A Case Study on a Watertight Concrete for Constructions

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Chapter 1 Introduction

Abstract. Its permeability aspect by checking it on the instrument known as water permeability cell. The water tight concrete we prepared can be used to construct different structure like water tank, dam, buildings, water retaining wall and other structures. This concrete has much benefit than conventional concrete in relation of its corrosion resistance, water tightness, and durability. Watertight concrete structures Have Lot of Benefits over structures with Outside waterproofing membrane. The Case study of watertight concrete structures is regulated by guidelines. Although these principlesand procedures are widely used, it can be problematic to make them failure-free. The causes of this situation are manifold, but primarily related to the lack of designer's knowledge and contractor's technological indiscipline. Considering the importance of leaking separation cracks in terms of serviceability and durability of watertight structures, the contribution analyses constructional, technological and execution measures to reduce the occurrence of failures. Perhaps the paper can contribute to a better understanding of the behavior and reasons of failures of this advanced technology. To make the structures water tight with the help of integral water proofing system like use of admixture in proportion to cement. Also to improve durability of concrete, crack resistance of concrete and overall strength of concrete.
The concept that concrete is 100% solid is wrong, because it contends fine cracks. These cracks are responsible for the permeability of concrete hence the project has very wide scope and its application is possible to any construction work.

Keywords: watertight concrete, underground structures, Waterproofing or Damp proofing W/C ratio and Permeability Coefficient, waterproofing admixture, Tensile Strength and Compressive Strength.

Introduction

In this project we are preparing water tight concrete and study in detailed manner its permeability aspect by checking it on the instrument known as water permeability cell. The water tight concrete we prepared can be used to construct different structure like water tank, dam, buildings, water retaining wall and other structures. This concrete has much benefit than conventional concrete in relation of its corrosion resistance, water tightness, durability etc.

Generally we goes on checking the strength of concrete but we never think about its Water Tightness , so in our project we are designing concrete with various doses of admixtures and studying different characteristics along with water tightness.

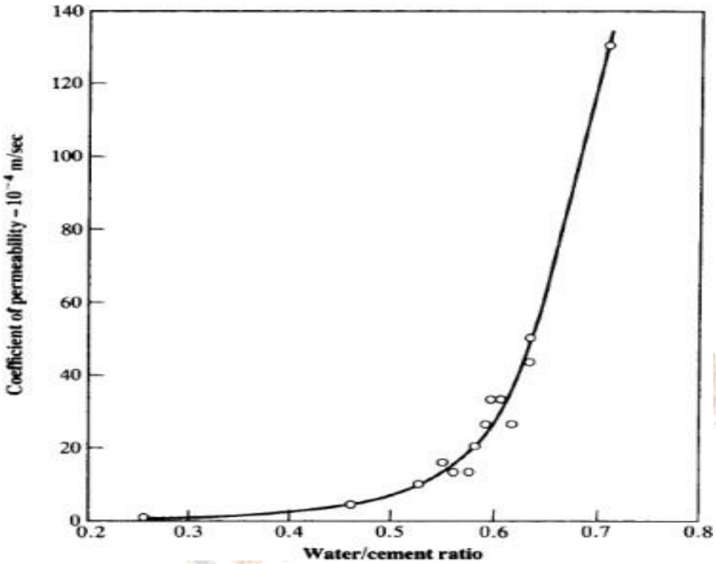
Concrete is comprised of aggregate of different sizes, cement and water, with cement substitute and chemicals such as water-reducing admixtures (plasticizers) often added. The proportions of these ingredients can vary widely, affecting the concrete's performance characteristics.

Concrete is inherently water-resistant, so it is an ideal construction material for structures such as basements and bridges. However, variations in the mix of ingredients can affect the degree of water resistance and porosity of the concrete. Concrete with a low water/cement ratio has an extensive network of "capillary pores" – essentially small, connected gaps between the cement crystals that are full of water. With a higher water/cement ratio, the concrete will become more porous. With a considerable excess of water, a vacuum can be created within the concrete as it dries out, which can lead to shrinkage and cracking.

1.1 Waterproofing or Damp proofing

Many a times, we come across the dilemma whether damp proofing to be adopted or waterproofing materials to be used or both to be implemented or both these are one and the same. As per ASTM D 1079, Waterproofing is defined as "Treatment of surface or structure to prevent the passage of water under hydrostatic pressure." Whereas, damp proofing is defined as "Treatment of surface or structure to resist the passage of water in the absence of the hydrostatic pressure.

1.2 Water Cement Ratio



Relation between permeability and water/cement ratio for mature cement pastes (93% of cement hydrated)

(From T. C. POWERS L. E. COPELAND J. C. HAYES AND H. M. MANN Permeability of Portland cement paste, J. Amir concer. inst 51, PP. 285 – 98 (Nov, 1954).

Fig No 1.2 – Relation between W/C ratio and Permeability Coefficient.

Water/cement ratio is directly related to the mechanical and physical properties of concrete and thus the durability. The lower the water/cement ratio, the higher the concrete density, hence the higher concrete strength and durability. As mentioned above, hydration products formed during curing of concrete blocks the concrete pores. Concrete with high w/c ratio would have insufficient hydration products to block the capillary pores, and is therefore porous and permeable. With the use of admixtures, very low water content can be achieved and the porosity of concrete can be reduced

The Water/Cement Ratio Influences Concrete permeability to a great extent. The higher the water concrete ratio the greater the concrete permeability. Increase in water concrete ratio from 0.45 to 0.65, increases the permeability by nearly 4 orders to magnitude. Example from 10^{-12} cm/s to 10^{-8} cm/s

1.3 Effects by Application of Admixtures in Water retaining Structures

i. Water reducing- To reduce water content. W/c ratio can be lower. Or higher cement content can be used high strength dense concrete can be achieved.
ii. Plasticizing - To make flowable concrete. Workability can be increased. Or to maintain the workability but to reduce cement content so that the thermal and shrinkage effects can be controlled.
iii. Pour filling - Finely divided materials to fill the voids in concrete to produce denser concrete and to replace part of the cement as they are mostly cementitious materials with pozzolanic effect. The thermal effect can be reduced hence a reduction of shrinkage cracking.
iv. Waterproofing - A combination of mainly water reducing, pore reducing and other ingredients to give greater plasticity and workability to fresh 1

1.4Waterproofing admixtures.

There are two ways for water to penetrate through the concrete. When concrete is under hydrostatic pressure on one surface, water passes through the channels formed by interconnecting cracks and voids to the other surface. The other way for the passage of moisture through the concrete from the wet side to the dry side is by capillary action.

It should be noted that currently there are no nationally recognized standards covering the performance anduse of these admixtures.

1.5 Integral Waterproofing Admixtures

An integral waterproofing admixture is a combination of admixture that has the ability of producing concrete with reduced permeability.

Generally waterproofing admixture is classified as follows:

Finely divided solids such as fuller earth, talc, etc. betonies and other siliceous powder which are inert pore filling materials.

Chemically reactive finely divided solids such as mineral admixture mentioned in above section.

Conventionally chemical admixture such as water reducer, accelerator, air entraining agents and super plasticizer.
The combination of above admixture results in lower water content, workable and dense concrete with reduced permeability.

Chapter 2 Literature Review

Many research workers had worked on the different aspects of water tightness of concrete their study is as follows

Geetha .P .Perumal [1]
In the accelerated corrosion test addition of waterproofing admixtures reduces the loss of weight in the corroded bar and thus reduces the corrosion due to the hydrophobic action of waterproofing admixtures. It also reduces the permeability of water and corrosion as they blocked the pores or capillaries present in the concrete mass .They also concluded that addition of admixtures increases the flexural strength with respect to the dosage. The effects of admixtures are more in case of 7 days specimen than 28 days specimen .Addition of admixture reduces the deflection in the middle and $1/3^{rd}$ portion of the prism specimen in the flexure test and thus increase the strength.

Mukesh Kumar et.al.[2]
KIM (Krystal Internal Membrane) has some retarding influence on the hydration of cement and does not change the overall process of hydration .The hydration products which may be of nano size block the pores of the cement paste and mortar as a result water percolation is reduced in the presence of KIM. Since the pores are blocked, the compressive strength and durability are increased.
So, apart from this compressive strength and flexure strength explained as above our target is to compare the exact effect on permeability nature of concrete. Therefore we perform the permeability test on concrete.

Elena Danke[3]
Director of marketing at Aquafina, says, "Application is as easy as pouring the solution into the concrete mix, allowing it to mix for three to five minutes, and then placing the concrete. This is a very cost effective and simple solution for waterproofing new concrete structures."
She adds, "In addition to the integral waterproofing, it is very important to treat the penetrations and construction joints, which is why Aquafina also carries a line of water stops to ensure all facets of the waterproofing are properly addressed."

Kevin Yuers[4]
"Their biggest advantages are the self-sealing ability, absence of seams, low overall cost and the fact that they are not compromised by poor site conditions, poor membrane workmanship or worksite damage." Yuers is vice president of operations at Kryton International, a Canada-based manufacturer of integral crystalline waterproofing, "By using the whole concrete mass as the waterproof membrane, integral waterproofing products have several major advantages over surface applied products," says Yuers. "First and foremost is their invulnerability to damage. The 'internal membrane' cannot be scraped, punctured or torn. It lasts as long as the concrete."
Robert G. Revera [5]
Founded in the 1970's in New York, USA, Penetron International Ltd. has been focusing on concrete protection and waterproofing systems building its reputation on its core crystalline technology. Today the company is the leading manufacturer of innovative crystalline waterproofing products with an established presence in over 65 countries worldwide. Penetron International has remained at the forefront of product innovation by listening to customer feedback, monitoring industry trends and staying abreast of market changes and demands and, in doing so, have introduced developments such as the easy-touse, portion controlled Penetron Admix clear soluble bag and Penetron Admix Tracer. These products were developed to meet specific concerns – such as quality control, product authenticity, time savings and ease of use – both of concrete producers and designers alike. Penetron products are produced in accordance to strict QA/QC procedures in our state-of-the-art, ISO- 9001-2008.

Xypex’s Faure[6]
“Adding crystalline waterproofing treatment to the concrete mix at the batch plant ensures that the crystalline formation occurs uniformly throughout the structure, rather than penetrating from the surface, as would be the case with a surface application. The admixture reduces the rate of water loss in fresh concrete, resulting in less shrinkage and increased compressive strength. He adds that, unlike many coatings and membranes, crystalline products are so safe they have been approved for use inside tanks that hold drinking water. Crystalline admixtures are also self-healing, reacting throughout the life of the concrete structure to automatically seal cracks up to half a millimeter wide. This is especially useful on large concrete pours, as it is enough to waterproof most cold joints with no additional treatment needed. Crystalline waterproofing is also extremely durable, and in laboratory tests have withstood up to 200 psi. That’s 460 feet of hydrostatic pressure. “Crystalline waterproofing is preferable to use in any project where the concrete will be subjected to hydrostatic pressure,”

Dr. Paul Glover [7]
The initial (pre-digenesis) porosity is affected by three major micro structural parameters. These are grain size, grain packing, particle shape, and the distribution of grain sizes. However, the initial porosity is rarely that found in real rocks, as these have subsequently been affected by secondary controls on porosity such as compaction and geochemical digenetic processes. This section briefly reviews these control.
It was noted above that the ordered cubic packing of identical sphere leads to a porosity that is grain size independent. This is also true for the other ordered packing lattices, but not true for the random arrangement of spheres. In real depositional environments, ordered packing’s are not formed because they are energetically unstable, and the grains become randomly distributed. The equilibrium porosity of a porous material composed of a random packing of spherical grains is dependent upon the stability given to the rock by frictional and cohesive forces operating between individual grains. These forces are proportional to the exposed surface area of the grains. The specific surface area (exposed grain surface area per unit solid volume) is inversely proportional to grain size. This indicates that, when all other factors are equal, a given weight of coarse grains will be stabilized.

Mohammed H. Mohammed [8]
Concrete performance is strongly affected by the particle packing degree since it determines the distribution of the cementitious component and the interaction of mineral particles. By using packing theory designers will be able to select optimal
Aggregate materials for preparing concrete with low cement content, which is beneficial from the point of cost. Optimum particle packing implies minimizing porosity and thereby reducing the amount of cement paste needed to fill the voids between the aggregate particles, taking also the rheology of the concrete into consideration. For reaching good fluidity super plasticizers are required. The results from pilot tests at Lulea University of Technology (LTU) show various forms of the
Proposed theoretical models, and the empirical approach taken in the study seems to provide a safer basis for developing new, improved packing models.
Concrete behavior is affected by the packing degree of the concrete components, making it necessary for engineers working to consider, in detail, particle packing concepts and their influence on concrete behavior for being able to select suitable fine aggregate material. The aim of optimizing concrete mixing is to prepare concrete with the being as densely packed as possible. The amount of binder for filling the aggregate voids can be minimized still keeping the freshly mixed concrete (workability) sufficiently fluid.
A minimum amount of binder is beneficial not only from economical points of view but also to reduce shrinkage and creep and thereby obtain a product that is more durable and strong than one with more binder.

The w/c ratio is a strength controlling parameter that is affected by the packing concept. Particle packing models give a basis for mix designs not only for traditional concrete but also for selecting mix proportions for special concrete like high performance, self-compacting and high strength concrete.

Reymond W.M.Chand [9]
Concrete is a composite material, which consists of cement and aggregates. The aggregates are dense materials that do not usually have permeability problem. It is the permeability of the cement paste that determines the water-tightness of the concrete. The gel pores are very small. It does not affect too much the concrete density. The capillary pores inside the cement paste together with micro-cracks and macro-cracks form capillaries and passages for water. The capillary pores formed during the early age of concrete can be

blocked by further hydration during the curing period if there is sufficient hydration product produced. The application of admixtures could reduce the amount of pores and make better dispersion of cement particles so that more dense concrete can be made.

Asthana (2003) [10]
He analyzed about the problems and solutions for waterproofing in building. This paper says that one of the chronic problem in the construction industry is obtaining a defect free work, avoiding ingress of moisture in the buildings. If such seepage is allowed to continue, then unhygienic conditions will prevail and also the building may deteriorate to the extent that ultimately it becomes uninhabitable. In many cases the durability of the structure itself is seriously affected .Ingress of water or dampness or atmospheric pollution in the RCC structures results in corrosion of steel and spilling of concrete. It should be the deep of concern of every construction engineer to ensure that buildings are free from unwanted moisture or water. From that study it was observed that integral waterproofing admixtures fill up the pores in concrete preventing the passage of water into it thus increasing the strength and durability of concrete.

Chapter 3 Flow Chart

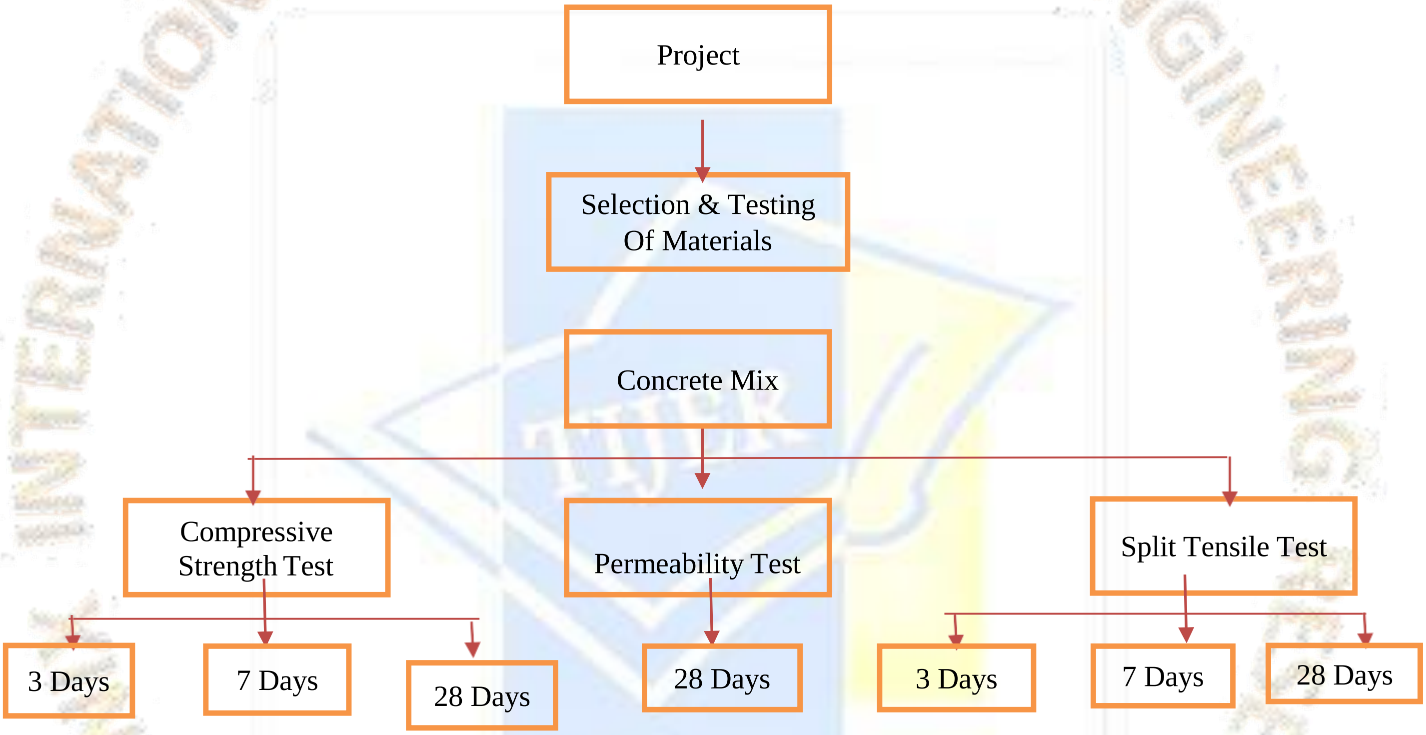


Figure No 3.1 General Flow Chart

The present project work requires preliminary investigations in a methodological manner.
3.1. Material and grade of mix
Selection of type of grade of mix, mix design by an appropriate method, trial mixes, final mix proportions.
Estimating total quantity of concrete required for the whole project work.
Estimating quantity of cement, fine aggregate, coarse aggregate required for the project work.
Testing of properties of cement, fine aggregate, coarse aggregate.
3.2. Production of concrete mixes
Production of mix (normal concrete of grade M-30) in the laboratory is carried out by IS method of concrete mix design (IS 10262-2007).

3.3. Test on ingredients materials
The ingredients of concrete i.e. cement, fine aggregate, coarse aggregate are tested before producing concrete. The respective Indian standard codes are followed for conducting various tests on ingredients materials and the concrete.

3.3.1. Test on cement

3.3.1.1. Consistency of cement

To determine standard consistency of cement using Vicat apparatus, measuring cylinder, needle, etc.

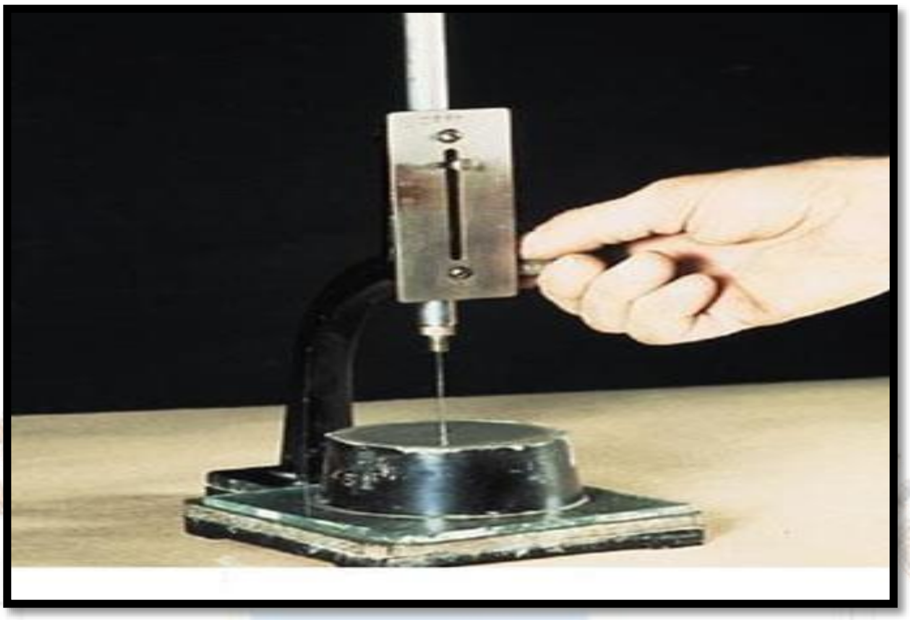


Figure No 3.2 Consistency of cement

Observation Table:

Table No. 3.1- Table for Consistency of Cement

Sr. No.	Type of Cement	Weight of cement (gm.)	Weight of Water Added (gm.)	Penetration Measured (mm)	Percentage of water %
1.	Sample 1	400	100	35	25
2.	Sample 2	400	120	9	30
3.	Sample 3	400	132	5	33

Result:

Percentage of water required to produce a paste of standard consistency is 33%, as found out to be satisfactory according to IS 12269-1987.

Initial and final setting of cement

To determine the initial and final setting time of cement by using Vicat apparatus, stop watch, measuring cylinder, needle, etc.

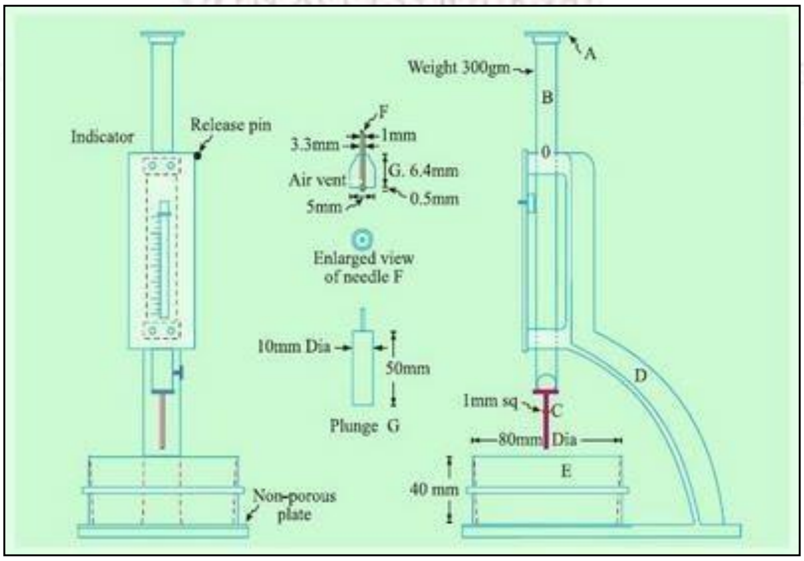


Figure no 3.3 Apparatus for Initial and Final Setting Time of CementObservation Table:

Table No. 3.2 - Table for Initial and Final Setting Time of Cement

Sr. No.	Type of Cement	Initial Setting Time	Final Setting Time
1.	Sample 1	43 Minutes	556 Minutes
2.	Sample 2	51 Minutes	560 Minutes
3.	Sample 3	55 minutes	573 Minutes

Result:
Initial Setting Time is 50 minutes and Final Setting Time is 563 minutes. So as sample found out to be satisfactory according to IS 12269-1987.

3.3.1.3. Soundness of cement
To determine soundness of cement by Le-Chatterers apparatus by using Le-Chatterers apparatus, weighing balance, measuring cylinder, glass plate, etc.

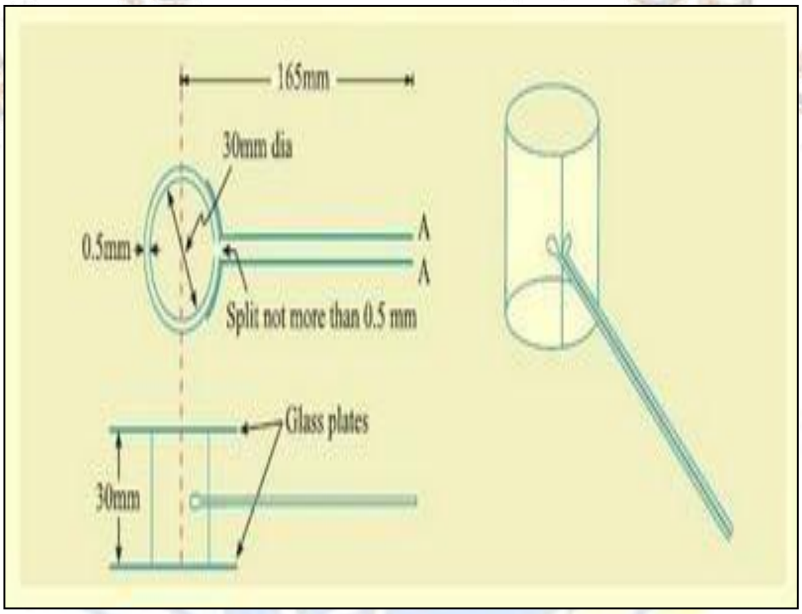


Figure no 3.4 Apparatus for soundness test of cement.

Observation Table:

Table No. 3.3 - Table for Soundness of Cement

Sr. No.	Type of Cement	D1 (mm)	D2 (mm)	D2-D1 (mm)
1.	Sample 1	6.5	7.0	0.5
2.	Sample 2	6.5	7.5	1.0
3.	Sample 3	7.2	8.2	1.0

Result:
Soundness of cement is (D2-D1) = 1.0 as found out to be sample is satisfactory according to IS 269-1967 and IS 4031-1968.

3.3.2. Test on Fine Aggregate
Natural sand from Provera River Basin Confirming to IS 383-1970 is used. Various test such as specific gravity, sieve analysis have been conducted to know their quality and grading. The above said test results are shown below.

3.3.2.1. Particle size distribution by Sieve analysis
To determine Fineness modulus of Fine Aggregate by using Set of Sieve, mechanical sieve shaker, etc.

Observation Table:

Table No. 3.4 - Table for Fineness Modulus of Fine Aggregate

Sr. No.	Sieve Size	Weight Retained (gm.)	Cumulative weight retained (gm.)	% cumulative weight	% passing
1.	4.75mm	124	124	24.8	75.4
2.	2.36mm	58	182	36.4	63.6
3.	1.18mm	139	321	64.2	35.8
4.	600mic.	77	398	79.6	20.4
5.	300 mic.	75	473	94.6	5.4
6.	150 mic.	19	492	98.4	1.6
7.	Pan	8	500	100	0
8.	Total	500			

Result:
Fineness modulus of Fine Aggregate is = Total % cumulative weight/100
= 498/100
= 4.98

The sample of Fine Aggregate tested so, as found out to be satisfactory according to IS 269-1967 and conforming to zone 1.

3.3.2.2. Specific Gravity of Fine Aggregate
To determine Specific Gravity of Fine Aggregate by using Pycnometer, weighing balance, etc.
Observation Table:

Table No.3.5- Table for Specific Gravity of Fine Aggregate

Sr. No.	Particulars	Sample 1 (gm.)	Sample 2 (gm.)
1.	Mass of Pycnometer(M_1)	670	670
2.	Mass of Pycnometer + Soil (M_2)	1083	1083
3.	Mass of Pycnometer + Soil + Water(M3)	1740	1740
4.	Mass of Pycnometer + Water(M_4)	1481.1	1481.1
5.	Specific Gravity= $\frac{(M_2 - M_1)}{(M_2 - M_1) - (M_3 - M_4)}$	2.68	2.68

Result:
Specific Gravity of Fine Aggregate is = 2.68.
The sample of Fine Aggregate tested so, as found out to be satisfactory according to IS 269-1967.

3.3.2.3. Water Content in Fine Aggregate
To determine water content in Fine Aggregate by using Weighing balance, Oven, etc.

Observation Table:

Table No.3.6 - Table for Water Content in Fine Aggregate

Sr. No.	W1 (gm.)	W2 (gm.)	% of Moisture Content	Average Moisture Content
1.	1000	982	1.8	1.8
2.	1000	982	1.8	
3.	1000	982	1.8	

Result:
% of Moisture Content is = W2-W1/W1x100
= 1.8%

The sample of Fine Aggregate tested so, as found out to be satisfactory according to IS 269-1967.

3.3.3. Test on Coarse Aggregate

Crushed black trap basalt rock of aggregate of size 20mm and 10mm is used confirming to IS 383-1970.Various test such as such as sieve analysis aggregate impact value etc.; have been conducted on coarse aggregate to know their quality and grading.

3.3.3.1. Fineness modulus of Coarse Aggregate

To determine fineness modulus of Coarse Aggregate by using Set of Sieve, mechanical sieve shaker, etc.

Observation Table:

Table No. 3.7 - Table for Fineness Modulus of Corse Aggregate

Sr. No.	Sieve Size	Weight Retained (gm.)	Cumulative weight retained (gm.)	% cumulative weight	% passing
1.	40 mm	-	-	-	100
2.	20 mm	2324	2324	46.48	53.52
3.	10 mm	2660	4984	99.68	.32
4.	4.75 mm	16	5000	100.00	00
5.	2.36 mm	-	-	-	-
6.	1.18 mm	-	-	-	-
7.	600 mic.	-	-	-	-
8.	300 mic.	-	-	-	-
9.	150 mic.	-	-	-	-
10.	Total	-	-	-	746

Result:
Fineness modulus of Coarse Aggregate is = Total % cumulative weight/100
= 746/100
= 7.46

The sample of Fine Aggregate tested so, as found out to be satisfactory according to IS 269-1967.

3.3.3.2. Water Content in Course Aggregate

To determine water content in Course Aggregate by using Weighing balance, Oven, etc.

Observation Table:

Table No. 3.8 - Table for Water Content in Fine Aggregate

Sr. No.	W1 (gm.)	W2 (gm.)	% of Moisture Content	Average Moisture Content
1.	1000	999	0.1	0.1
2.	1000	999	0.1	
3.	1000	999	0. 1	

Result:
% of Moisture Content is = W2-W1/W1x100
= 0.1%
The sample of Fine Aggregate tested so, as found out to be satisfactory according to IS 269-1967.

3.3.3.3. Impact Value of Coarse Aggregate
To determine Impact value of Coarse Aggregate by using Impact testing value, weighing balance, Sieve (2.36 mm) etc.

Observation Table:

Table No. 3.9 Table for Impact Value of Course Aggregate

Sr. No.	Particulars	Sample 1 (gm.)	Sample 2 (gm.)
1.	Total weight of dry sample (W_1)	350	350
2.	Weight Passing 2.36 mm Sieve (W_2)	92.82	92.55
3.	Aggregate impact value (W_2 / W_1 x 100)	26.52	26.44
4.	Average Impact Value	26.48	

Result:
Impact value of Coarse Aggregate is = 26.48
The sample of Fine Aggregate tested so, as found out to be satisfactory according to IS 269-1967.

3.4. Mix Design for M30 Grade of Conventional Concrete
Assumptions:
Compressive strength required for 28 days = 30 MPa
Maximum size of aggregate = 20 mm (angular)
Degree of quality control = Good
Type of exposure = Mild
Data
Specific Gravity of Cement = 3.15
Specific Gravity of Fine Aggregate = 2.68
Specific Gravity of Coarse Aggregate = 2.68
Water Absorption of Coarse Aggregate = Nil
Water Absorption of Fine Aggregate = 1.8%
Slum required = 50 – 100 mm
Free moisture in Sand = 2%

Calculations:
Target Mean Strength:
$f_{t.}$ = fck + K x S
= 30 + 5 x 1.65
= 38.25N/mm^2
Selection of Water Cement Ratio:
Free water cement ratio for target mean strength = 0.45
Selection of Water and Sand Content:
For 20mm nominal maximum size aggregate and sand confirming to grading zone II, water content per cubic meter of concrete = 186 kg and add 3% of total water for slump 75 mm.
Required water content = 186+ 186 x 3/100
= 192lit/m3
Determination of Cement Content:
Water cement ratio = 0.45
Water = 192 liters
Cement = 427Kg/m^3
This cement content is adequate for mild exposure condition.
From Table-3
Volume of C.A. = 0.6

Volume of F.A. = 0.4
As w/c ratio is 0.45 increase volume of C.A. by 0.01
Therefore
Volume of C.A. = 0.61
Volume of F.A. = 0.39
1. Volume of concrete=1m^3
2. Volume of cement= $(427/3.15)*10^{-3}$
=0.1356 m^3
3. Volume of Admixture = 1% of cement = 4.27 Kg/m^3
Volume = $(4.27/1.145)*10^{-3}$
=0.0038 m^3
4. Volume of water = 0.192 m^3
5. Volume of all in aggregate =
= [1-(0.1356+0.0038+0.192)]
= 0.6686 m^3
6. Mass of C.A. = 0.743*0.61*2.68*1000
= 1215 Kg
7. Mass of F.A. = 0.743*0.39*2.68*1000
=777 Kg

Table No. 3.10 - Table for Mix Proportion.

On basis of	Water	Cement	Fine Aggregate	Coarse Aggregate
Mass	192	427	777	1215
Ratio	0.45	1	1.82	2.89

3.5. Measurements of Ingredients:
All cement, sand, coarse aggregates and measured with digital balance. Water is measured measuring cylinder of capacity 1 liter and measuring jar of capacity 100 ml and 200 ml.

3.6. Mixing of Concrete:
The ingredients are thoroughly mixed in concrete mixer. The sand, cement, and aggregate are measured accurately and are mixed in dry state for normal concrete. Whereas for coconut shell concrete, first measured quantity of cement and other required ingredients as per mix design and then added in concrete mixer. Care is taken to avoid segregation of concrete.

3.7. Placing of Concrete:
The fresh concrete is placed in the mounds by trowel. It is ensured that the representative volume is filled evenly in all the specimens to avoid accumulation of aggregates, segregation, etc. while placing concrete in moulds compaction is done to remove entrapped air or voids in concrete.

3.8. Finishing of Concrete:
The concrete is worked with trowel to give uniform surface. Care is taken not to add any extra cement, water or cement mortar for achieving good surface finish. The additional concrete is chopped off from the top surface of the mould for avoiding over sizes etc. Identification marks are given on the specimens by embossing over the surface after initial drying.

3.9. De-molding of Specimens:
The plain cement concrete specimens are de-molded after 24 hours of casting and kept in water tank for curing. Similarly coconut shells concrete specimens are demoulded after 24 hours of casting and kept in water tank for curing at 28 days.

3.10. Curing of Specimens:
The specimens are de-molded after 24 hours of casting and immediately kept for curing.

3.11. Details of Specimens:
Details of specimens are given below:
Cube: For compressive test: 150mm x 150mm x 150mm
Cylinders: For tensile test: 150mm (diameter) x 300mm (Height)

Table No. 3.11 - Schedule of Specimen Preparation

Sr no	Concrete	Admix. Content	W/C ratio	Compression Test	Tensile test	Permeability Test
				28 Days	28 Days	28 Days
1.	General	0%	0.45	3	3	3
2.	Test Sample	0.5%	0.45	3	3	3
3.	Test Sample	1.0%	0.45	3	3	3
4.	Test Sample	1.5%	0.45	3	3	3
Total number of specimen = 36 nos.						

3.12. Testing
Compressive test and split tensile test are carried out on compression testing machine (CTM) of capacity 2000 KN. Cube and Cylinders are tested for 7 days and 28 days.

CHAPTER 4. EXPERIMENTAL ANALYSIS

4.1 EXPERIMENTAL WORK

4.1.1 Test Conducted On Hardened Concrete: Confirming to IS 516-1959
In present study cube compression test, flexural test on beams, split tensile test on cylinders on conventional concrete and coconut shell concrete are carried out. The experimental results and results discussion for various tests are described below.

4.1.2 Compressive Strength Test:
Compression test is performed on standard cubes (150mm*150mm*150mm) of conventional concrete and concrete made from different doses of admixture. The results for the test are shown in Table no. 4.1 to Table no. 4.4. The Compressive strength of the specimen is calculated by the following formula:

$f_{cu} = P/A$

Where,
P= Failure load in compression (KN)
A= Loaded area of cube (mm^2)

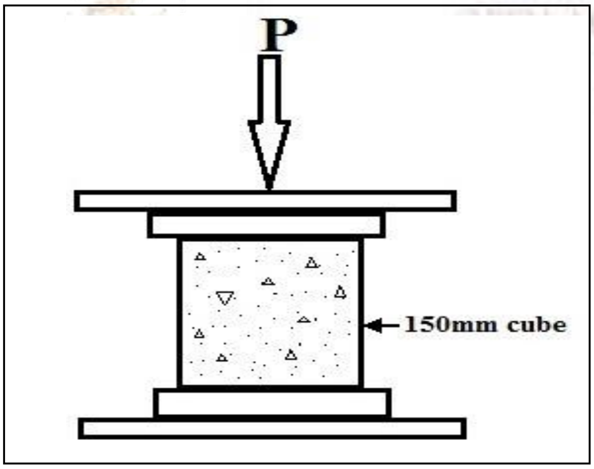


Figure No.4.1 Compressive test setup

Figure No 4.2 Compressive Strength of Conventional Concrete

Table No. 4.1 - Table for compressive strength of conventional concrete

Days	Sample	Load (KN)	Loaded Area (mm^2)	Strength in (N/mm^2)	Average Strength in (N/mm^2)
3	A3	199	22500	8.84	9.3
	A3	196	22500	8.71	
	A3	233	22500	10.35	
7	A7	421	22500	18.71	19.39
	A7	445	22500	19.78	
	A7	443	22500	19.68	
28	A28	683	22500	30.35	30.53
	A28	678	22500	30.13	
	A28	700	22500	31.13	

Table No.4.2 -Table for compressive strength of sample concrete 0.5% Admixture

Days	Sample	Load (KN)	Loaded Area (mm^2)	Strength in (N/mm^2)	Average Strength in (N/mm^2)
3	B3	209	22500	9.28	9.49
	B3	212	22500	9.42	
	B3	220	22500	9.78	
7	B7	443	22500	19.69	19.68
	B7	450	22500	20.00	
	B7	439	22500	19.52	
28	B28	700	22500	31.11	31.55
	B28	750	22500	33.33	
	B28	680	22500	30.22	

Table No.4.3 - . Table for compressive strength of sample concrete 1% Admixture

Days	Sample	Load (KN)	Loaded Area (mm^2)	Strength in (N/mm^2)	Average Strength in (N/mm^2)
3	C3	211	22500	9.39	9.63
	C3	223	22500	9.83	
	C3	219	22500	9.70	
7	C7	463	22500	20.58	20.21
	C7	459	22500	20.40	
	C7	445	22500	19.85	
28	C28	712	22500	31.64	30.88
	C28	680	22500	30.22	
	C28	693	22500	30.8	

Table .No.4.4. - Table for compressive strength of sample concrete 1.5% Admixture

Days	Sample	Load (KN)	Loaded Area (mm^2)	Strength in (N/mm^2)	Average Strength in (N/mm^2)
3	D3	219	22500	9.78	10.16
	D3	235	22500	10.44	
	D3	231	22500	10.26	
7	D7	480	22500	21.33	20.803
	D7	472	22500	20.97	
	D7	468	22500	20.80	
28	D28	737	22500	32.62	31.91
	D28	720	22500	32.00	
	D28	700	22500	31.11	

4.1.3 Split Tensile Test:

The split tensile test is well known indirect test used to determine the tensile strength of concrete. Due to difficulties involved in conducting the direct tension test, a number of indirect methods have been developed to determine tensile strength of concrete. In these tests, in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses induced in the specimen.

The tensile strength at which failure occurs is the tensile strength of concrete. In this Investigation the test is carried out on cylinder by splitting along its middle plane parallel to the edges by applying the compressive load to opposite edges.

The arrangement for the test is as shown in fig. 2. The split tensile strength of cylinder is calculated by the following formula.

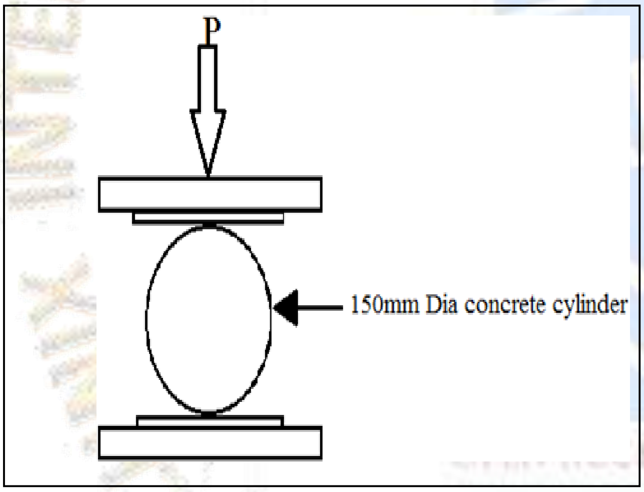


Figure no4.3. Cylinder Split tensile test setup

Figure no 4.4. Tensile Strength of Concrete

$F_t = 2P/\pi LD$

Where,

F_t = tensile Strength (N/mm^2)

P = Load at Failure (N)

L = Length of Cylinder (mm)

D = Diameter of cylinder (mm)

Table No.4.5 - Table for Tensile strength of conventional concrete

Days	Sample	Load (KN)	Loaded Area (mm^2)	Strength in (N/mm^2)	Average Strength in (N/mm^2)
3	A3	162	$1.41*10^5$	2.29	2.23
	A3	152	$1.41*10^5$	2.16	
	A3	159	$1.41*10^5$	2.25	
7	A7	215	$1.41*10^5$	3.04	3.09
	A7	219	$1.41*10^5$	3.10	
	A7	222	$1.41*10^5$	3.14	
28	A28	275	$1.41*10^5$	3.88	3.85
	A28	278	$1.41*10^5$	3.92	
	A28	267	$1.41*10^5$	3.76	

Table No 4.6 - Tensile strength of sample concrete of 0.5% Admix.

Days	Sample	Load (KN)	Loaded Area (mm^2)	Strength in (N/mm^2)	Average Strength in (N/mm^2)
3	B3	158	$1.41*10^5$	2.21	2.35
	B3	169	$1.41*10^5$	2.39	
	B3	173	$1.41*10^5$	2.45	
7	B7	235	$1.41*10^5$	3.33	3.24
	B7	225	$1.41*10^5$	3.19	
	B7	227	$1.41*10^5$	3.21	
28	B28	278	$1.41*10^5$	3.92	3.95
	B28	281	$1.41*10^5$	3.96	
	B28	283	$1.41*10^5$	3.99	

Table No 4.7 - Tensile strength of sample concrete of 1% Admix.

Days	Sample	Load (KN)	Loaded Area (mm^2)	Strength in (N/mm^2)	Average Strength in (N/mm^2)
3	C3	188	$1.41*10^5$	2.66	2.59
	C3	178	$1.41*10^5$	2.52	
	C3	185	$1.41*10^5$	2.59	
7	C7	279	$1.41*10^5$	3.25	3.25
	C7	221	$1.41*10^5$	3.13	
	C7	238	$1.41*10^5$	3.38	
28	C28	284	$1.41*10^5$	4.01	4.08
	C28	290	$1.41*10^5$	4.08	
	C28	293	$1.41*10^5$	4.14	

Table No. 4.8 - Tensile strength of sample concrete of 1.5% Admix.

Days	Sample	Load (KN)	Loaded Area (mm^2)	Strength in (N/mm^2)	Average Strength in (N/mm^2)
3	D3	195	$1.41*10^5$	2.76	2.70
	D3	189	$1.41*10^5$	2.68	
	D3	187	$1.41*10^5$	2.65	
7	D7	239	$1.41*10^5$	3.39	3.39
	D7	240	$1.41*10^5$	3.41	
	D7	238	$1.41*10^5$	3.38	
28	D28	275	$1.41*10^5$	3.88	4.07
	D28	289	$1.41*10^5$	4.08	
	D28	301	$1.41*10^5$	4.25	

4.1.4 Permeability test

4.1.4.1 Permeability Unit

The permeability unit shall consist of a specimen standard cubes (150mm*150mm*150mm) held between a bottom plate and a water cell. The hydraulic head for testing shall be obtained by connecting the unit to a, compressor through a water pressure vessel. A pressure regulator and a pressure gauge shall be included between the compressor and water pressure vessel to indicate the test pressure. Water percolating through the specimen .shall be collected in a container Fig. I and Fig. 2 give the details of an individual unit. The connecting pipeline from the water cell to the water pressure vessel shall also be of non-corroding metal or of hard polythene. This requirement is necessary since the tests last over a number of days in which mild steel or allied materials will corrode and the rust formed will coat the top of the specimen and affect the permeability. The connection of units to the compressor shall be done by means of armored heavy duty rubber hose. The water Pressure vessel shall be made of galvanized steel and capable of withstanding the applied pressure with an adequate margin of safety.

Observation table

Measuring Cylinder = 100 mm Diameter

Area of Cylinder = $(\pi/4*0.1^2) = 7.85 * 10^{-3}\ m^2$

Time = 24 Hrs.

Table No. 4.9 - Table for Permeability of concrete.

Sr. No.	Sample of concrete	Water collected in 24 hr.	Discharge m^3/sec 10^{-10}	Avg.
1	Normal M30 concrete[P]	0.008	7.26	6.96
		0.008	7.26	
		0.007	6.35	
2	0.5% of Admix. Dose[Q]	0.005	4.54	4.84
		0.006	5.54	
		0.005	4.54	
3	1.0% of Admix. Dose[R]	0.003	2.73	2.58
		0.0025	2.27	
		0.003	2.73	
4	1.5% of Admix. Dose[S]	0.001	0.91	1.21
		0.001	0.91	
		0.002	1.18	

CHAPTER 5. RESULTS & DISCUSSIONS

Result with respect to observation table:
1. Workability = 75 – true slump (average)

2. Compaction factor = 0.9 (average)

3. Compressive strength (28 days)
   i. 0% dose of admixture = 30.53MPa
   ii. 0.5% dose of admixture = 31.53MPa
   iii. 1% dose of admixture = 30.88MPa
   iv. 1.5% dose of admixture = 31.91MPa

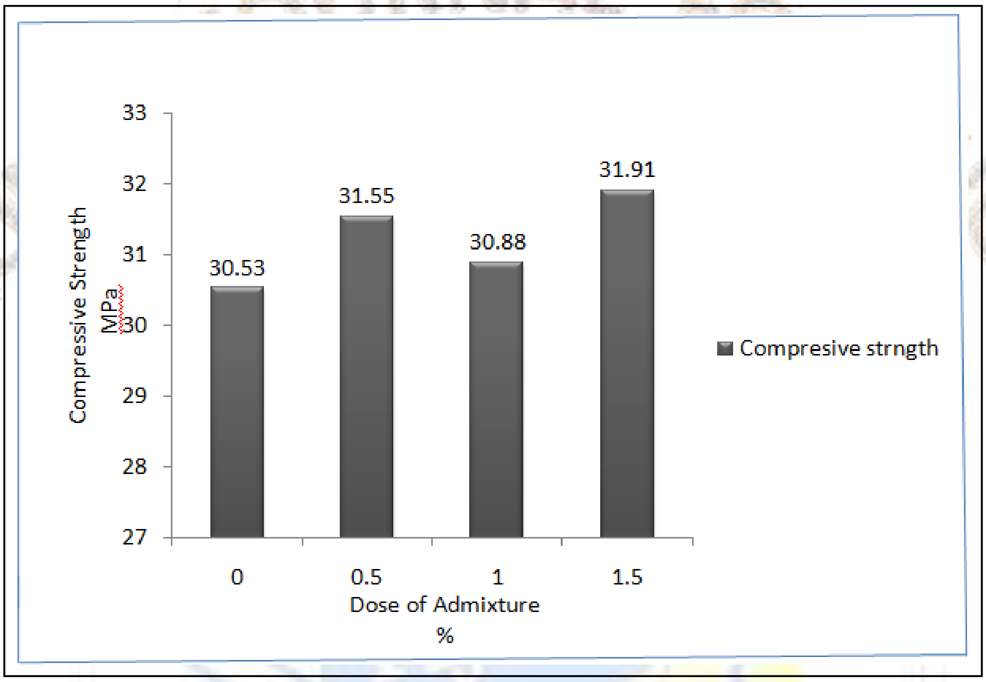


Figure No. 5.1. Comparison between Compressive Strength of Conventional Concrete and Concrete of different doses of admixtures at 28 days.

4. Split tensile test (28 days)
   i. 0% dose of admixture = 3.85 MPa
   ii. 0.5% dose of admixture = 3.95 MPa
   iii. 1% dose of admixture = 4.07MPa
   iv. 1.5% dose of admixture = 4.08MPa

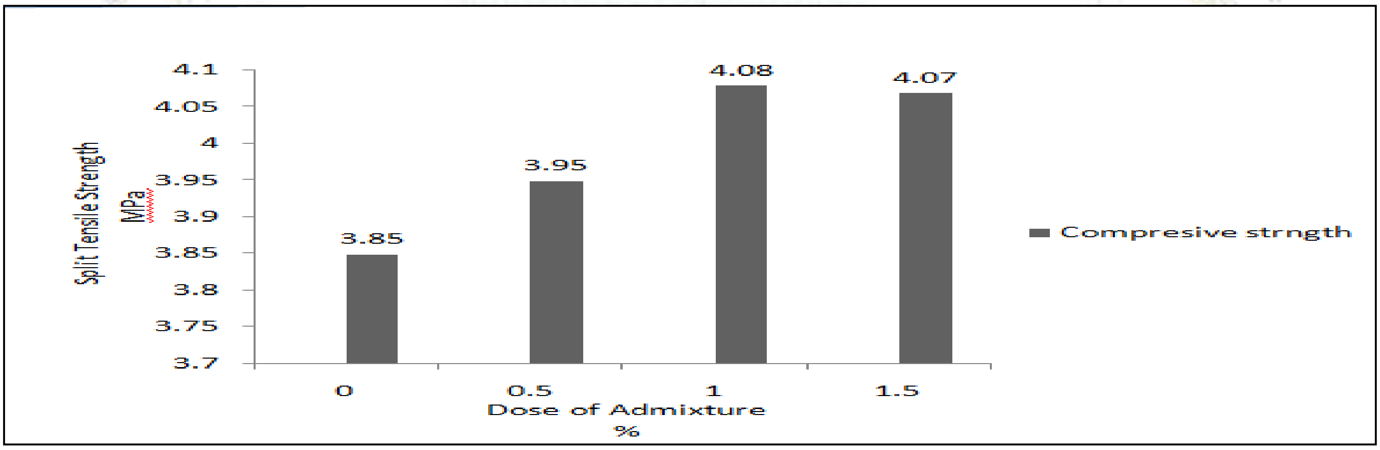


Figure No. 5.2. Comparison between Split Tensile Strength of Conventional Concrete and Concrete of different doses of admixtures 28 days.

5. Permeability test (28 days)

Discharge through concrete is measured in m^3/s for 24 hours

i. 0% dose of admixture = $6.9x10^{-10}$

ii. 0.5% dose of admixture = $4.84x10^{-10}$

iii. 1% dose of admixture = $2.58x10^{-10}$

iv. 1.5% dose of admixture = $1.21x10^{-10}$

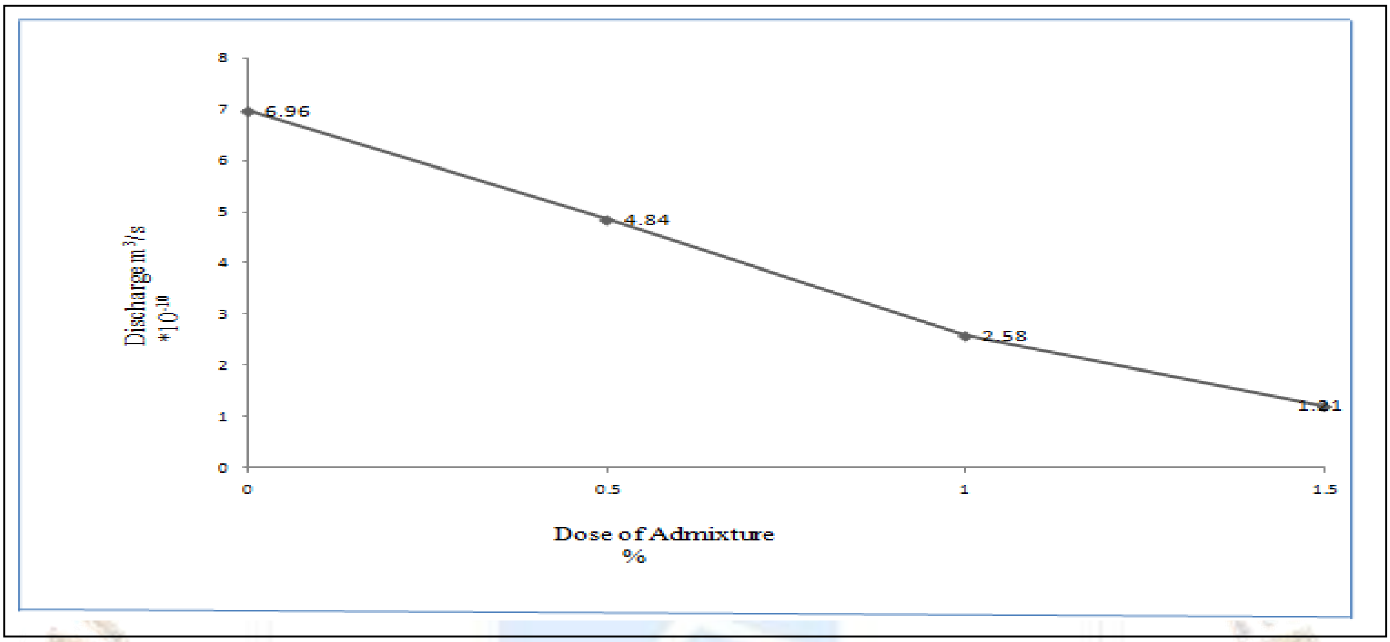


Figure No. 5.3. Graph of Discharge vs. different doses of admixtures.

Discussion

1. From the results shown above we can say that the workability of concrete is not affected by the dose of admixture. But as the dose increases it gives more workable concrete so there is no need of extra workability admixture.

2. From the study of compressive strength test we can say that the dose of admixture does not affect the compressive strength of concrete. But tit increases with increase in dose of admixture.

3. From split tensile strength test we can say that the dose of admixture does not affect the split tensile strength of concrete. But it increases with increase in dose of admixture.

4. From the study of permeability test, we say though the concrete is solid but it contents hair-cracks so through which water percolates which reduces durability of concrete. So we used different dose of watertight admixture, by the study of test we came to the conclusion, as the dose is increased, water flowing through the concrete i.e. discharge through the concrete reduces. Also it satisfy IS requirement (IS 2645:2003). Integral waterproofing compounds for cement mortar and concrete- specifications (second revision).

CHAPTER 6. CONCLUSIONS

6.1 Conclusions Drawn from the Study

This project work presents the effective way of use of admixture in concrete. Also the concrete obtained using admixture satisfies all the requirement of strength and permeability under BIS considerations. Based on the tests following conclusions were made:

1. The concrete is well workable so there is no need of extra admixture.
2. Also there is no bleeding of water and segregation of material.
3. Compressive strength is improved due to use of admixture and it does not cause any harm to concrete and increase the durability.
4. Tensile strength is improved due to use of admixture and it does not cause any harm to concrete and increase the durability.
5. Permeability is very well reduced by the use of admixture without causing any harm to the concrete.

So we can use this concrete in different projects like dams, water tanks, etc.

6.2 Future scope and study

1. In this project work we are bound to study the permeability of M30 grade concrete only. But we can vary the grade of concrete and with different dose of admixture the discharge through it is studied.
2. We can also study the same with different type of cement and with replacement of cement by fly ah. And compare the results to the 100% cement used. Also different test like compressive, split tensile, workability test can be performed and compare the results.
3. Also the study can be done with different type of admixtures and results are compared.
4. Generally, people neglect the permeability of concrete, but there are many disadvantages which we have studied in the project work. So where concrete is subjected to water, it is advisable to use admixture to improve the water tightness and to prevent loss of water.

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