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Factors Affecting Strength of Pervious Concrete with Mix Design

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ABSTRACT

Pervious concrete has some properties like it is permeable and it allows the flow of water from rain and other means easily through it. The problem with normal concrete is it block the movement of water that may reduce and lower down the ground water table and also water is collected over the surface that may create problems. At that point, the concrete adhesive covers the aggregates and permits water to pass through the concrete component. Pervious concrete is customarily utilized as a part of stopping zones, regions with light movement, private boulevards, person on foot walkways, and nurseries. Porosity of any entity may increase if their voids are interconnected. In road pavement the drainage system is main concern. If water is collected over pavement then it will effect on compressive strength when it is subjected to heavy load. In this research the concrete material like course aggregate, cement and fine aggregate having specific gravity 2.68, 3.15 and 2.65 respectively. The grade of cement is taken in this research is OPC-43. The seepage quality of pervious concrete is focused and impact of compressive strength with different percentage of fine aggregate is determined in this research. The main focus is to determine the improvement in compressive and flexural strength of PCC blends and the mechanical properties of pervious concrete is also tested at different water cement ratio. An optimum percentage will be find out which shows the concrete is permeable and having good compressive and flexural strength. It is difficult to make pervious concrete with high porosity and high strength.

INTRODUCTION :-

Pervious concrete has some properties like it is permeable and it allows the flow of water from rain and other means easily through it. The problem with normal concrete is it block the movement of water that may reduce and lower down the ground water table and also water is collected over the surface that may create problems. Pervious concrete has some advantages like the water can pass easily and soil below the road surface is in wet condition. The aesthetic condition of road surface is improved that may lead to pleasant traffic condition. The pervious concrete help to keep road material warm. A consistent and stable surface can only be achieved by adequately compacting the subgrade. When installing pervious concrete directly over sandy soil, it is advised to keep the subgrade between 92 and 96% of the thickest possible. With silty or clayey soils, the degree of compaction will tones of black-top arrangement, and it would be necessary to place a layer of open-assessed stone on top of the soil. With compressive values of 10 to 30 MPa, the voids can range from 18 to 35%.

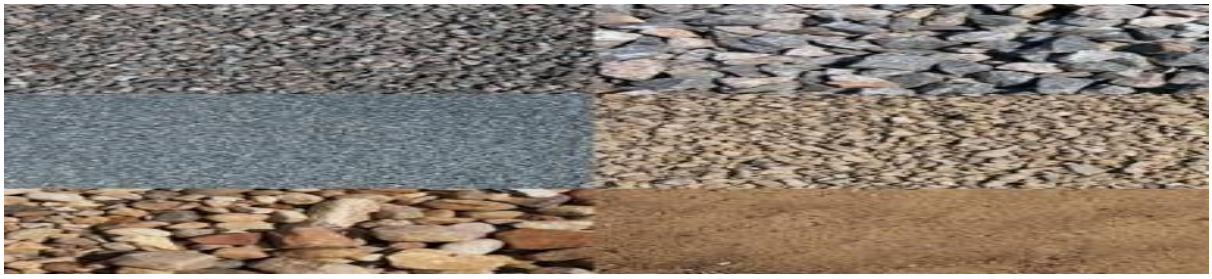
Material required

(A)Water

Water is very essential component concrete. Without water concrete behaves like powder when it is subjected to load. A great deal of water and solid will transform into a soupy mix taking after mollusk chowder instead of a viable assistant material. Water is essential for two reasons. One is to hydrate the security and the second is to make a workable substance. In order to form bonds with the aggregate that give solid its character, the bond's hydration is essential. However, the solid's quality is being hindered by the close proximity of water-filled gaps inside the solid. There are indications that porosity and the water-bond extent (W/C) have a direct impact on the solid quality. The hydration method demonstrates this. The volume of solids grows as hydration progresses. This volume is in the ahead-controlled space of the dry concrete. The growth in the volume of solids shows a reduction in porosity.

(B) Aggregate Type and Size

When considering the quality of cement, total quality is typically not taken into account. Solid instances in a weight test frequently become frustrated at the aggregate paste interface. This demonstrates the idiom "You are similarly as strong as your weakest association." This shows that the security quality is worse to both the paste quality and the aggregate quality. All indications point to the quality of the bond, not the individual components, as the factor coordinating the solid's quality.



(C) Ordinary Portland Cement

Cement acts as folder in concrete and plays major role towards potency of concrete and its permanence. Any type of cement can be used but due to accessibility. It is natural binding material and it work when water is added then so many chemical reaction occurs in cement and after it is a hard just like a solid rock . it is best and easy to use and transport for construction purpose .

PROBLEM STATEMENT: -

Flooding happens when an extraordinary volume of water is conveyed by waterways, streams and numerous other geological highlights into regions where the water can't be depleted satisfactorily. Regularly amid times of overwhelming precipitation, waste frameworks in local locations are not satisfactory, or unchecked common advancement extremely hinders the usefulness of a generally worthy seepage framework. Surges cause to a great degree substantial quantities of fatalities in each nation, however because of India's to a great degree high populace thickness and regularly under-implemented improvement measures, a lot of harms and numerous passing which could be generally maintained a strategic distance from, are permitted to happen. India witnesses surge because of extreme rain which at that point brings about flood of waterways, lakes and dams, which adds to make a lot of harm individuals' lives and property. Before, India has seen a significant number of the biggest, most cataclysmic surges, making unsalvageable harm individuals' job, property, and pivotal foundation.

Every monsoon in India it has been observed that all major cities are flooded due to heavy rain causing heavy loss to economy and property of people. Major cities like Chennai, Mumbai have always been in news for roads completely filled with water and failure of drainage systems. Due to such inconvenience and loss caused to people there arises a need to find an alternative to conventional roads and drainage systems which can help in controlling floods and make people’s life easier.

One of the solution to this problem is Pervious Concrete which can not only drain heavy monsoon rain water but also helps to recharge ground water level and prevents pollutants to meet into water sources due to water runoff.

Literature Review

1.Introductions

Porosity of any entity may increase if their voids are interconnected. In road pavement the drainage system is main concern. If water is collected over pavement then it will effect on compressive strength when it is subjected to heavy load. Pervious concrete has some properties like it is permeable and it allows the flow of water from rain and other means easily through it. The problem with normal concrete is it block the movement of water that may reduce and lower down the ground water table and also water is collected over the surface that may create problems

Malhotra V. M. et al. (1976) discussed pervious concrete as it relates to applications and properties. He gave purposes of enthusiasm on such properties as consistency, extents of materials, unit weight, comparability, and curing endeavoring to open up penetrability in the pervious cement. Malhotra also drove various investigations on various test chambers endeavoring to find a connection between's compressive quality and any of the material's properties. He gathered that the compressive quality nature of pervious cement was reliant on the water bond proportion and the total concrete ratio.

Suleiman, M. T., Kevern, J., Schaefer, V. R., & Wang, K. (2006) described in his paper “Effect of compaction energy on pervious concrete properties" Compaction influences PCPC properties by decreasing compressive quality, split quality, unit weight, and expanding penetrability. For instance, the normal 7day compressive quality at 22% voids proportion decrease from

2603 psi to 2315 psi, which speak to 11% diminishment. Split rigidity decreases from around 12.3% to around 9.5% of the compressive quality as the compaction vitality diminish from standard vitality to low vitality. Be that as it may, the normal penetrability of PCPC at a void proportion of 22% increments from 372 inch/hour to 614 inch/hour, which speak to 65% expansion. At the point when subjected to solidify defrost cycles, tests arranged at general compaction vitality bombed through the total while disappointment through total and glue was watched for blends arranged at low compaction vitality. Compaction vitality has critical impact on solidify defrost solidness of PCPC, in this manner, assist examination of the compaction consequences for PCPC properties is suggested.
Table 2.1 demonstrate the association between compressive quality and time using distinctive water concretes proportions and total bond proportions. He in like manner contemplated that even the perfect proportions still would not give compressive quality characteristics equal to traditional cement. Malhotra proceeded to investigate the effects of compaction on compressive quality. Table 2.2 show the connection between's compressive quality and unit weights when various total concrete proportions close by various total assessing are used. Malhotra furthermore examined various sorts of totals and their effect on compressive quality. Table 2.3 shows the association between total kind and compressive quality. Malhotra (1976), found that the thickness of vulnerable cement is generally around 70 percent of customary solid when made with comparative constituents. The thickness of permeable cement using general totals vacillates from 1602 to 1922 kg/m3

Pitroda J., Umrigar D. F., Principal B. & Anand G. I. (2013) describe In his paper "Assessment Of Sorptivity And Water Absorption Of Concrete With Partial Replacement Of Cement By Thermal Industrial Waste (Fly Ash)" expresses a trial examine on the properties of Water absorbing concrete by halfway replacement of cement by warm modern waste. The mix design was done for M20 grade concrete according to IS 10262:2009.

Neithalath, N., Weiss, J., &Olek, J. (2006) analysedIn his paper "Predicting the permeability of pervious concrete (enhanced porosity concrete) from non-destructive electrical measurements" has sketched out a system to non-damagingly survey the pressure driven properties of pervious solid utilizing electrical property estimations. The porosity and pore size of pervious solid blends made utilizing single estimated totals and mixes of these totals were estimated utilizing volumetric strategy and picture investigation system. The water driven conductivity was estimated utilizing a falling head permeameter particularly outlined and created for this reason. It was watched that the porosity and pore sizes did not hold up under any immediate connection to porousness. Electrical impedance spectroscopy was utilized to decide the compelling conductivity of pervious solid examples soaked with sodium chloride arrangements of changing focuses. Utilizing an altered adaptation of parallel law of blends, a term called adjusted standardized conductivity was characterized, which identified with the pore structure highlights of the material. Utilizing the Kozeny-Carman condition, water driven network factor was characterized, which can be thought of as a mix of parameters that portray the pore space volume and geometry such that the natural porousness is identified with porosity and pressure driven availability factor. The water driven network factor βH offers a methods for grouping EPC in view of their pressure driven attributes. The blends with comparative pressure driven network esteems display comparative porousness.

Methodology

In this chapter after analyzing the literature review methods of research is discussed for analyzing of pervious concrete by following steps:-
1. Building quality parameter with pervious concrete is decided and it will be compared with ordinary concrete.

2. Casting of various trial blends of pervious concrete is done and its compressive strength will be analyzed.

Mix design for M20 (w/c = 0.50):-

First of all we design three concrete mixes at three different cement content and making proportion at 5:0 of fine aggregate and coarse aggregate, we will choose the mix design with lower cement content and with lower concrete density. Mix design 5.3 having the lower concrete density as compare to mix design 5.1 and 5.2. Therefore after choosing mix design 5.3 with minimum cement content i.e. 384 kg/m3 and lower concrete density, then after we design two more concrete mix proportions at ratio 4:1

and 3:2 of coarse aggregate and fine aggregate at cement content 384 kg/m3. We will use little fine aggregate to boost the strength of pervious concrete**.**

CASTING AND TESTING

4.1 Cement

Ordinary Portland concrete, 43 Grade fitting in with IS: 269 – 1976. Normal Portland bond, 43 Gradewas utilized for casting every one of the Specimens. Distinctive kinds of concrete have diverse water necessities to create glues of standard consistence. Diverse kinds of bond additionally will deliver concrete have alternate rates of quality improvement. The decision of brand and sort of bond is the most imperative to deliver a decent nature of cement.

4.2 Coarse Aggregate

Locally accessible squashed blue rock stones complying with evaluated aggregate of ostensible size 12.5 mm according to Seems to be: 383 – 1970. Pounded rock aggregate with particular gravity of 2.77 and going through 4.75 mm sifter and were utilized for casting all examples. A few examinations reasoned that most extreme size of coarse aggregate ought to be limited in quality of the composite..

4.3 Fine Aggregate

Locally accessible sand was sieved before utilizing it in the blend. Aggregate a large portion of which passes 4.75-mm IS Sieve and contains just so substantially coarser material as allowed in IS2386-Part1-1963. Regular Sand can be characterized as fine aggregate coming about because of the characteristic crumbling of shake and which has been saved by streams or cold organizations was utilized.

4.5 Casting process

4.5.1 Size of Test Specimens

The cube which is used in this research having size of 150 mm*150 mm*150mm and beam is casted of size of 500mm*100mm*100mm. the compressive strength and flexural strength is computed and check on casted cubes and casted beam of pervious concrete respectively.

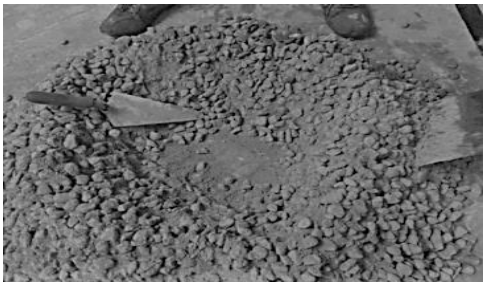
4.5.2 Preparation of Moulds

Moulds are prepared very carefully and it require more time. Oil is applied on surface for cleaning purpose. Moulds should be tightened properly and bolting shouldbe done carefully.

Moulds preparations

4.5.3 Mixing

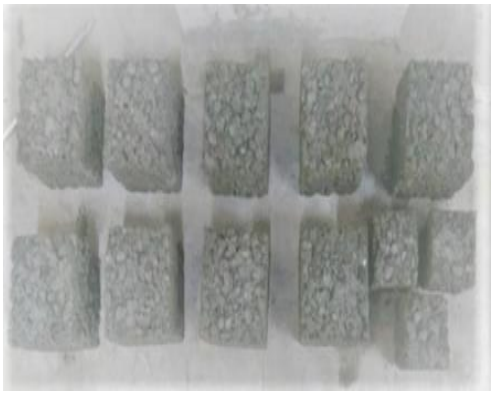
All the concrete mixing is done manually. And all the concrete quantity is taken as per calculation of concrete mix design. First of all dry mixing is done properly and special care were taken on floor while mixing. Floor should be dry. When dry mixing is completed then application of water takes place properly. It was kept in mind that all of the water was added within 1/3rd of the total mixing time. Again further mixing was carried out in order to obtain homogeneous mixture.



Homogeneous dry mix

finishing of top surface of concrete in cube and beam

The concrete was left for 24 hours for hardening purpose the after this period concrete cube was demoulded.



demoulded cubes

Curing of cube Specimen in ambient conditions

When the demoulding was done the curing was carried out by placing them in curing tank for 3 days, 7 days, 28 days as required for testing.

The temperature of water was at room temperature that is in ambient conditions. Clean tap water was used for curing of specimens. All the specimens were numbered and marked with help of wax crayon to remember the type of mix.

Curing of beam Specimen in ambient conditions

4.6 Testing of Specimen

IS 516 is used for testing of all the specimen for check of compressive strength of pervious concrete and compression testing machine. For check of flexural strength of beam the flexural testing machine.


Compression Testing Machine

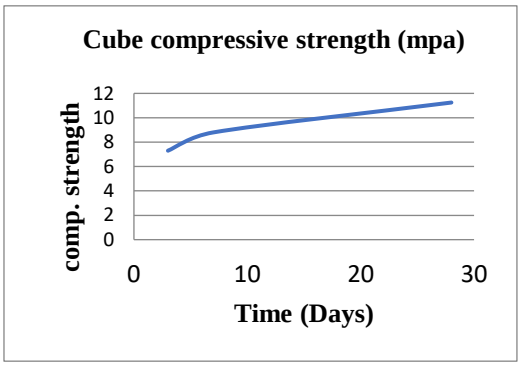
Results

5.1 Compressive strength of cube

5.1.1 Course aggregate: Fine aggregate = 5:0

S.no.	Time duration (days)	weight (kg)	cube-Density (kg/m3)	cube compressive strength (mpa)
1	3	7.31	2166	6.9
2	3	7.33	2172	7.6
3	3	7.31	2166	7.4
4	7	7.31	2166	8.2
5	7	7.3	2163	8.8
6	7	7.33	2172	9.4
7	28	7.32	2169	10.55
8	28	7.32	2169	11.3
9	28	7.33	2172	11.9

Table: 5.1.1 - Cube- compressive strength with zero fine aggregate

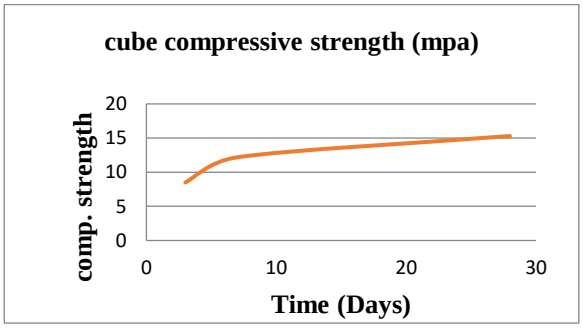


As we know that strength is directly proportional to time, therefore after testing cube at 3days, 7days and 28 days this graph shows the increase in the compressive strength from 3 days to 28days. But for this sample fine aggregates are not used therefore compressive strength is lower than that of other two sample

5.1.2 Course aggregate: Fine aggregate = 4:1

S.no.	Time duration (days)	weight (kg)	cube-Density (kg/m3)	cube compressive strength (Mpa)
1	3	7.61	2256	8.53
2	3	7.63	2260	8.88
3	3	7.61	2256	8.1
4	7	7.61	2256	11.87
5	7	7.6	2254	11.82
6	7	7.63	2260	12.88
7	28	7.62	2258	13.55
8	28	7.62	2258	15.7
9	28	7.63	2258	16.66

Table: 5.1.2 - Cube- compressive strength with fine aggregate



As we know that strength is directly proportional to time, therefore after testing cube at 3days, 7days and 28 days this graph shows the increase in the compressive strength from 3 days to 28days. But for this sample little fine aggregates are used therefore compressive strength is higher as compare to previous sample

5.1.3 Course aggregate: Fine aggregate = 3:2

S.no.	Time duration (days)	weight (kg)	cube-Density (kg/m3)	cube compressive strength (mpa)

1	3	7.98	2364	18
2	3	7.94	2352	17.82
3	3	7.98	2364	18.1
4	7	7.98	2364	33.64
5	7	7.97	2361	32.26
6	7	7.99	2367	33.82
7	28	7.99	2367	42.04
8	28	7.97	2361	41.91
9	28	7.98	2364	41.56

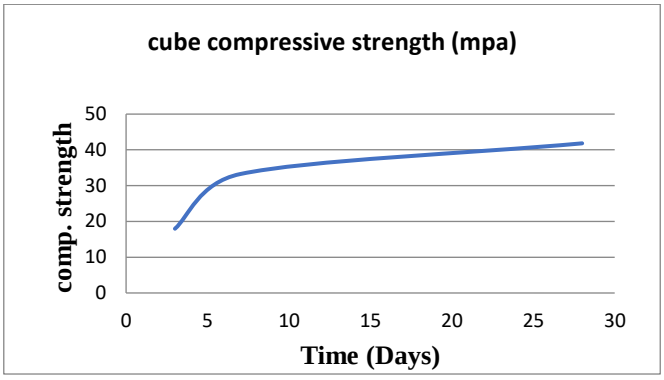


Table: 5.1.3 - Cube- compressive strength with fine aggrega

As we know that strength is directly proportional to time, therefore after testing cube at 3days, 7days and 28 days this graph shows the increase in the compressive strength from 3 days to 28days. But for this sample little more fine aggregates are used therefore compressive strength is higher as compare to previous two samples.

5.2 Flexural strength of beam

5.2.1 Course aggregate: Fine aggregate = 5:0

S.no.	Time duration (days)	weight (kg)	Beam-Density (kg/m3)	Beam flexural strength (Mpa)
1	7	10.1	2020	2.76
2	7	10.23	2046	2.73
3	7	10.41	2082	3
4	28	10.22	2044	2.99
5	28	10.3	2060	3.26
6	28	10.41	2084	3.5

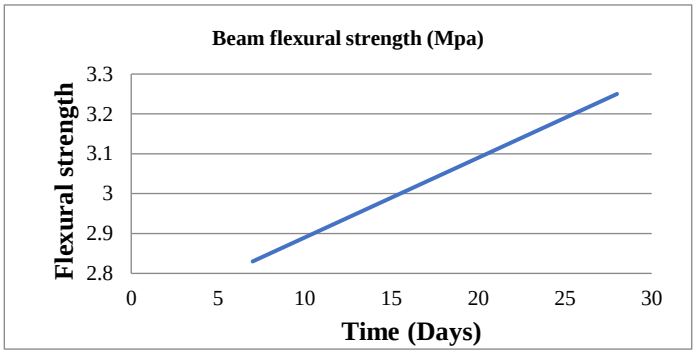


Table: 5.2.1– Beam-flexural strength with zero fine aggregate

As we know that strength is directly proportional to time, therefore after testing beam at 7days and 28 days this graph shows the increase in the flexural strength from 7 days to 28days. But for this sample fine aggregates are not used therefore flexural strength is lower than that of other two samples

5.2.2 Course aggregate: Fine aggregate = 4:1

S.no.	Time duration (days)	weight (kg)	Beam-Density (kg/m3)	Beam flexural strength (Mpa)
1	7	10.25	2050	4
2	7	10.21	2042	3.25
3	7	10.09	2018	3
4	28	10.24	2048	4.2
5	28	10.26	2052	4.3
6	28	10.22	2044	3.9

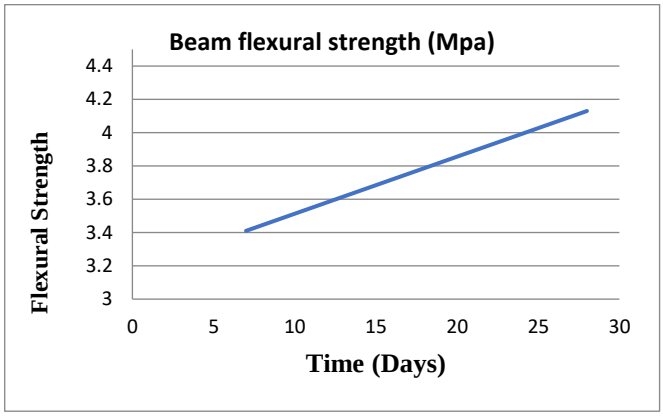


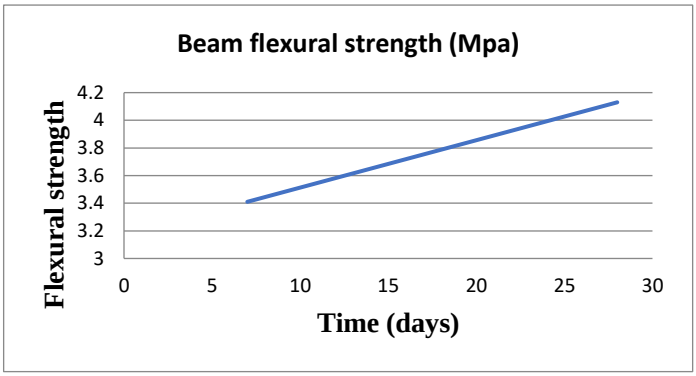
Table: 5.2.2 – Beam-flexural strength with fine aggregate

As we know that strength is directly proportional to time, therefore after testing beam at 7days and 28 days this graph shows the increase in the flexural strength from 7 days to 28 days. But for this sample little fine aggregates are used therefore flexural strength is higher as compare to previous sample.

5.2.3 Course aggregate: Fine aggregate = 3:2

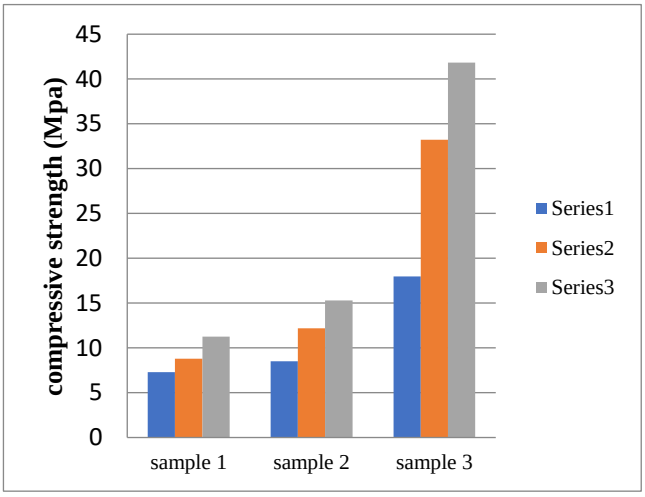
S.no.	Time duration (days)	weight (kg)	Beam-Density (kg/m3)	Beam flexural strength (Mpa)
1	7	10.84	2168	4.6
2	7	10.72	2144	4.5
3	7	10.35	2070	4
4	28	10.44	2088	6
5	28	10.36	2072	5.75
6	28	10.4	2080	5

Table: 5.2.3 – Beam-flexural strength with fine aggregate

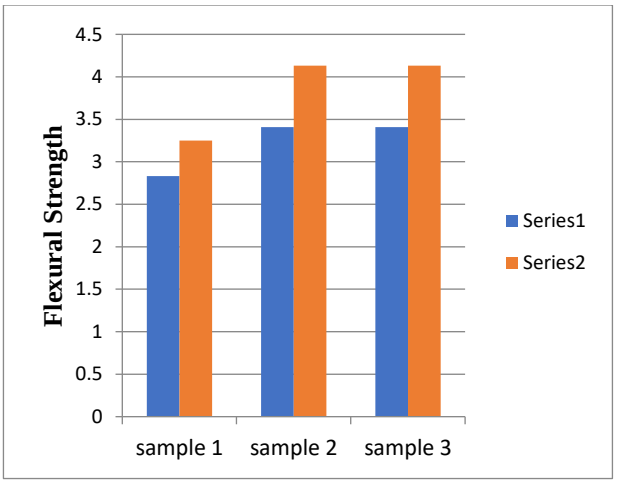


As we know that strength is directly proportional to time, therefore after testing beam at 7days and 28 days this graph shows the increase in the flexural strength from 7 days to 28 days. But for this sample little more fine aggregates are used therefore compressive strength is higher as compare to previous two samples.

Comparison for compressive strength of Cube
Comparison for flexural strength of Beam



Compressive strength comparison graph



Flexural strength comparison graph

Conclusion

In this chapter we will discuss about some conclusion that are listed as follows-

1. It was found that the most essential component in pervious concrete is quantity of cement and it has great influence if it will be more then it will be settled down when water is applied after dry mixing and it will make concrete cube base impermeable.
2. A proper tray is used to reduce the loss of water while mixing.
3. It is recommended to done compaction manually (hand compaction) because use of vibration tale will make cement to settle down and pervious properties at base may be lost.
4. Oiling on cube mold should be done very carefully because it can cause hole on concrete cube surface.
5. Three concrete mixes was used at the quantity of 479 kg/$m^{3,}$ 446 kg/m^3 and 384 kg/m^3 but 384 kg/m^3 quantity of cement shows better permeability than others.

6. The sand quantity was used as zero, fifteen and thirty percent and thirty percent quantity of sand makes concrete mix impervious and out of zero percent and fifteen percent of sand quantity the fifteen percent exert better compressive strength along with significant permeability. So it will be recommended to use.

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