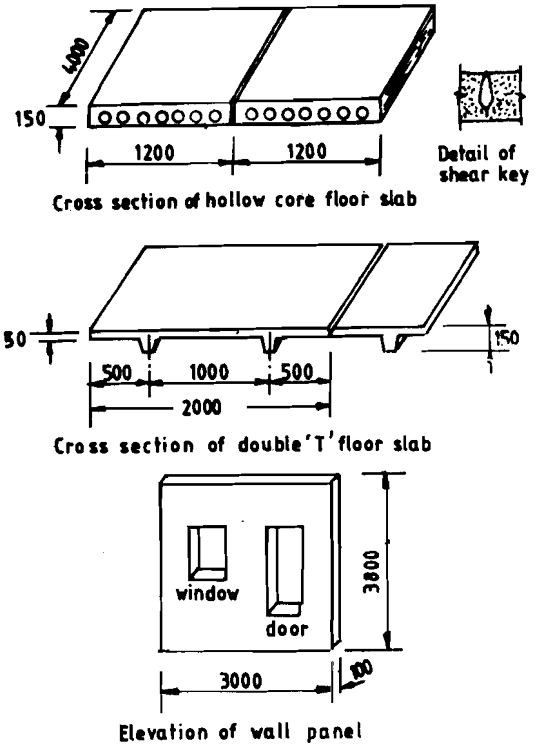


Figure 18.9 : Precast Concrete Sigments

18.4 PRECAST FLOORING AND ROOFING SYSTEMS

We will now discuss some of the precast elements developed by NBO. We will now take up precast Flooring and Roofing Systems. These systems/techniques have the manifold advantages of saving in cost, consumption of cement and steel and accelerated pace of construction. These systems make use of components which are fabricated on the ground, ready in all respects for erection in the housing unit. In these systems, in-situ concreting work is minimised and the necessity for putting up centering and shuttering is completely eliminated thus leading to saving both in time and money.

18.4.1 Precast Channel Unit

These are structural members having trough or channel shape as can be seen in Figure 18.10. They are considered suitable for floors, roofs of residential or office, school buildings for spans upto 3.5 metres generally. This unit generally has a width of 300 mm, however units of higher width upto 900 mm can also be cast but then they require mechanical lifting.

Precast channel units may be designed as per relevant Indian Standard codes of practice and stresses are checked for safety against shear and bond. Longitudinal moment keys and vertical shear keys are provided on the unit. While designing the units care should be taken to limit the weight of the units such that they are commensurate with the available handling and erection equipment and facilities.

The channel units are cast in well seasoned timber moulds with M-15 concrete using 10 mm and below aggregates. The concrete compaction is carried out by plate vibrator to prevent honey combing. The units are then cured for 14 days by keeping the trough filled with water and then they are air cured for another 14 days before being used. The channel units are placed side by side on the wall (See Figure 18.11) and all joints are filled with M-15 concrete which is properly compacted. Wherever required, negative reinforcement is also provided. Electrical conduits and fan hooks etc are embedded in the cast-in-situ concrete filled in the joints.

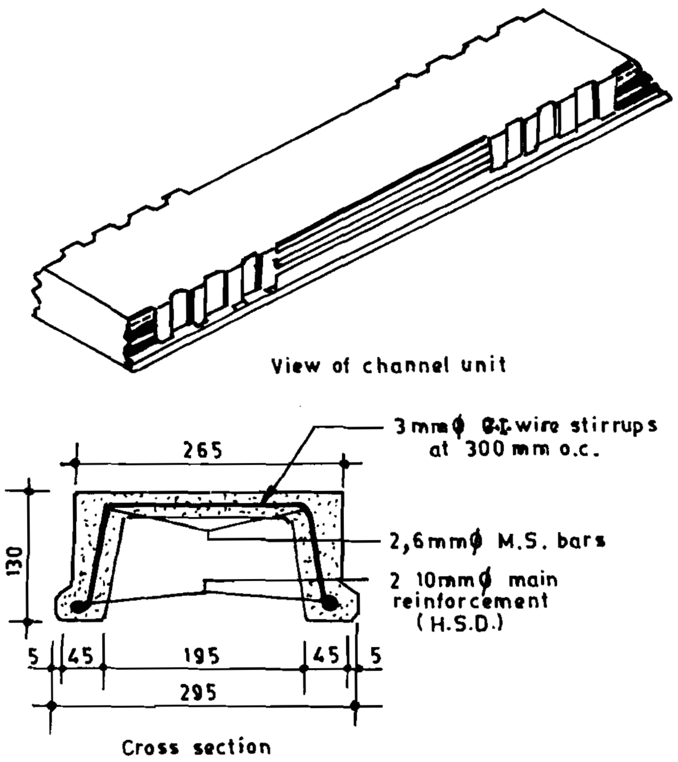


Figure 18.10 : Precast RC Channel Unit for Roofing

As you can see, shuttering and centering are completely eliminated in this precast construction. It has been seen that when the requirement of material for precast channel unit flooring comprising three continuous bays of 3.6 m each is compared with 115 mm

Figure 18.11 : View of Precast RC Channel Units beings Placed on Walls

thick conventional RCC one-way slab, the savings achieved component wise by use of precast channel unit are as under :

Component	Saving
Steel reinforcement	2 per cent
Cement	36 per cent
Coarse aggregate	36 per cent
Fine aggregate	36 per cent
Overall cost	20 per cent

This precast channel unit has been used in different types of residential accommodation and primary schools in several states in India.

18.4.2 Precast R.C. Cored Unit

These are used as roof/floor units in place of conventional cast-in-situ RCC slabs. They can be used in load bearing wall construction as well as in framed structures. It has two circular cores throughout its length. The unit does not require any temporary support or propping during construction.

The nominal wdith of unit is kept as 300 mm with actual width as 295 mm. Though the depth of the unit depends upon the span and loading conditions, a depth of 130 mm is generally adopted in normal situations. If mechanical handling facilities are available then Units having width of 600 to 900 mm can also be used (The unit is shown in Figure 18.12).

The minimum flange/web thickness of the unit is kept as 20 mm. The top and bottom of the units are flush while the sides are corrugated along the length with vertical grooves at the ends. These provide a key between two adjacent units.

The moulds for these units are made from well seasoned good quality timber or steel moulds can be used. G.I. pipes are used for forming the hollow cores. Depending upon the span ranging from 2.5 to 3.5 metre and the type of floor unit i.e. floor or roof unit, the reinforcement at top & bottom could vary from 2 nos. 6 mm at top and 2 nos. 8 mm to 2 nos. 10 mm at bottom with 3 mm wire stir ups at 30 cm etc. However, proper design should be done as per I.S. code considering all loads and for continuous spans negative reinforcement should be provided.

The use of precast cored units could effect upto 20% saving in consumption of cement as compared to solid RCC slab and 5 to 10% saving in the cost of roofing.

18.4.3 Precast Cellular Unit

The cellular units are precast with plain concrete and are not reinforced. They have hollow cellular spaces running along their length. The sizes of cellular units are fixed keeping in view the ease of handling. These units are generally made in two sizes:

1.2 m × 0.6 m × 7.5 cm thick (Four hollows)

1.0 m × 0.5 m × 10.0 cm thick (Three hollows)

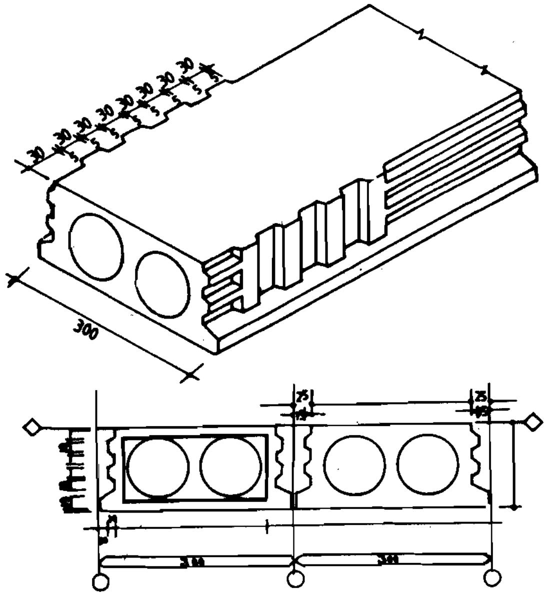


Figure 18.12 : Precast Cored Units

Their weight is about 80 kgs and 55 kgs per unit respectively.

A deck of 35 mm thick 1:8:16 cement concrete is laid over the assembled roof. The adoption of these units results in saving in formwork, speeding up of construction and upto 1% saving in the cost of roofing.

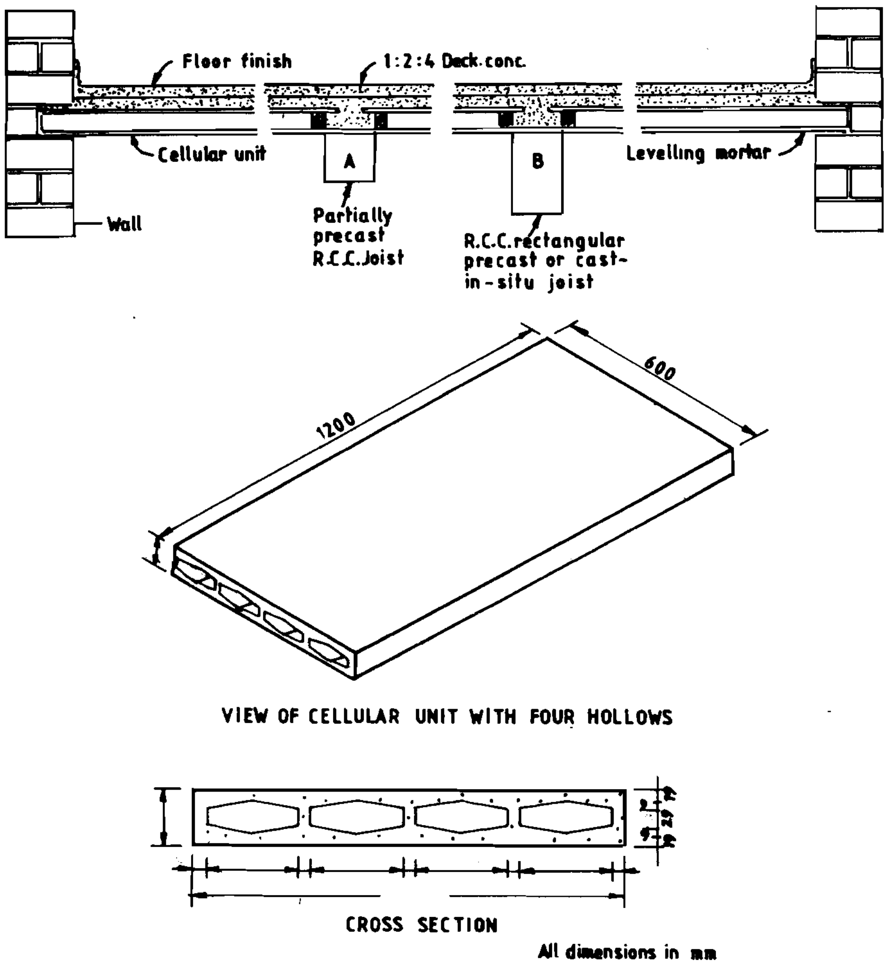


Figure 18.13 : Precast Cellular Units

18.4.4 Precast R C Plank and Joist System

These units can be used for floors/roofs resting on load bearing walls. The planks are generally 300 mm wide and 1500 mm long. The thickness of this precast plank varies from 60 mm at centre to 30 mm at the edges. A part of the unit is provided with tapered concrete.

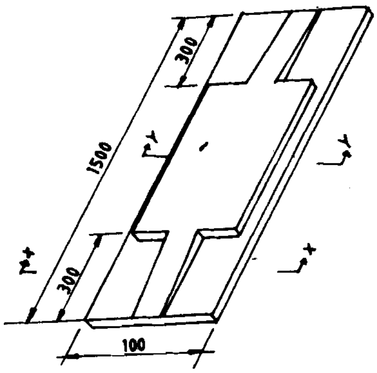


Figure 18.14 : Precast RC Plank

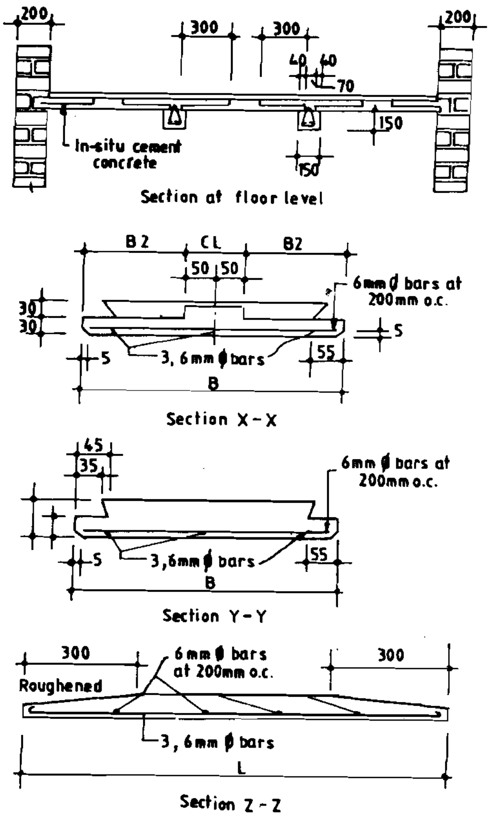


Figure 18.15 : Details of RC Plank System

The planks are placed on partially precast reinforced concrete joists of size 150 × 150 mm (see Figure 18.16)

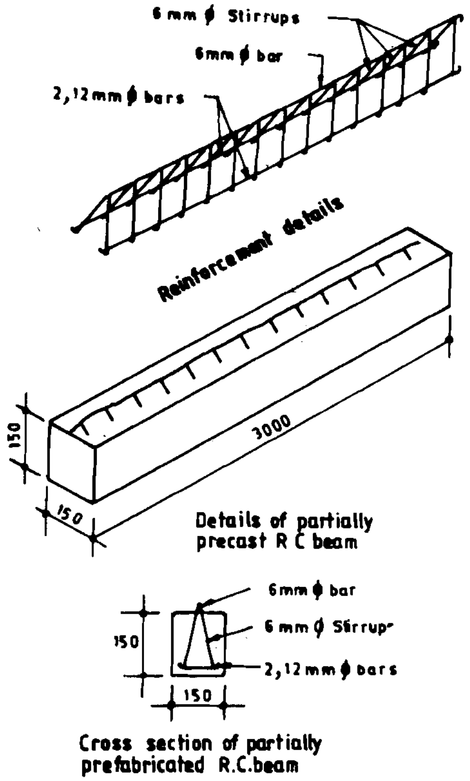


Figure 18.16 : Partially Precast RC Joist

Now the planks and joists are made monolithic by placing 6 mm diameter bars in both directions and then connecting the joists and haunches of the plank.

The joists and planks are precast in well-seasoned timber moulds or steel moulds and water cured for 14 days. During this operation planks are stacked in vertical position resting on edge. Then they are air cured for 14 days. Since both units are of moderate size and weight so no mechanical handling is required also only propping is required for joists during execution. This results in saving of time of about 25 percent compared to conventional RC slab. Also the savings in cost for a room size of 3.5 m × 3.5 m by this precast technique when compared to conventional concrete slab are as under:

Reinforcement	14%
Cement	27%
Coarse aggregate	27%
Fine aggregate	25%
Saving in total cost	21%

This precast unit has been adopted for construction of houses on mass scale by several construction agencies in India as well as under NBO Experimental Housing Scheme.

18.4.5 L-pan Roofing System

This precast roofing system consists of full span R.C.C.'L' shaped components. Here the sheetings and purlins, normally used for a conventional sloping roof are monolithically composed into single individual component as can be seen in Figure 18.17.

The smaller leg of L-section functions as rib of an L-beam and the wider leg (flange) as sheeting. The length of 'L' component depends upon the width of the room and can be upto 4 m. The dimensions are selected to obtain maximum economy and that units can be handled conveniently. Full span components are supported on gable walls or trussess sloping at 1:4 to 1:3 slope as per climatic conditions prevailing in the area.

The mould which can be of timber or steel consists mainly of two parts. The outer frame is composed of four separate pieces while the inner one is a single piece. The precast component can be removed to curing yard after 48 to 60 hours as per curing temperatures and can be used after 20 days of curing. During handling the flange of the component is kept vertical.

L-panel units are light, aesthetically appealing, durable and useful for sloping roof. They have been adopted for construction in many states.

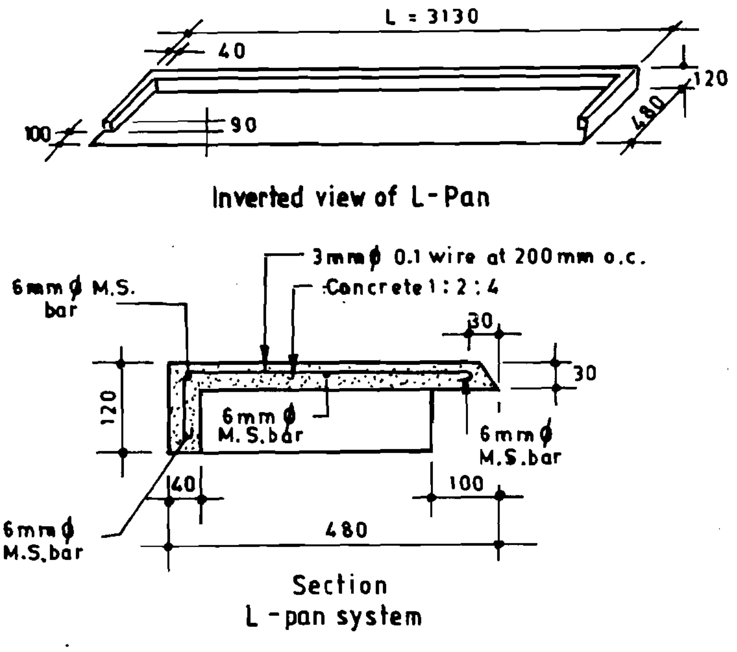


Figure 18.17 : L-panel Roofing System

18.4.6 Other Systems

In addition to above, there are several other flooring/roofing precast systems, some of which are:

a) Precast Doubly Curved Tile Roof

b) Precast Waffle shell

c) Precast Hyperbolic shell for roofing

d) Precast brick panel system

e) Thin precast lintel etc.

18.5 LARGE PANEL CONSTRUCTION

Large Panel construction is one of the rapid construction techniques which has found acceptance in many countries. There are a large number of construction systems using large prefabricated panels, which are in vogue. Some of the popular systems are - Reema, Bison (U.K), Barets, Estiot, Coignet, Camus (France), Unit Flat System, Tracoba, Larsen Neilsen, Boll mora (Scandinavia). Their systems differ from each other in regard to basic planning, components used and their production methods.

Basically there are two types of factory set-ups used to produce panels:

a) Permanent/Centralised Factory

b) Site Oriented Factory

A centralised factory is a fully automatic plant comprising sophisticated equipment with elaborate control systems. It is many times bigger than a site oriented factory.

Thermal insulation and leak proof jointing details for external walls are major problems affecting large panel construction. Thermal efficiency has been improved by adopting cellular concrete or sandwich panels.

Production of panels is the most important aspect in prefabrication systems. Horizontal casting occupies a very large casting space and excessive movement of men, machines and materials is involved. Therefore a vertical casting method called Battery Casting Technique is used.

18.5.1 Large Precast R.C. Wall Panels

It is a common practice to use precast concrete blocks (hollow, solid) for the construction of walls. However precast reinforced concrete wall panels offer certain advantages like imcreased impermeability to rain water seepage and obtaining first class finished surface during precasting itself. Also wall panels can be designed as local bearing members to eliminate the use of beams and columns resulting in saving of erection efforts and construction time.

To illustrate the point, we refer to a particular housing project where large panel precast system has been adopted for wall panels and roof panels. The precast wall panels were of maximum size of 3.5 m wide × 3.8 m high × 100 mm thick and made of concrete M-10 with reinforcement as per codal requirements. These wall panels were cast vertically in a battery casting system using specially designed steel moulds. Three types of wall panels have been used : solid panels, panels with door opening and panels with window opening. Integrally-cast doors and window frames are provided in wall panels thus eliminating the need for separate wooden frames. Door and window shutters are directly fixed to the hinges provided in the wall panel.

The walls are designed as load bearing walls and behave as rigid shear walls to absorb and transport horizontal forces due to wind and earthquake to foundation.

18.5.2 Large Precast Roof Panels

The precast prestressed technique is used to advantage here. The roof panel size used in a particular project was 4.5 m long × 2.3 m wide with two ribs at 1 m centres using M-40 grade concrete. These roof panels are cast on a special type of casting bed which is about 120 metre long and 2.5 metre wide. It has stressing abutment on both sides of the costing bed. 34 to 40 panels can be cast together. The moulds are first cleaned and then mould releasing agent is applied on the top surface of the mould for easy removal. High tensile steel wires of 5 mm diameter are provided in each rib for prestressing the roof panels together with special stir ups as shear reinforcement. The thickness of slab is 50 mm and overall depth of double "T" slab was 150 mm.

Concreting is done after prestressing the wires and vibration is done by platform and needle vibrators. After the release of prestress and cutting of prestress wires the individual slabs are shifted from casting bed to stacking yard where they are further cured.

All panels should be marked with identification numbers and date of manufacture. The roof panels can be stacked one over other in case of double "T" roof panel while wall panels are stacked side ways.

18.5.3 Erection

The wall panels are erected over the foundation in vertical position using a crane or gantry and alignment is maintained by using adjustable props. After they are erected, the joints are filled with rich mortar and props are removed only after the joints have attained sufficient strength.

Now the roof panels are placed over the wall panels and adjacent roof panels are connected with each other by welding the shear connectors.

Joints are now filled with mortar mixed with waterproofing compound and they are further protected against breakage by providing joint sealant over the mortar joint.

SAQ 2

a) Mention a few precast flooring/roofing systems.

b) What are the advantages of L-panel roofing system?

c) What is a precast channel unit ?

d) What are the different factory set-ups to produce large panels?

e) What is the saving due to use of precast RC cored unit?

18.6 SPECIAL ASPECTS OF PRECASTING

Following special aspects should be kept in view :

a) It is evident that for optimum use of materials precasting is the ideal solution. This economy can be maintained in precast construction by proper planning and standardisation of the dimensions of the structure Repetition being the essence of economy, the building plan should be prepared keeping uniform span for prefab components. Building planned on cross wall system is well suited for adoption of precast units.

b) In view of high transportation costs and limited transportation capabilities, it is usually found suitable and economical to set up a precasting yard near the construction sites. The casting yard should be well planned so as to provide facilities for manufacture of different type of precast components like beams, slabs, columns, wall panels etc.

c) Moulds need to be designed and manufactured carefully to cater for vibrations, fatigue in welding due to repeated use, handling, assembling and demolding etc.

d) Mix design can help in achieving economic in cement. Higher grades of concrete are preferred for precasting. Concrete must be well compacted by using platform, shutter and poker vibrators.

e) Curing of precast concrete can be done in various ways like steam curing and sprinkler curing. A system of vacuum dewatering of surplus water in concrete can be gainfully employed to achieve lowest possible water/cement ratio and denser precast elements.

f) Various quality control measures like selection and testing of constituents, mix design, cube testing and deflection tests are essential and should be carried out. The element should be checked for dimensional tolerances and any defects or cracking before erection.

Non-destructive tests such as ultrasonic pulse velocity test and rebound hammer test can be carried out on elements. In many projects full load test is carried out on each type of building as per IS 456–1978.

18.7 ANCHORING TECHNIQUES

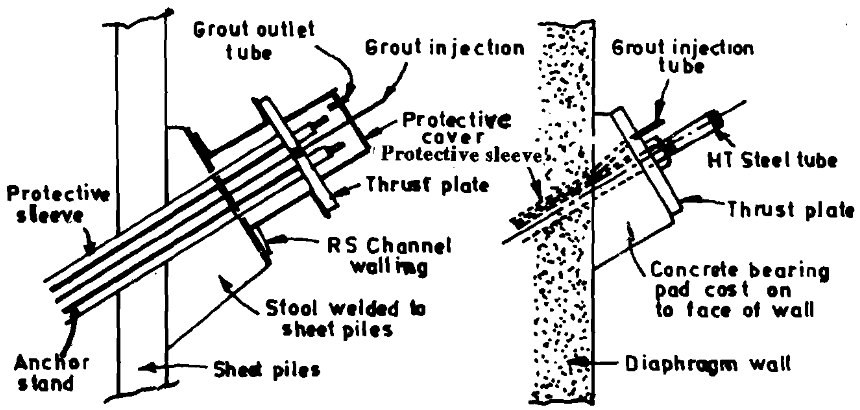
Another construction technique which is becoming very popular is the technique of anchoring of different type of structures like retaining walls, buoyant foundations, excavation supports, diaphram walls etc.

a) **Anchoring of buoyant foundations by anchor piles**

You will appreciate that it is necessary to prevent the sub-structure from floating and tilting before the superstructure loads are sufficient to prevent uplift. It is seen that in underground structures where there is a net uplift because of light superstructure loading, it becomes essential to provide some positive anchorage to prevent floatation. This can be done by providing anchor piles. If anchor piles are embedded wholly in soil then they must be designed as friction piles. However if rock is present, the anchorage could be in the form of steel rods grouted into holes drilled into the rock. The uplift resistance of anchor piles can be increased by drilling a large diameter hole deep into the rock and concreting or by drilling a deep hole into the rock at the bottom of pile, followed by concreting in steel rods or cable made up from high tensile wires lowered into the drilled hole.

b) **Anchoring by ground anchors**

Ground anchors are installed by drilling holes at a downward inclination to obtain a grouted bond length beyond the Zones of potential slipping or yielding of the tied back mass of soil. The anchors are usually inclined downwards at angles of 15 to 20° to the



a) Load on Cable Anchors Transferred to Sheet Piling through Horizontal Walls

b) Load on Bar Anchor Transferred to Diaphragm Wall through Bearing Pad

Figure 18.18 : Arrangement at Head of Ground Anchors

horizontal. Earth pressure on the anchored wall is transferred to the tendons either through horizontal wailing or through bearing plates at the head of each anchor. The latter method is generally used for stiff walls like diaphragm walls capable of distributing the load over an area surrounding the anchor head. The use of wailings gives greater security should one anchor fail under load. Anchor loads are calculated from a knowledge of the lateral earth pressure on the wall (see Figure 18.18).

Similar techniques can be used to stabilise and anchor impending slippage/sliding of rock mass by the side of a hill road. This is also called Rock Bolting.

18.8 SUMMARY

Vacuum dewatering system is used to eliminate the ill effects of using extra water by the concrete in plastic condition so that the subsequent performance of hardened concrete is greatly improved. This results in improved wear resistance, elimination of curling, higher compressive strength, reduction in plastic shrinkage, improvement in durability and helps in speeding up the construction.

Precast concrete is a method of construction as well as a material of construction. It covers a large range of products i.e. a hollow concrete block which may be weighing about 5 kgs, a wall panel weighing 5000 kgs, a complete precast room weighing 50,000 kgs, a bridge deck girder weighing 5,0,00,00 kgs and a concrete drilling oil platform of 50,00,000 kgs. Several precast elements have been developed by NBO which can be gainfully employed. Large panel construction has also been used in large projects. Precast construction has the advantages of speed, economy, good quality, less maintenance and durability.

18.9 KEY WORDS

Vacuum dewatering	:	Removal of extra water from concrete by vaccum during plastic stage.
N.B.O.	:	National Building Organisation.
Prefab	:	Prefabrication, precasting of units like wall, floor/roofs etc.
Joist	:	Beam.
R.C.	:	Reinforced Concrete.
M.S.	:	Mild steel.
H.S.D. bars	:	High Strength Deformed bars.
I.B.S.	:	Industrialised Building System.

18.10 ANSWERS TO SAQs

SAQ 1

a) The components are (a) Double Beam Screed Vibrator (b) Vacuum pump with hose (c) Suction Mat with Cover (d) Power trowel with blades & disc (e) Pokervibrator.

b) Vacuum processing takes only 1.5 to 2 minutes per centimetre thickness of the Concrete slab.

c) Surface vibration ensures a better overall compaction. The surface vibrator should be run twice over the concrete surface. This vibrator can be pulled by two men or with a winch. It is particularly advantageous for laying a wear course on old concrete as it ensures good adhesion to the base concrete.

d) It increases wear resistance and compressive strength, eliminates curling and reduces plastic shrinkage.

e) It speeds up floor construction; produces non-dusting, crack free, durable floor goes smooth wear resistance surface and reduces permeabilty among other advantages.

SAQ 2

a) They are :

(a) Precast channel unit (b) Precast cored unit (c) Precast cellular unit (d) Precast RC Plank and Joist system (e) L-pan roofing system.

b) The L-panel roofing units are light, aesthetically appealing, durable and useful for sloping roof.

c) This unit has trough or channel shape. It is considered suitable for floors, roofs of residential buildings and school buildings of spans upto 3.5 metres generally. This unit generally has a width of 300 mm, though units of bigger width upto 900 mm can also be cast but they require mechanical lifting.

d) They are (a) Permanent/ Centralised factory (b) Site oriented factory.

e) The use of precast RC cored unit could effect upto 20% saving in consumption of cement as compared to RCC slab and 5 to 10% saving in the overall cost of roofing.

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