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A STUDY OF CONCRETE ON THE APPLICATION OF VACUUM DEWATERING

Ankit Kumar Singh[1], Akhilesh Bahadur[2], Chandra Prakash Pandey[3], Mohd.Sadique Khan[4], Mr.Ankit Srivastav[5]

[1234]Undergraduate, Civil Engineering, Buddha Institute of Technology, (India)
[5]Lecturer, Civil Engineering, Buddha Institute of Technology (India)

ABASTRACT

This experiment provides a new way of concrete flooring by the used of vacuum dewatering concrete technique/Tremix method in the area of concrete flooring in civil structure with its advantages of VDF system. Vacuum concrete is the effective technique used to overcome this contraction of opposite requirement of workability and high strength. This process is a means to efficiently remove excess water from newly placed, compacted and leveled concrete surfaces. Vacuum dewatering of concrete has been refined to specially address concreting of large exposed surfaces in any weather conditions. Vacuum dewatering greatly improves the abrasion and impact resistance of the concrete surface. The uncontrolled removal of water from the concrete matrix can result in adverse effects such as plastic shrinkage cracking. Excessive bleeding of concrete can negatively interfere with surface characteristics such as resistance to wear. Thus the durability and service life of the flooring element is in question. Concreting in areas exposed to the elements, specifically in hot and windy conditions poses even higher demands in order to produce quality, durable concrete. The main aim of the technique is to extract water from concrete surface using vacuum dewatering. As result of dewatering, there is a marked reduction in effective water-cement ratio and the performance of concrete improves drastically. The improvement is more on the surface where it is required the most.

Keywords- Vacuum Dewatering, Tremix Method, Cement, Sand, Aggregate.

1. INTRODUCTION

1.1 Definition

A vacuum dewatering concrete flooring/Tremix method can be defined as "Vacuum Dewatered Flooring is a special type of Flooring Technique to achieve High Strength, Longer Life, Better Finish and Faster Work. This type of floor is suitable for high abrasion & heavy traffic movement". Technologies applied in concrete flooring will improve concrete flooring physical behavior. This method used like concrete flooring in warehouse, concrete road, parking area, production area in industrial buildings.

1.2 History of vacuum dewatering concrete flooring

The vacuum dewatering process, patented in the United States, nearly half a century ago, has attracted increased interest in recent years after several Scandinavian firms simplified the equipment enough to make it practical for

almost any builder Vacuum dewatering is used widely throughout Europe today, and in Sweden the method is used for 40 to 50 percent of all concrete floors. Basically, the process improves strength, durability, and other properties of concrete by reducing the water-cement ratio immediately after the mix is placed, usually in floors and other flatworks. Tremix or vacuum dewatering flooring is popularly known in India, is actually Vacuum dewatering process of concrete. It was originally invented by Tremix AB, Sweden many years ago.

1.3 Vacuum dewatering concrete & its benefit

A high quality concrete floor or pavement requires not only being level, but it should also have high wear resistance, high compressive strength, reduced shrinkage and minimum water permeability. The Vacuum Dewatering (VD) flooring method & glass fiber is a system for laying high quality concrete floors with superior cost-effectiveness. The key to the use of this method is the dewatering of concrete by vacuum process. Surplus water from the concrete is removed immediately, after placing and vibration, reducing the water-cement ratio to an optimum level and making structure lightweight.

2. LITRATURE REVIEW

From International Conference on 11th April 2015, S.N Patel Institute of technology & Research Centre Bardoli, Gujrat.

2.1 Vacuum treatment of concrete based on Ordinary Portland Cement Results in a marked increase in compressive strength. In General, Compressive strength of vacuum dewatering processed concrete is 25-45% Higher at 28 days after casting.

2.2 Increases flexural strength as well as a higher modulus of elasticity.

3. METHODOLOGY

3.1 Tremix Method of Vacuum Dewatering

Tremix or vacuum dewatering flooring is popularly known in India, is actually Vacuum dewatering process of concrete. It was originally invented by Tremix AB, Sweden many years ago. This process was introduced in India by Aquarius Technologies in 1987. The Tremix method facilitates use of concrete with better workability than what is normally possible. Vacuum dewatering process removes surplus water always present in the concrete. This is done using the vacuum equipment comprising of Suction Mat Top cover, Filter Pads and Vacuum Pump. This technique is effectively used in industrial floors, parking lots and deck slabs of bridges etc. The magnitude of applied vacuum is usually about 0.08 MPa and the water content is reduced by up to 20-25%.

Fig 1:- Tremix Method of Dewatering

4. EQUIPMENT & MATERIAL USED IN EXPERIMENT

4.1 **Vacuum pump** Vacuum pump is a small but strong pump of 5 to 10 HP. Water is extracted by vacuum and stored in the water separator. The mats are placed over fine filter pads, which prevent the removal of cement with water.

Fig 2:- Vacuum Pump & Flooring

4.2 **Water separator** Proper control on the magnitude of the water removed is equal to the contraction in total volume of concrete. About 3% reduction in concrete layer depth takes place. Filtering pad consists of rigid backing sheet, expanded metal, wire gauze or muslin cloth sheet.

4.3 **Filtering pad** A rubber seal is also fitted around the filtering pad filtering pad should have minimum dimension of 90cm x 60cm.

4.4 **Screed board vibrator** Vibro screed is used for the leveling as well as compaction of concrete. It consists of high quality steel bar (4.2 meter) with spacing of 250 mm in between. Special water protective vibrator motor is mounted in the centre.

4.5 **Cement** The ingredients of cement primarily consist of calcareous materials in the form of limestone, chalks and marl and argillaceous materials. The ordinary Portland cement (OPC) of 25 Grade is used.

4.6 **Fine Aggregate** Fine aggregate is a material such as sand, crushed stones or crushed gravel passing through 4.75 mm size. Locally available sand is used as fine aggregate in the concrete mix. The specific gravity of fine

aggregate is 2.71. The test procedures as mentioned in IS-383(1970) were followed to determine the physical properties of fine aggregate as shown in Table 1.

Table 1: Physical Properties of Fine aggregate

Physical Properties	Observed values	Recommended values
Grading Zone	1	-
Fineness modulus	3.173	2.9-3.2
Specific Gravity	2.632	2.6-2.67

4.7 Coarse Aggregate Two single sized crushed stone aggregates ranging from 12.5 mm to 2.36 mm and 20 mm to 4.75 mm (10mm and 20mm sizes) were used in respective proportions in concrete mixes. The aggregates were tested in accordance to IS-383: (1970). The results obtained are tabulated in Table 2.

Table 2: Physical Properties of coarse aggregate

Physical Properties	Observed values		Recommended values
	10mm aggregate	20mm aggregate	
Fineness Modulus	6.28	7.11	6.5-8.0
Aggregate Crushing Value	18.15	25.13	Not more than 45%
Aggregate Impact Value (%)	28.63	22.10	Not more than 45%

4.8 **Water (**As per recommendation of IS: 456 (2000), the water to be used for mixing and curing of concrete should be free from deleterious materials. Therefore potable water was used in the present study in all operations demanding control over water quality).

5. PROCEDURES

5.1 All the basic ingredients (Cement, sand, aggregate) of the matrix are batched by weight.

5.2 When the slurry is ready then mixtures poured in mould cube or slab.

5.3 With the help of screed vibrator the surface is vibrated and compacted.

5.4 This is done using the Vacuum Equipment comprising of Suction Mat Top Cover, Filter pads and Vacuum Pump. The process starts immediately after surface vibration.

5.5 Filter pads are placed on the fresh concrete leaving about 4 inches of fresh concrete exposed on all sides. The Top Cover is then placed on the filter pads and rolled out till it covers the strips of exposed concrete on all sides. The Top Cover is then connected to the vacuum pump through a suction hose and the pump is started.

5.6 Water from concrete is vacuum and stored in water separator.

5.7 Vacuum is immediately created between the filter pads and the top cover. Atmospheric pressure compresses the concrete and the surplus water is squeezed out. This process lowers the water content in the concrete by 15-25%.

5.8 About 3% reduction in concrete layer depth takes place.

5.9The dewatering operation takes approximately 1.5-2 minutes per centimeter thickness of the floor. The dewatered concrete is compacted and dried to such an extent that it is possible to walk on it without leaving any footprints. This is the indication of concrete being properly dewatered and ready for finishing.

5.10 By the use of power trowel and power floater the surface is given a hard and smooth.

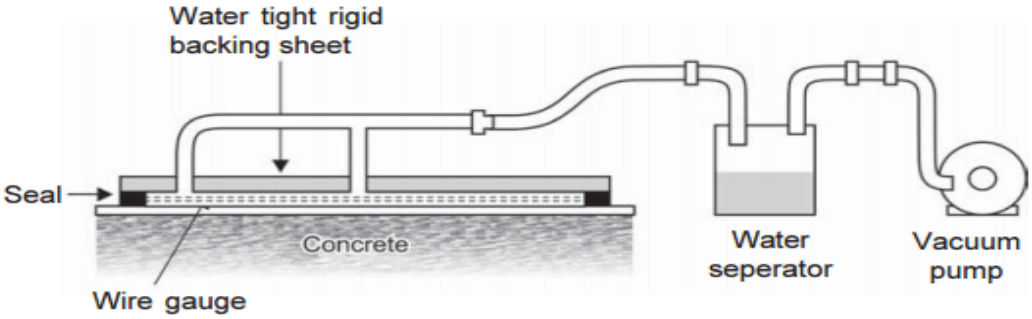

Fig.3:- Vacuum Concrete

6. Discussion about Testing

6.1 **Workability Test**

Workability tests were performed using Slump moulds as it is the quick measure of workability of concrete mixes. The slump test was done in accordance with the IS 1199-1959.

6.2 **Initial Setting Time of Cement**

Initial setting time is that time period between the time water is added to cement and time at which 1mm square section needle fails to penetrate the cement paste, placed in the Vicat's mould 5mm to 7mm from the bottom of the mould.

6.3 **Final Setting Time of Cement**

Final setting time is that time period between the time water is added to cement and time at which 1mm needle makes an impression on the cement paste in the mould but 5 mm attachment does not make any impression.)

6.4 **Compressive Strength Test**

Compressive strength test was performed according to IS 516: 1959.Cubes of specimen of size 150 mm x 150 mm x 150 mm were prepared for each mix. After 24 hours the specimens were de molded and cured in water for 7days, 14 days and 28 days until testing. The values of compressive strength are 65%, 90%, 99% respectively. For specimens with uneven surfaces, capping was use minimize the effect of stress concentration. The compressive strength reported is the average of three results obtained from three identical cubes.

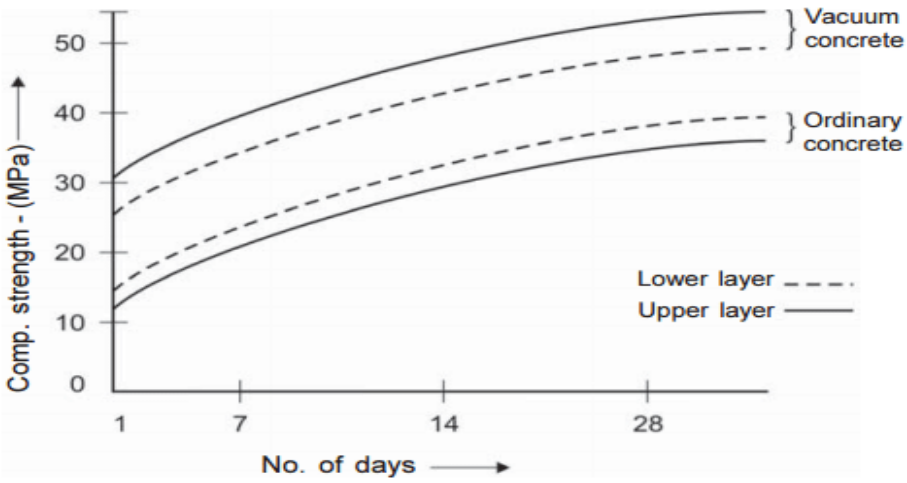

Fig4:- Graph of compressive strength

6.5 **Flexural Strength Test**

The bed of the testing machine shall be provided with two steel rollers, 38 mm in diameter, on which the specimen is to be supported, and these rollers shall be so mounted that the distance from centre to centre is 60 cm for 15.0 cm specimens or 40 cm for 10.0 cm specimens. The load shall be applied through two similar rollers mounted at the third points of the supporting span that is, spaced at 20 or 13.3 cm centre to centre.

6.6 **Tensile Strength Test**

The splitting tests are well known indirect tests used for determining the tensile strength of concrete. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens. The test were performed according to the procedure adopted in IS 5816: 1999. Cylinders of specimen size 150 mm x 300 mm were prepared for each mixes.

7. Advantages

7.1 Due to dewatering through vacuum, both workability and high strength are achieved.

7.2 Level floor, flatness accuracy.

7.3 Void free & denser concrete.

7.4 It gains early setting time.

7.5 Impact resistance increased by 10%.

7.6 Concrete become corrosion resistance.

7.7 It enhances the wear resistance of concrete surface.

7.8 Abrasion resistance increased in concrete.

8. Disadvantages

8.1 Need specific equipment.

8.2 High power consumption.

8.3 Need trained labor.

8.4 High initial cost.

9. Application

9.1Industrial floor sheds like cold Storage, etc.

9.2 Workshops.

9.3 Railway goods, Platforms.

9.4 Go downs, Warehouse etc.

9.5 Canals.

9.6 Hydropower plant.

9.7 Airport runway / Hangers

9.8 Bridge port and Harbor.

10. CONCLUSION

From these studies it is concluded that, Vacuum dewatering concrete is very important in modern construction in the context of economy, facility, modern technology and comfort. It is very useful special purpose project like for Warehouse, Parking area, industrial flooring, Pavement and Bridge. In which increase in compressive strength, corrosion resistance, tensile strength, flexural strength, workability, durability and decrease in permeability, shrinkage, minimize the cracks and concrete become denser than conventional concrete. And now a day vacuum dewatering process is very easily used in the construction industry by using any modern techniques and machineries. Good quality of floor and pavement can be obtained. 200 to 250sqm concrete flooring can be done in 8-10 hours. And 15 to 25% water extracted out with the increases the compressive strength about 20-25%.

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