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Recent Trends In Structural Repairing Techniques – Evaluation Studies

G.Srinivas[1], Dr.S.B.Sankar Rao[2]
[1] *Department of Civil En gineering, Mahatma Gandhi Institute of Technology, Hyderabad,*
[2] *Emeritus Professor (JNTUH), Hyderabad, Telangana,*

Abstract: In the Recent trends concreti ng under special circumstances such as constructions in basements, sewerage and other works gaining momentum drawing attention of Civil Engineers. In such occasions concr ete is placed under water or in contact with the earth or sand. Co ncrete is placed under such difficult situations ne eds special care. If proper precautions are not taken the cement may be leached or the aggregates may become segregate d.

It is also sometimes necessary to place c oncrete under extreme weather conditions- either very hot weather as in summer in New Delhi or in very cold weather as in Kashmir during the winter. The present dem and on buildings and Civil Engineering structures makes it to imperative for work to be continued in extreme hot and cold weather conditions. So it is necessary to have complete knowled ge on concreting in these extreme conditions. Therefore this paper deals with concreting under such special conditio ns with evaluation studies emphasized on (1) underg round construction and (2) sheet piles and bracings.

Index Terms: gaining momentum, leac hing, segregation, sheet piles and bracings

Introduction:

There are often situations in which concreting must be done under special circumstances lik e inbasements, sewerage and marine works. In such occasions, concrete is placed under water or in con tactwith earth or sand. Concrete is placed under such dif ficult situations needs special care. If properprecaution s are not taken the cement may be leached or the aggregates may become segregated. It is also sometimes necessary to place concrete under extreme weather c onditions- either very hot weather as in summer in New Delhi or in very cold weather as in Kashmir during the winter.The present demand on buildings and Civil Engineering structures makes it to imperative fo r work to be continued in extreme hot and cold wea ther conditions. So it is necessary to have complete knowledge on concreting in these extreme conditions.

Methodology:

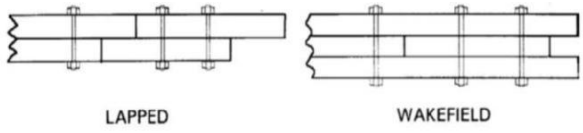
The Methodology for two major salie nt parameters is discussed. They are 1. Underground constructions 2. Under water Vs land constructions.

1. Underground constructions:
   In respect of underground constructions the following methods are adopted.
   a). vertical sheet piling
   b). Bracing system composed of either wales or struts or prestressed tiebacks.
   c). A bottom seal course if required to seal out the water.
   For Example Coffer dams are used in such situations where the adjacent ground must be supported against settlements or slides and in the construction of bridge piers an d abutments in relatively shallow water.

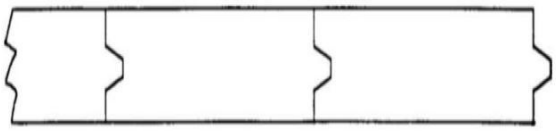
Sheet piles and Bracing:

There are three ba sic materials used for the construction of sheet piles: Wood, concrete and steel.

Wood sheet piling can consists of single line of boards and it is suitable for comparatively small excavations in which there is no serious ground water problem.In saturated soils, particularly in sand gravel, it is neces sary to use more elaborate form of sheet piling which can be reasonably water tight with over topping boards spiked or bolted together. The entire set up is calledas Lappedsheetpilingorwakefieldsystem.



Lapped and Wakefield Sheet Piling.

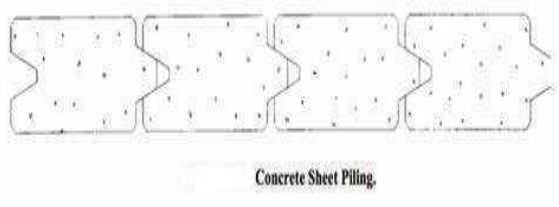


Tongue and Groove Wood Sheet Piling.

Sometimes Tongue an d groove wood sheet piling is used in situations wh ich provides more strength for sheet piling.

Precast concrete sheet piles are normally used in situations where the pr ecast members are going to be incorporated in to the final structure or are going to remain in place after they fulfill their purpose. Precast concr ete sheet piling is usually made in the form of a Tongue and groove wood sheet piling. This type of sheet piling is not always perfectly watertight, but the spaces between the piles can be grouted. In order to provide more watertight precast conc rete sheet pile, two halves

of a straight steel web sheet pile which splits longitudinally intohalf and embedded in the pile.



Concrete structures under water:

The use of concrete for large structures has been quiet common on land and, therefore, the technology and related parameters may be considered as well as understood. However, there are special considerations for constructions in or near sea. Structures on land are exposed entirely to uniform environment, whereas in the sea the following environments are common.

a). A temperature range of 20^0 to 40^0C above water in the ocean around India and for submerged zone it is below 20^0. But in cold regions these variations could be much higher.

b). winds over seas are higher than over land and structures near seas are subjected to cyclones/hurricanes of speeds up to 200KMPH.

c). External pressure or loading on concrete at 20m depth of sea water is around $2T/m^2$ in case the

d). Organic growth and swell of concrete can add to self-weight by 7% to 10%and therefore affect buoyancy.

e). Sulphate of magnesium present in sea water and its reaction on cemen in concrete could lead to the expansion of concrete.

f). Implosion due to pressure on the walls of supporting columns is also possible.

The repairs in under water structures broadly classified into three types.

1. Guniting
2. Shotcrete
3. Underpinning

Guniting:

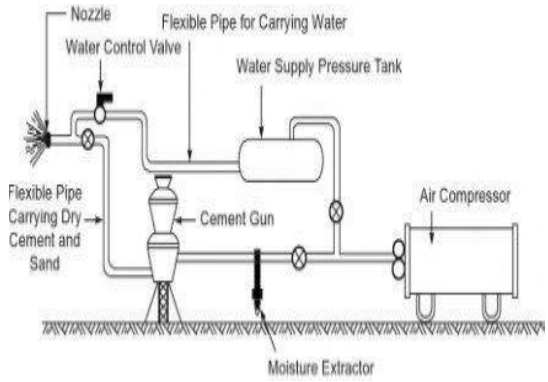
Guniting is a process used in construction for the application of slope stabilization and certain rehabilitation purpose mainly in the construction of retaining walls, swimming pool construction, tunnel construction, in fluid tank construction and some of the concrete repair works.

Guniting was a method of early origin in the US, where the method is defined as the process of spraying a mix or mortar or concrete to a surface of application with the help of a spray gun. This method makes use of a spray gun and hence the process was named as Guniting.

Now later it came to know that the dry Shotcreting process is called as the guniting. This is how shotcrete and guniting differs.The guniting is hence called as the dry-mix shotcrete process which convey dry material from a machine to surface of application through a nozzle by means of compressed pressure and high velocity.

The application is facilitated by the addition of water at the nozzle area. The mix that finally comesout is a combination of dry material and water. The operator has the control on the addition of water and the combination water content.

The mix used in guniting is cement mortar mix. There may be variations based on the application andrequirements of the area. The figure below shows a typical arrangement of a guniting or dry-mix shotcrete system.



The general requirements for undergoing a good quality guniting process are:

1. A high quality finished work through guniting is obtained by having careful and skillful operation and control of the nozzle.

2. The surface of application must be free from dirt, grease or any other defective materials. This must be cleaned by high pressure water jet or by air blast.

3. Sand blasting can be carried out the surface of application before undergoing guniting. This helps in removing rust on the reinforcement.

4. If the surface of treatment has high adsorption, then it must be kept wet for a time period of 6 hours before undergoing guniting.

5. The mix proportion used for guniting is 1:3 and 1:4:5. This will generally have a water cement ratio of 0.30. A 1:3 mix will attain strength of 70MPa in the 7th day after application.

Shotcrete:

Shotcrete or sprayed concrete is concrete or mortar conveyed through a hose and pneumatically projected at high velocity onto surface, as a construction technique. It is typically reinforced by conventional steel rods, steel mesh, or fibers.

Shotcrete is usually an all-inclusive term for both the wet-mix and dry-mix versions. In pool construction, however, shotcrete refers to wet mix and gunite to dry

mix. In this context, these terms are not interchangeable. Shotcrete is placed and compacted at the same time, due to the force with the nozzle. It can be sprayed onto any type or shape of surface, including vertical or overhead areas.

The dry mix method involves placing the dry ingredients into a hopper and then conveying them pneumatically through a hose to the nozzle. The nozzle man controls the addition of water at the nozzle. The water and the dry mixture is not completely mixed, but is completed as the mixture hits the receiving surface. This requires a skilled nozzle man, especially in the case of thick or heavily reinforced sections. Advantages of the dry mix process are that the water content can be adjusted instantaneously by the nozzle man, allowing more effective placement in overhead and vertical applications without using accelerators. The dry mix process is useful in repair applications when it is necessary to stop frequently, as the dry material is easily discharged from the hose.

Wet-mix shotcrete involves pumping of a previously prepared concrete, typically ready-mixed concrete, to the nozzle. Compressed air is introduced at the nozzle to impel the mixture onto the receiving surface. The wet-process procedure generally produces less rebound, waste (when material falls to the floor), and dust compared to the dry-mix process. The greatest advantage of the wet-mix process is all the ingredients are mixed with the water and additives required, and also larger volumes can be placed in less time than the dry process.

Shotcrete machines are available which control the complete process and make it very fast and easy. Manual and mechanical methods are used for the wet spraying process but wet sprayed concrete is traditionally applied by machine. The high spray outputs and large cross-sections require the work to be mechanized. Concrete spraying systems with duplex pumps are mainly used for working with wet mixes. Unlike conventional concrete pumps, these systems have to meet the additional requirement of delivering a concrete flow that is as constant as possible and therefore continuous, to guarantee homogeneous spray application.

Underpinning:

Underpinning is a method used to increase foundation depth or repairing faulty foundations. This might be the case if you plan to add stories to an existing structure or when the foundation has been damaged. One visible sign that your building needs underpinning is when cracks are visible. A building needs underpinning its foundation when cracks are wider than ¼ inch and there are some signs of a faulty foundation, especially diagonal cracks.
The most used method of underpinning is mass pour method. This process requires excavating sections in sequence to a pre-established depth below the footing and place concrete on each pit. Repeat the method until the entire affected area has been underpinned. There are other methods and techniques to underpinning which are described in the following sections.

Underpinning With Screw Piles and Brackets:

Underpinning with screw piles and brackets is normally used in certain instances where traditional underpinning process is not possible. Some buildings might require excavating to great depths or maybe is unfeasible to use a piling rig making it ideal to use the screw piles and brackets method. The screw piles and brackets can be installed by only a two man crew by hand or using small equipment such as a mini excavator.

Pile and Beam Method:

Underpinning with pile and beams is another great and preferred method to alleviate footing. Using this system requires that a min-pile must be installed on either side of the affected wall. After the piles have been installed, then brickwork is removed below the wall and reinforced concrete needle beam is used to connect the piles and support the wall. Reducing the distance between needle beams can accommodate very high loads. The bearing capacity of the underlying strata will determine the number, diameter, depth, and spacing of piles used. Augured piles or case driven piles can be used with this method of underpinning.

Underpinning Using Piled Raft :

Underpinning with a piled raft must be used when the whole structure needs to be underpinned. It is recommended when foundations are too deep for other underpinning methods or in areas where the soil is so hard that small equipment could not excavate up to require depth.

Piles are placed at determined locations by loading conditions; then pockets below footings are broken and reinforced needle beams are placed to bear the wall's load. A ring beam is then built to link all needles and the structure is poured with concrete.

Results and Discussions:

From the review of repairing techniques in respect of RCC structures with soil and water the following recent developments are presented below.

Materials / Techniques	Applications
Ferro-cement	Thin watertight walls
Fibre Reinforced concrete	High impact resistance
Polymer concrete	Impermeable, high-strength concrete
Epoxy coatings	Water proofing under high pressure in deep sea
Sacrificial anodes	Protection against corrosion
FRP reinforcement bars	Reducing corrosion in

	embedded steel
Expanded polystyrene foams	Adds buoyancy to hollow concrete

The above materials and techniques used for building marine structures.

If we analyze some of the above techniques, it can be seen that fabricated steel had to be eliminated as a structural material in preference to other corrosion resistant materials for oceanic structures.

Conclusions:

Concrete placed underwater (or grout) may play a wider role in undersea structures in the future.It is already extensively used for reinforced bell footings under steel platforms in many off-shore structures.

The rules and procedures advocated herein apply to concrete placed under water as well. Proper procedures must be followed:
The cover must be substantially increased to cover practical tolerances and the local entrapment of laitance, etc., and the structure should be over-filled or over flowed so as to ensure good quality of concrete at the top of the design surface.

The water -cement ratio should be kept to about 0.40.

The practices recommended to ensure maximum durability are listed below.

1. The amount of chlorides and sulphates in the mix should be reduced to a minimum.

2 The water -cement ratio should be less than 0.45; preferably 0.40or less.

3. Cement factor: 400kg/m^3.

4. Air entrainment, 5%-6%, should be used in the freeze –thaw zone.

5. The cover over reinforcement steel in submerged zones should be not less than twice the maximum size of coarse aggregate or 1.5 times diameter of the reinforcing bar, whichever is greater.

6. Reinforcement should be well distributed, with a maximum spacing of 30cm in each direction on each Face.

7. Construction joints should be cleaned of laitance and roughened to a depth of 6mm.

8. The external face of the joint should be painted with epoxy, up to 30cm on each side.

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