MIX DESIGN AND FACTORS AFFECTING STRENGTH OF PERVIOUS CONCRETE

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CERTIFICATE

This is to certify that the work which is being presented in the project title **"MIX DESIGN AND FACTORS AFFECTING STRENGTH OF PERVIOUS CONCRETE"** in partial fulfilment of the requirements for the award of the degree of Master of technology and submitted in Civil Engineering Department, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Sagar (162611)** during a period from July 2017 to May 2018 under the supervision of **Mr. Aakash Gupta** Assistant Professor, Civil Engineering Department, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of my knowledge.

Date:- May 2018

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ABSTRACT

Pervious concrete which is likewise called permeable concrete, penetrable concrete, no fines concrete and permeable asphalt is a sure sort of concrete with a high porosity utilized for concrete flatwork applications that will permit the water from precipitation and different sources to go straightforwardly through, along these lines diminishes the overflow from a site and permitting groundwater revive. Pervious concrete is made utilizing huge totals with practically no fine totals. The concrete glue at that point coats the totals and enables water to go through the concrete piece. Pervious concrete is customarily utilized as a part of stopping zones, regions with light movement, private boulevards, person on foot walkways, and nurseries.

It is a vital application for maintainable development and is one of numerous low effect advancement systems utilized by manufacturers to secure water quality. With interconnected void content we can achieve high porosity. Water to cementious material ratio is 0.40 to 0.50. Design made at different water cement ratio and these ratios shows the different exposure conditions. In this paper specific gravity of cement, coarse aggregate and fine aggregate is 3.15, 2.68, 2.65. Cement used in this project is OPC- 43. Coarse aggregate is used at different proportions. The present examination tended to the quality and seepage parts of pervious concrete blends and furthermore the impact of CS as a FA.

A point by point contemplate is required to know the impacts of total degree with different kinds of total. In this undertaking I will think about the mechanical properties of Pervious Concrete used to plan Road Pavements. The properties of PCC blends to be examined are compressive quality and flexural quality. 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. In this project I will study the mechanical properties of Pervious Concrete used to design Road Pavements. Main focus of the project will be to determine and improve compressive strength, and flexural strength.

KEY WORDS: - Pervious, OPC, NFC, FA, CA, River Sand, Crushed Stone.

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CHAPTER 1

INTRODUCTION

Pervious cement is a mix of shake or stone, bond, water and alongside zero sand which influences an open cell to structure that empowers water and air to experience it. According to EPA (Environmental Protection Agency's) storm water flood can send as much as 90% of toxic substance, for instance, oil and other hydrocarbon. The limit of pervious cement to empower water to travel through itself resuscitates ground water and restricts the level of defilement and whirlwind water overflow. Pervious cement is used to allow storm water to attack through the black-top and diminish or shed the necessity for additional control structures, for instance, support lakes.

The pervious solid black-top has various ideal conditions that improve city condition as takes after:

1. The water can quickly channel into ground, so the groundwater resources can reestablish in time as the black-top is air permeable and water vulnerable, the soil underneath can be kept wet.
2. The pervious solid black-top can hold the commotion of vehicles, which influences peaceful and pleasant to condition.
3. In tempestuous days, the pervious solid black-top has no plash at first look and does not flash around night time. This improves the comfort and prosperity of drivers.
4. The pervious solid black-top materials have openings that can cumulate warm.

Such black-top can change the temperature and soddenness of the Earth's surface and gets rid of the wonder of hot island in urban zones. An achieved installer is irreplaceable to accomplishment of pervious solid black-tops as with any solid black-top, fitting subgrade status is crucial. The subgrade should be properly compacted to give a uniform and stable surface. Right when pervious black-top is set direct on sandy soil it is recommended to moderate the subgrade to 92 to 96% of the most extraordinary thickness. With silty or clayey soils, the level of compaction will tons of black-top arrangement and a layer open assessed stone may must be put over soil. The voids can go from 18 to 35% with compressive qualities of 10 to 30 MPa. The invasion rate of pervious cementious materials, coarse totals, water with practically no fine total and admixtures. Expansion of little measures of fine totals will continuously lessens the void substance and increment the quality, which might be attractive in specific circumstances. This material is touchy to changes in water content, so field modification of crisp blend is typically important. The right amount of water in the solid is basic. An excess of water will cause isolation, and too little water will prompt balling in the blender and moderate blender emptying. The Water/Cement and Cement/Aggregate proportions are regularly goes from 0.25 to 0.45 and 1:3.5 to 1:6.

1.1 Material Required

A) Water

So also as water is a wellspring of life for each and every living thing, so it is the fundamental component for the beginning of all solid. Without water or too little water, all that exists is a load of rocks and powder. The backwards can in like manner negatively impact the headway of cement. 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. Hydration of the bond is vital to shape bonds with the aggregate which in this way give solid its quality. Then again the closeness of water filled spaces inside the solid is obstructing to its quality. Signs are that solid quality is direct related to porosity and the water-bond extent (W/C). This is showed up by the hydration technique. As hydration of solid advances, the volume of solids increases. This volume is in the space in advance controlled by the unhydrated concrete. The development in solids volume demonstrates a decreasing in porosity.

Porosity impacts quality yet quality itself is a delayed consequence of holding. Making bonds in mixes with high W/C extents is troublesome as a result of the detachments between particles. A high W/C extent infers a mix with a high porosity. In like manner a high porosity infers weaker bonds which in this manner provoke bring down quality. The measure of water required to complete hydration and achieve most extraordinary quality has for quite a while been gone head to head with respect to. As of now discussed, the quality in concrete is made through bonds. These bonds make through a manufactured reaction of cement and water. This reaction produces calcium silicate hydrate. One gram of cement requires 0.22 grams of water in order to totally hydrate. In any case, the volume of the consequences of hydration is more unmistakable than the volume of bond and water used as a piece of the reaction.

Specifically, it requires a volume of 1.2 ml of water for the aftereffects of hydration for 1ml of cement. This thinks about to a W/C extent of 0.42 for complete hydration (Aitcin and Neville, 2003). As noted previously, a part of the water is required for workability of the solid. This extra water is required because of flocculation that hops out at the particles of cement. This floc reduces workability and blocks hydration. It is possible to fuse admixtures which wipe out flocculation. Water once used to adjust this effect is as of now used for hydration, in this way diminishing the measure of water required.

Water and its application in pervious cement are to an awesome degree fundamental. Since fines are discarded from pervious solid, quality relies upon the commitment of the bond paste and its interface with the aggregate. Similarly with normal cement, too little water achieves no holding and an extreme measure of water will settle the paste at the base of the black-top and hinder the pores. The correct measure of water will help the quality without exchanging off the permeability properties of the pervious cement

.

The thoughts of hydration and workability will be considered while making mixes of pervious cement with contrasting extents of bond, aggregate, and water. Water will be added to various mixes of aggregate and bond in tests expected to support hydration and upgrade compressive quality. The goal is to choose a legitimate extent of W/C extents that will yield high compressive qualities in the pervious

B) Aggregate Type and Size

Generally the quality of total isn't considered while discussing the quality of cement. Frustration of solid cases in a weight test generally occurs at the aggregate paste interface. This exhibits the expression "You are similarly as strong as your weakest association." This demonstrates the security quality is weaker than both the quality of the paste and the quality of the aggregate. All signs are that the quality of the solid is coordinated by the quality of the bond and not the individual parts.

In any case, in pervious cement the bond stick is obliged and the aggregate rely upon the contact surfaces between each other for quality. Thusly harder aggregate, for instance, stone or quartz, would yield higher weight quality than a milder aggregate like limestone. Typically add up to inside the extent of 3/8" and 3/4" are used because of enhanced dealing with and circumstance. Anything greater would realize greater void spaces however would give a rougher surface.

Add up to accommodated this examination is obliged to 3/8". The sort of aggregate used is lime stone and it's specific gravity will be found through trials drove on the stone later in the examination.

Fig. 1.1.1 Sample of Coarse Aggregate and Fine Aggregate along with Crushed Stone and River Sand

C) Aggregate-Cement Ratio

The measure of total in respect to the measure of concrete is another imperative element. The greater concrete glue accessible for compaction the higher the compressive strength. Again this will stop up the pores and is unfavorable to the capacity of the pervious concrete. Using information acquired from earlier research, a reasonable scope of A/C proportions will be utilized to make different blends of pervious concrete to be tried for compressive strength.

D) Ordinary Portland Cement

Cement acts as binder in concrete and plays major role towards strength of concrete and its durability. Any type of cement can be used but due to availability, OPC has been used in this study project.

Fig 1.1.2 Sample of Portland Cement

Fig. 1.1.3 Sample of Pervious Concrete

Fig. 1.1.4 Picture demonstrating drainage capability of Pervious Concrete Road Pavements

1.2 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 passings 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.

CHAPTER 2

LITERATURE REVIEW

To make a pervious solid structure with ideal porousness and compressive quality, the measure of water, measure of bond, sort and size of total, and compaction should all be considered. A colossal number of examinations have been now driven all through the past couple of decades by an assortment of specialists contrasting a few or these components. The results are presented in a movement of tables and diagrams.

Malhotra V. M. (1976)[1]

In this paper "No-fines concrete-Its properties and applications" V.M. Malhotra 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.

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 weight 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.

Attractive vibration is essential for nature of customary cement. The use of porous cement is one of a kind and is a self-pressing item. Malhotra (1976) recommends that the use of mechanical vibrators and smashing isn't proposed with porous cement. A light rodding should be attractive and used to ensure that the solid accomplishes all regions of the formwork. This isn't an issue with customary cement since it has more prominent stream capacity than penetrable cement. The light rodding ensures that the solid entered every one of the regions obstructed by fortifying steel.

Malhotra stresses that in circumstances where common conditions are not refined amid arrangement and curing, the formwork ought not be expelled following 24 hours as with normal cement. Permeable cement has low cohesiveness and formwork ought to stay until the point that the bond glue has solidified adequately to hold the total particles together. Be that as it may, this is to a greater degree a thought in low temperature conditions and when utilized as a part of non-asphalt applications where the solid isn't adequately upheld by the ground or different means. [1]

Table 2.1: Relationship b/w Strength and W/C & A/C Ratios (Aggregate_"Gravel")

Aggregate Cement Ratio (A/C)*	Water Cement Ratio (W/C)**	Age of Test (Days)	Density (Kg/m^3)	Cement (Kg/m^3)	Compressive Strength (MPa)
6	0.38	3	2015.12	258.66	8.928
		7	2008.71	258.66	11.445
		28	1999.10	258.66	14.341
8	0.41	3	1922.22	193.40	5.860
		7	1914.21	193.40	7.273
		28	1912.60	193.40	9.411
10	0.45	3	1869.35	154.84	4.309
		7	1864.55	154.84	5.377
		28	1861.34	154.84	6.998

Source: Malhotra (1976), ACI Journal, Vol. 73, Issue 11 , p 633.

*A/C Ratios are by volume.

**W/C Ratios are by weight.

Table 2.2: Relationship between 28 Day Compressive Strength and Grading

(Water Content = 0.36)

Grading	Aggregate Cement Ratio (A/C) by volume	Unit Weight (Kg/m^3)	CompressiveStrength (MPa)
A	8	1909.40 1870.96 1858.14 1813.29	8.480 6.722 7.515 5.619
B	9	1883.77 1819.70 1800.47	7.170 5.688 5.136
C	7	1877.36 1851.73 1826.10 1826.10	8.825 7.101 6.894 6.550

Source: Malhotra (1976), ACI Journal, Vol 73, Issue 11, p 634

Table 2.3: Relationship between 28 Day Compressive Strength and Aggregate

(Water Content = 0.40)

Type of aggregate	Dry Density (Kg/m^3)	Compressive Strength (MPa)
Rounded Quartzite Gravel	1842.12	8.618
Irregular Flint Gravel	1585.83	4.826
Crushed Limestone	1826.10	6.894
Crushed Granite	1697.96	7.584

Source: Malhotra (1976), ACI Journal, Vol 73, Issue 11, p 634

Teware P. R. & Harle S. M. (2016)[2]

In this paper "Mix Proportion of Cementitious material in pervious Concrete" the pervious concrete needs appropriate mix design. The mix design for substitution of the cement in the concrete by fly ash and ground granulated blast furnace slag up to a few percentage. The proportion of cement, fly ash or GGBS, water, coarse aggregate and water cement proportion have been computed with the assistance of Indian standard code (IS: 10262 : 2009). To cast the concrete cubes the mix design is exceptionally fundamental. The testing, for example, compressive strength, split tensile strength, workability test, and so on can be directed appropriately for the pervious concrete. The information got in this research paper is very useful for further procedure related to the concreting procedure. [2]

Castro J., Spragg R.Kompare P. & Weiss W. J. (2010)[3]

In this paper "Portland cement concrete pavement permeability execution Nov 2010" expresses a test ponder on transport properties of concrete are controlled by the attributes of its pore arrange. Add up to porosity, pore size, pore connectivity, and pore saturation all impact the deliberate transport coefficients (Garboczi 1990; Bentzetal. 1999). Water absorbing concrete was first utilized as a part of the 1800s in Europe as pavement surfacing and load bearing walls. Cost effectiveness was the principle thought process because of a diminished measure of cement. It ended up prominent again in the 1920s for two story homes in Scotland and England. It turned out to be progressively suitable in Europe after WWII because of the shortage of cement. It didn't move toward becoming as well known in the US until the 1970s. In India it ended up well known in 2000. The first Water absorbing placement in the Indian Metro Area was in Sugar Creek, MO in November 2005. Since that time around 30+ pavements have been put and numerous lessons found out about what makes Water absorbing concrete "great". Here in, are the present rules that have been educated and adjusted. [3]

Pitroda J., Umrigar D. F., Principal B. & Anand G. I. (2013)[4]

In this 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. [4]

Shah D. S., Pitroda J., & Bhavsar J. J. (2013)[5]

In this paper "Water absorbing Concrete: New Era For Rural Road Pavement" states examine on utilizing pervious concrete as street development material generally new idea for provincial street pavement, with expanding issue in country zones identified with low ground water level, farming issue. His report center around pavement utilization of concrete which additionally has been referred on pervious concrete, penetrable concrete, no fine concrete, hole reviewed concrete and upgraded porosity concrete. [5]

Eathakoti S., Gundu N., & Ponnada M. R. (2015)[6]

In this paper "Water absorbing Concrete: New Era For Rural Road Pavement" an innovative model that can transport water go into the pavement has been proposed toward this path. Diverse mixes of Cement, water and Course aggregate with various greatest size and gradation were adopted for mixing procedure to make roughly at M20 grade concrete. M20 grade concrete is accomplished with a w/c proportion of 0.4 to 0.45. Coarse aggregate of nominal size 20 mm and with a cement to Course aggregate proportion of 1:4. Its density and flexural strength quality were seen to be 21 kN/m^3 and 35 kg/cm^2 individually. A pavement piece appropriate for low activity volume streets is planned according to IRC SP62: 2004 which permits stockpiling of water up to 125 lit/m^3 of concrete pavement giving time for invasion in this way diminishing the runoff and reviving the ground water or adequate time for transport of it. A perforated pipe can be given at focus of the pavement above sub-base with the end goal that it gathers the water put away in concrete and depletes it to the required treatment plant or a fill pit. This however needs encourage examination and trials before practical implementation. [6]

Table 2.4: Mix Design in tabular form as per past work

Refrences	Year	Cementitious Material Kg/m^3	Aggregates Kg/m^3	W/C	Agg./C Ratio	Water (W) lt.
Khankhaje et al.	2016	340	1460	0.32	---	109
Chandrappa et al.	2016	321-487	1373-1692	0.25-0.35	3 - 5	84 – 161
Yahia & Kabagire	2014	195-535	1500-1700	0.30	---	---
Nguyen et al.	2013	309	1525	0.30	4.9	93
Bassuoni & Sonebi	2010	315-415	1200-1400	0.28-0.40	4 - 6	125 – 154
Kervern et al.	2009	180-380	1510-1620	0.24-0.30	4 – 10	50 – 100
Crouch et al.	2007	287-345	1542-1620	0.30	4.5 – 5.6	87 – 105
Ghaffori et al.	1995	300-413	1651-1800	0.37-0.42	4 - 6	125 - 154

Nishikant K., Nachiket A., Avadhut I., & Sangar A. (2016)[7]

In this paper "Manufacturing of Concrete Paving Block by Using Waste Glass Material" expresses an experimental work of utilizing an alternate kind of concrete for pavement work over conventional technique for utilizing cement concrete. He has included fine pound glass which prompts high strength of concrete all together deliver concrete block. He has replaced the waste glass with the fine aggregate which give pore in concrete to vast degree and furthermore expanding the strength of concrete in the permeable frame and the extraordinary concrete arranged by him he has utilized for influencing concrete pavement to block. Solid clearing pieces has been generally used as a piece of various countries for quite a while as a particular basic reasoning method for giving asphalt in zones where normal sorts of advancement are less intense on account of various operational and natural reasonableness. This advancement has been executed in India being developed, 10 years earlier, for specific essential works, for instance, pathways, stopping regions et cetera however now being gotten extensively in different uses where the common improvement of asphalt using bond solid innovation isn't plausible or alluring. Solid pieces were first introduced in Holland in the fifties as substitution of paver shut which had ended up being obliged due to the post-war building improvement impact. These pieces were rectangular perfectly healthy and had basically an unclear size from the squares. In the midst of the past five decades, the square shape has steadily created from interlocking to non-interlocking to totally interlocking shapes. [7]

Balaji M. H., Amarnaath M. R. & Kavin R. A. (2015)[8]

In this paper "Design Of Eco Friendly Pervious Concrete" concentrated the mix design of pervious concrete according to ACI 522R-06 gave by American Concrete Institute for design of Pervious Concrete Road Pavements. He found that Aggregate Cement Ratio of 3:1 had most elevated strength quality. The 3days, 7days, 14days, 27days strength quality were observed to be 7.32, 17.16, 23.4, 24.57 and 25.73 individually. [8]

Dr. M. Mageswari (2016)[9]

In this paper "High Strength Permeable Pavement utilizing no Fines Concrete" concentrated pervious concrete with various mixes of Cement, GGBS, water and Coarse aggregate. M20 grade concrete was accomplished with a w/c proportion of 0.36, Coarse aggregate of nominal size 20 mm passed and 10 mm held, cement was halfway supplanted with 30% of GGBS and with a cement to Coarse aggregate proportion of 1:4. Its compressive strength were seen to be 20.4 kN/m^3. A perforated pipe can be given at focus of the pavement above sub-base with the end goal that it gathers the water put away in concrete and depletes it to the required treatment plant or a recharge pit. [9]

Patil V. R., Gupta A. K. & Desai D. B. (2010)[10]

In this paper "Utilization of Pervious Concrete in Construction of Pavement for Improving Their Performance" created solid and think about pervious cement blends for low-volume boulevards. The effects of two sorts of fine totals, i.e. Pulverized Stone and River Sand, on various properties of pervious cement were considered. The fine total to coarse total extent was 1:5.720 appeared differently in relation to standard pervious bond concrete blends. Bond content was changed from 300 kg/m3 to 340 kg/m3 with an expansion of 10 kg/m3. In entire 10 particular pervious cement blends were prepared reasoning about each level of bond content and every sort of fine total. What's more steel fiber was used to grow the quality parameter. The effects of such minor takeoff from the properties of pervious cement blends were considered. [10]

Nataraja, M. C., & Das, L. (2010)[11]

In this paper "Concrete mix proportioning as per IS 10262:2009 – Comparison with IS 10262:1982 and ACI 211.1-91" communicated that one should be wary while picking the fundamental w/c extent, as it picks the figured bond content. For example, for a M20 solid blend, one can acknowledge w/c as 0.5 or 0.55 in any case and in like way concrete substance will change. The degree of this examination was to dissect BIS and ACI proposed blend configuration rules. The estimation frames in the two codes were consolidated by demonstrating the plan steps. A typical M20 blend configuration was introduced using these strategies. [11]

Dierkes, C., Kuhlmann, L., Kandasamy, J., & Angelis, G. (2002)[12]

In this paper "Pollution Retention Capability and Maintenance of Permeable Pavements" permeable asphalts made of solid clearing stones are frequently utilized for storm water infiltration in Germany. Contaminations like overwhelming metals and hydrocarbons in the overflow can imperil soil and groundwater, when they are not adequately evacuated by the asphalts (GOLWER 1991). Four unique frameworks of clearing stones, pavers with invasion joints, permeable solid pavers with channel layer, greened permeable pavers and pavers with greened penetration joints were explored to their toxin maintenance capacities. Each of the four frameworks demonstrated high contamination maintenance limits, however the greened frameworks and the permeable pavers work more effective than the framework with the penetration joints. In another examination, the permeable solid pavers were explored with various roadbeds to their toxins evacuation. Contrasts in contamination maintenance limits between the subbase materials exist. The most astounding poison maintenance limits were come to by pulverized stones with high substance of $CaCO_3$.

To check the research facility comes about a field consider on a current asphalt before a grocery store was done. The asphalt comprises of permeable solid pieces and was worked in 1985. One stopping box was uncovered and tests of the pavers, the joint filling, the subbase and the basic soil were taken and explored for substantial metals and hydrocarbons. A slight increment of overwhelming metals was found in the upper 2 cm of the structure; be that as it may, the dirt was not influenced. Mineral oils were additionally found in the dirt, however focuses were low and don't achieve as far as possible for contaminants in soils. From the consequences of the field think about no imperiling of soil and groundwater could be recognized following 15 years of task.

Stopping up and the diminishing of the invasion limit regularly happen in penetrable asphalts. Another cleaning gadget to recuperate the penetration limit was produced that guarantees a lifetime activity of the researched asphalts. he assurance of the penetration limit when the cleaning strategy with the as of late new created cleaning vehicle appears, that the invasion limit could be recouped from 1l/(s.ha) to in excess of 1500 l/(s.ha). With that esteem, the German control for porous asphalts is satisfied. A standard cleaning of the asphalts is essential. [12]

Hein, D., & Schaus, L. (2014)[13]

In this paper "Permeable Pavements for Roadway Shoulders" conventional shoulders are intended to give a wellbeing zone to crisis pull offs, give an activity path amid restoration and upkeep tasks, give sidelong help to the mainline asphalt and in addition giving a movement path to different methods of transportation. A porous asphalt bear framework would give these highlights and additionally storm water administration benefits. Roadway bear applications give a novel arrangement of plan contemplations that should be assessed and appropriately intended for preceding building penetrable shoulders. The plan of penetrable asphalt shoulders requires a harmony between giving a fundamentally adequate asphalt to withstand activity stacking and in addition accomplishing the storm water administration/

hydrologic outline objectives. Development strategies and appropriate upkeep of the porous shoulders are basic to the achievement and the life span of the penetrable asphalt shoulders.

Scratch configuration highlights incorporate a cautious evaluation of the porous asphalt site and its encompassing area use to guarantee that the asphalt surface does not end up sullied with sand/clean or vegetative issue. A hydrological configuration considering precipitation water arriving on the asphalt and water shed from the encompassing territory can be suited into the porous asphalt and after that legitimately treated for water quality enhancements and allowed to leave the asphalt either through penetration into the subgrade or controlled through underdrains. Development procedures and systems ought to think about the security of the asphalt from contaminants amid development and to guarantee that the asphalt can oblige both vehicle stacking and water penetration and exfiltration as per the asphalt plan. At last, upkeep practices ought to including vacuum clearing to guarantee the life span of the penetrable surface with repairs finished to address any limited lacks, for example, settlement and raveling and so on. [13]

Kevern, J. T., Wang, K., & Schaefer, V. R. (2008)[14]

In this paper "Concrete in Severe exposures" sources incorporate tempest water spillover from parking areas, water that typically would fly out through tempest sewers to neighborhood waterways and streams without treatment. Stage I of the NPDES program, distributed in 1990, applies to districts of 100,000 people or more prominent and development locales more prominent than 2.0 ha (5 sections of land). Stage II, distributed in 1999, applies to regions of 10,000 people or more noteworthy and development locales more prominent than 0.4 ha (1 section of land), which enormously builds the quantity of influenced areas. Permeable asphalt, particularly portland bond pervious cement (PCPC), helps control contamination release by enabling water to quickly penetrate into an opengraded total subbase and after that into the ground. Hydrocarbons (for instance, engine oil and fuel) end up joined to the vast surface zone of the PCPC or the total subbase and are diminished by common weakening, either through vanishing or natural degradation.1,2 PCPC likewise mechanically sift through bigger bits of metal or organic material for later gathering amid routine upkeep. Accordingly, the lion's share of first-flush toxins are expelled by the pervious solid framework. This keeps the toxins from entering storm water authorities and being passed on to neighborhood surface waters.
By permitting storm water to normally permeate into the dirt, PCPC can likewise decrease or dispense with the requirement for storm water maintenance zones and the framework required to pass on the water. Soon after the Phase II usage of NPDES, the U.S. Green Building Council recorded pervious asphalt as a conceivably useful framework in its Leadership in Energy and Environmental Design (LEED®) program.4 Recognizing the subsequent expanded interest for this innovation in all parts of the U.S., including cool climate districts, Iowa State University (ISU) started a PCPC investigate program in 2004. The accompanying is an outline of the bit of our work that concentrated on the solidness of PCPC subjected to solidifying and-defrosting (FT) cycles. Allude to References 5 and 6 for extra data. [14]

Bentz, D. P. (2008)[15]

In this paper "Virtual pervious concrete: microstructure, permeation, and porousness" the effective improvement of a virtual pervious cement in light of a relationship channel 3D remaking calculation has been illustrated. The virtual pervious cement contains a 3D void structure that displays permeation qualities and processed transport properties in great concurrence with those of genuine pervious cements, in view of accessible writing information. While in this investigation, the required 2D connection capacities were acquired from the half and half HCSS show, later on, they might be gotten straightforwardly from 2D pictures of real pervious cements. At the point when full 3D tomography informational collections are accessible from real pervious concretes,1 the displayed permeation and transport property calculation codes might be advantageously used to register permeation, conductivity, and porousness of the genuine materials. At last, potential expansions of the virtual pervious cement to investigating strength issues, for example, solidifying and-defrosting protection and stopping up have been presented. [15]

Suleiman, M. T., Kevern, J., Schaefer, V. R., & Wang, K. (2006)[16]

In this 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% void 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. [16]

Neithalath, N., Weiss, J., & Olek, J. (2006)[17]

In this 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, a 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. [17]

Mahboub, K. C., Canler, J., Rathbone, R., Robl, T., & Davis, B. (2009)[18]

In this paper " Pervious concrete: compaction and aggregate gradation" in view of the information, the compressive quality and penneability are not straightforwardly related. Additionally inquire about is expected to decide the impact of molecule introduction on porousness and quality inside every compaction administration. A functional device was given in this paper will enable solid planners to evaluate the porosity of the pervious cement in light of its total mass thickness. In spite of the fact that this applies just to the smashed limestone totals utilized as a part of this examination, the idea driving this basic connection can be a noteworthy efficient device when planning pervious solid blends. While the development hones for pervious cement are not uniform, they all require some level of compaction. Pervious solid compaction techniques fluctuate in various parts of the nation. Along these lines, there is no extraordinarily characterized field •condition. Therefore, the test stays to outline research facility compaction methodology to coordinate the illusive field condition. The condition of training, nonetheless, will profit by lab example planning conventions that create examples with building properties like field developed cement. A key thought in such manner would be total molecule introduction. Along these lines, more research is expected to scientifically evaluate different impacts of molecule introduction and distinguish contrasts amongst lab and field delivered pervious cement. At last, all totals in this examination were from one source: focal Kentucky limestone. More research is expected to confirm the patterns introduced in this paper for different sorts of totals. [18]

Kevern, J., & Farney, C. (2012)[19]

In this paper " Reducing curing requirements for pervious concrete with a superabsorbent polymer for internal curing" This examination researched the utilization of a SAP in a pervious solid blend to diminish the requirement for curing under plastic. The outcomes demonstrate that the explored SAP is successful in pervious cement and can possibly wipe out plastic curing as a rule. Particular outcomes from the examination is resolved. The additional water conveyed by the SAP delivered a more workable pervious solid blend without the glue obstructing the water penetrable pores. At level with void substance, the blend containing the SAP was more grounded. The SAP blend had less over the top aggregate shrinkage. The SAP blend created higher strains previously splitting in controlled ring shrinkage testing, had postponed time to breaking, and had a higher level of leftover quality than the control blend. The SAP blend held an indistinguishable measure of water from the control, despite the fact that extra water had been incorporated into the blend. Amid a field situation, the SAP blend was sufficiently workable for hand position. After one winter, the SAP blend cured in outdoors had sturdiness like the control blend cured under plastic for 7 days. [19]

Henderson, V., & Tighe, S. L. (2011)[20]

In this paper " Evaluation of pervious concrete pavement permeability renewal maintenance methods at field sites in Canada" It is clear that all together for pervious solid asphalt to be utilized all through Canada as a stormwater administration instrument and furthermore as a practical asphalt elective, upkeep prerequisites should be comprehended. When all is said in done the test locales incorporated into this venture have performed well with least interest for support to keep up sufficient execution. Upkeep strategies have been trialed in any case, for examine purposes and furthermore to enhance the execution now and again. The accompanying discoveries have been made:

The underlying porousness of the pervious solid asphalt will delineate future execution. Power washing can push flotsam and jetsam more profound into voids and lessening porousness instead of enhance it. Clearing of the surface can be successful in expelling flotsam and jetsam just off the surface and not from profound voids, thusly not really fundamentally enhancing penetrability. Washing the surface with an expansive breadth hose can unstick flotsam and jetsam somewhere down in voids and restore penetrability, now and again, to close beginning porousness esteems. Support ought to be performed before the beginning of the freeze– defrost season to limit raveling trouble provoked by development of trash at first glance. It is critical to design development of zones including pervious solid so pointless flotsam and jetsam, for example, finishing material isn't set at first glance. A pervious solid asphalt that is developed with a satisfactory porousness rate can be kept up utilizing one of or a couple of the strategies sketched out in this paper. Additionally work ought to assess to what extent a pervious solid asphalt stays at a restored level and when extra upkeep is required to reestablish the penetrability indeed. [20]

CHAPTER 3
OBJECTIVE OF STUDY

1. The principle target of this examination is to build up a solid and tough pervious bond concrete (PCC) blend utilizing distinctive kinds of fine aggregates with changing the amount of fine aggregates. Moreover, it is likewise expected to think about the properties of these PCC blends.

2. The level of fine aggregates to be utilized as a part of PCC blend is set to 30% max.

3. The properties of PCC mixes to be looked into are compressive quality and flexural quality.

3.1 SCOPE OF THE PROJECT WORK

1. The present examination tended to the strength and seepage parts of pervious concrete blends and furthermore the impact of CS as a FA.

2. A definite report is required to know the impacts of aggregate gradation with different sorts of aggregate to get higher strength and satisfactory building properties of pervious concrete.

CHAPTER 4
METHODOLOGY

After distinguishing proof of issue and setting the targets of the research, the research methodology has carefully design to accomplish these destinations.

1. Accumulation and investigation of writing relating to the exposition work.
2. Decide the building properties of pervious concrete and contrast them with ordinary concrete.
3. Cast different trial blends with changing rates of pervious concrete and analyze for the compressive quality.
4. Get ready test tests with the rate esteem and test these examples for the different properties.
5. To remark on the reasonableness and confinements of pervious concrete with traditional concrete.

4.1 PLANNING SCHEDULE

Collection of material

1. Collection of OPC Cement
2. Preparation of Mould for casting of cubes and beams
3. Collection of CA and FA

Creating Test Mixes with varied percentage of CA and FA:-

Commercially available CA and FA will be collected and suitable percentages of both the aggregates will be fixed For e.g. NFA, 4:1, 3:2.

Finding out Optimum Cement Content:-

Mixes will be created by varying cement content from 350kg/m^3 to 480kg/m^3

Casting of Cubes and Curing:-

Sets of three cubes will be casted having different mix proportion. After 24 hours of casting, cubes will be de moulded and water cured for several days.

Laboratory Testing:-

Each set of cube will be tested for its mechanical properties at the end of 3, 7 and 28 days.

CHAPTER 5

CONCRETE MIX DESIGN

5.1 Mix design for M20 (w/c = 0.40) :-

Grade = M 20

Cement = OPC-43

Max. size of aggregate = 20mm

Min. cement content = 280 kg/m^3

Max w/c ratio = 0.40

Exposure condition = Extreme

Degree of supervision = Good

Type of aggregate = Crushed angular aggregate

Chemical admixture = Not used

Test Data:-

Sp. Gravity = 3.15 of cement

Sp. Gravity , CA = 2.68, FA = 2.65

Water Absorption:-

CA = 1.83%

FA = 1.0%

Surface Moisture = Nil

Target Strength:-

$F_{target} = F_{ck} + KS$

= 20 + 1.65*4

= 26.60

Selection of w/c ratio:-

From Table 5 of IS 456, (page no 20)

Maximum water-cement ratio for Extreme Exposure Condition = 0.40

w/c ratio = 0.40 max Hence ok

From Table 2 of IS 10262- 2009

Maximum water content = 186 Kg (for Nominal maximum size of aggregate — 20 mm)

Estimated water content = 186+ [(3/100) x 186] = 191.6 kg /m^3

Cement Content w/c = 0.40

191.6/c = 0.40

C = 479 kg/m^3

= 479 > 280 Kg/m^3 Hence ok

Mix Calculation:-

1. Vol. of concrete = 1m^3

2. Vol. of cement = (mass / sp.gravity) *(1/1000)

= [479/(3.15*1000)]

= 0.15206 m^3

3. Vol. of water = (191.60/1) * (1/1000)

= 0.1916 m^3

4. Vol. of aggregate = 1- (2+3)

= 1- (0.15206 + 0.1916)

= 0.6563 m^3

5. Vol. and wt. of CA (In proportion 5:0)

For 5:0 :-

= 0.6563 * (5/5) = 0.6563

Wt. = Vol. of CA * specific gravity * 1000

= 0.6563 * 2.68 *1000 = 1758.884 kg

Mix proportion for casting of Cubes:-

Table 5.1.1: Mix proportion for cube using no fine aggregate at cement content 479 kg/m^3

(w/c = 0.40) (CA: FA = 5:0)

Sr. No.	Material	Quantity per m^3 (kg)	For 1 Cube (150*150*150mm) (kg/mm^3)	For 4 Cubes (kg/mm^3)	Percentage Proportion (%)
1.	Cement	479	1.6166	6.466	19.72
2.	Water	191.60	0.6466	2.5864	7.88
3.	CA	1758.88	5.9362	23.744	72.40
4.	FA	Nil	Nil	Nil	Nil
5.	Yield	2429.48	8.1994	32.797	-------

5.2 Mix design for M20 (w/c = 0.45) :-

Grade = M 20

Cement = OPC-43

Max. size of aggregate = 20mm

Min. cement content = 260 kg/m^3

Max w/c ratio = 0.45

Exposure condition = Very severe

Degree of supervision = Good

Type of aggregate = Crushed angular aggregate

Chemical admixture = Not used

Test Data:-

Sp. Gravity = 3.15 of cement

Sp. Gravity, CA = 2.68, FA = 2.65

Water Absorption:-

CA = 1.83%

FA = 1.0%

Surface Moisture = Nil

Target Strength:-

$F_{target} = F_{ck} + KS$

$= 20 + 1.65*4$

$= 26.60$

Selection of w/c ratio:-

From Table 5 of IS 456, (page no 20)

Maximum water-cement ratio for Very severe Exposure Condition = 0.45

Adopt w/c ratio = 0.43 < 0.45 max Hence ok

From Table 2 of IS 10262- 2009

Maximum water content = 186 Kg (for Nominal maximum size of aggregate — 20 mm)

Estimated water content = 186+ [(3/100) x 186] = 191.6 kg /m^3

Cement Content w/c = 0.43

191.6/c = 0.43

C = 446 kg/m^3

= 446 > 260 Kg/m^3 Hence ok

Mix Calculation:-

1. Vol. of concrete = 1m^3

2. Vol. of cement = (mass / sp.gravity) *(1/1000)

= [446/(3.15*1000)]

= 0.14158 m^3

3. Vol. of water = (191.60/1) * (1/1000)

= 0.1916 m^3

4. Vol. of aggregate = 1- (2+3)

= 1- (0.14158 + 0.1916)

= 0.6668 m^3

5. Vol. and wt. of CA (In proportion 5:0)

For 5:0 :-

= 0.6668 * (5/5) = 0.6668

Wt. = Vol. of CA * specific gravity * 1000

= 0.6668 * 2.68 *1000 = 1787.024 kg

Mix proportion for casting of Cubes:-

Table 5.2.1: Mix proportion for cube using no fine aggregate at cement content 446 kg/m^3 (w/c = 0.43) (CA: FA = 5:0)

Sr. No.	Material	Quantity per m^3 (kg)	For 1 Cube (150*150*150mm) (kg/mm^3)	For 4 Cubes (kg/mm^3)	Percentage Proportion (%)
1.	Cement	446	1.5052	6.0208	18.39
2.	Water	191.60	0.6466	2.5864	7.90
3.	CA	1787.024	6.0312	24.124	73.70
4.	FA	Nil	Nil	Nil	Nil
5.	Yield	2424.62	8.1831	32.732	-------

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

Grade = M 20

Cement = OPC-43

Max. size of aggregate = 20mm

Min. cement content = 250 kg/m^3

Max w/c ratio = 0.50

Exposure condition = Severe

Degree of supervision = Good

Type of aggregate = Crushed angular aggregate

Chemical admixture = Not used

Test Data:-

Sp. Gravity = 3.15 of cement

Sp. Gravity, CA = 2.68, FA = 2.65

Water Absorption:-

CA = 1.83%

FA = 1.0%

Surface Moisture = Nil

Target Strength:-

$F_{target} = F_{ck} + KS$

$= 20 + 1.65*4$

$= 26.60$

Selection of w/c ratio:-

From Table 5 of IS 456, (page no 20)

Maximum water-cement ratio for Severe Exposure Condition = 0.50

w/c ratio = 0.50 max Hence ok

From Table 2 of IS 10262- 2009

Maximum water content = 186 Kg (for Nominal maximum size of aggregate — 20 mm)

Estimated water content = 186+ [(3/100) x 186] = 191.6 kg /m^3

Cement Content w/c = 0.50

191.6/c = 0.50

C = 384 kg/m^3

= 384 > 250 Kg/m^3 Hence ok

Mix Calculation:-

1. Vol. of concrete = 1m^3

2. Vol. of cement = (mass / sp. gravity) *(1/1000)

= [384/(3.15*1000)]

= 0.1219 m^3

3. Vol. of water = (191.60/1) * (1/1000)

= 0.1916 m^3

4. Vol. of aggregate = 1- (2+3)

= 1- (0.1219 + 0.1916)

= 0.6865 m^3

5. Vol. and wt. of CA (In proportion 5:0, 4:1, 3:2)

For 5:0 :-

= 0.6865 * (5/5) = 0.6865

Wt. = Vol. of CA * specific gravity * 1000

= 0.6865 * 2.68 *1000 = 1839.82 kg

For 4:1 :-

= 0.6865 * (4/5) = 0.5492

Wt. = Vol. of CA * specific gravity * 1000

= 0.5492 * 2.68 *1000 = 1471.85 kg

For 3:2 :-

= 0.6865 * (3/5) = 0.4119

Wt. = Vol. of CA * specific gravity * 1000

= 0.4119* 2.68 *1000 = 1103.89 kg

6. Vol. and weight of FA (In proportion 5:0, 4:1, 3:2)

For 5:0

FA = Nil

For 4:1

= 0.6865 * (1/5) = 0.1373

Or

= 0.6865 – 0.5492 = 0.1373

Wt. = Vol. of FA * specific gravity * 1000

= 0.1373 * 2.65 *1000 = 363.845 kg

For 3:2

= 0.6865 * (2/5) = 0.2746

Or

= 0.6865 – 0.4119 = 0.2746

Wt. = Vol. of FA * specific gravity * 1000

= 0.2746 * 2.65 *1000 = 727.69 kg

Mix proportion for casting of Cubes:-

Table 5.3.1: Mix proportion for cube using no fine aggregate at cement content 384 kg/m^3

(w/c = 0.50) (CA: FA = 5:0)

Sr. No.	Material	Quantity per m^3 (kg)	For 1 Cube (150*150*150mm) (kg/mm^3)	For 10 Cubes (kg/mm^3)	Percentage Proportion (%)
1.	Cement	384	1.2960	12.960	15.89
2.	Water	191.60	0.6466	6.466	7.93
3.	CA	1839.82	6.2093	62.093	76.16
4.	FA	Nil	Nil	Nil	Nil
5.	Yield	2415.42	8.1519	81.519	-------

After making the three mix design at three different cement content and making proportion at 5:0 of coarse aggregate and fine 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/m^3 and lower concrete density, we will make further two more mix proportion at ratio 4:1 and 3:2 of coarse aggregate and fine aggregate at cement content 384 kg/m^3. We will use little fine aggregate to increase the strength of pervious concrete

Table 5.3.2: Mix proportion for cube using fine aggregate at cement content 384 kg/m^3

(w/c = 0.50) (CA: FA = 4:1)

Sr. No.	Material	Quantity per m^3 (kg)	For 1 Cube (150*150*150mm) (kg/mm^3)	For 10 Cubes (kg/mm^3)	Percentage Proportion (%)
1.	Cement	384	1.2960	12.960	15.92
2.	Water	191.60	0.6466	6.466.	7.94
3.	CA	1471.856	4.967	49.670	61.03
4.	FA	363.845	1.2279	12.279	15.08
5.	Yield	2411.30	8.1375	81.375	-------

Table 5.3.3: Mix proportion for cube using fine aggregate at cement content 384 kg/m^3

(w/c = 0.50) (CA: FA = 3:2)

Sr. No.	Material	Quantity per m^3 (kg)	For 1 Cube (150*150*150mm) (kg/mm^3)	For 10 Cubes (kg/mm^3)	Percentage Proportion (%)
1.	Cement	384	1.2960	12.960	15.95
2.	Water	191.60	0.6466	6.466	7.95
3.	CA	1103.89	3.7256	37.256	45.85
4.	FA	727.69	2.4559	24.559	30.22
5.	Yield	2407.18	8.1241	81.241	-------

Mix proportion for casting of beams:-

Table 5.3.4: Mix proportion for beam using no fine aggregate at cement content 384 kg/m^3

(w/c = 0.50) (CA: FA = 5:0)

Sr. No.	Material	Quantity per m^3 (kg)	For 1 Beam (100*100*500mm) (kg/mm^3)	For 4 Beam (kg/mm^3)	Percentage Proportion (%)
1.	Cement	384	1.920	7.68	15.89
2.	Water	191.60	0.958	3.832	7.93
3.	CA	1839.82	9.1991	36.796	76.17
4.	FA	Nil	Nil	Nil	Nil
5.	Yield	2415.42	12.077	48.308	-------

Table 5.3.5: Mix proportion for beam using fine aggregate at cement content 384 kg/m^3 (w/c = 0.50) (CA: FA = 4:1)

Sr. No.	Material	Quantity per m^3 (kg)	For 1 Beam (100*100*500mm) (kg/mm^3)	For 3 Beam (kg/mm^3)	Percentage Proportion (%)
1.	Cement	384	1.920	5.76	15.92
2.	Water	191.60	0.958	2.874	7.94
3.	CA	1471.856	7.359	22.077	61.04
4.	FA	363.845	1.8192	5.457	15.08
5.	Yield	2411.30	12.056	36.168	-------

Table 5.3.6: Mix proportion for beam using fine aggregate at cement content 384 kg/m^3 (w/c = 0.50) (CA: FA = 3:2)

Sr. No.	Material	Quantity per m^3 (kg)	For 1 Beam (100*100*500mm) (kg/mm^3)	For 3 Beam (kg/mm^3)	Percentage Proportion (%)
1.	Cement	384	1.920	5.76	15.95
2.	Water	191.60	0.958	2.874	7.96
3.	CA	1103.89	5.519	16.557	45.85
4.	FA	727.69	3.638	10.914	30.22
5.	Yield	2407.18	12.035	36.105	-------

CHAPTER 6

EXPERIMENTAL DETAILS

6.1 Determination of specific gravity and water absorption of coarse aggregates :-

Aim of the Experiment:-
To determine the absorption and specific gravity of coarse aggregates.

Apparatus Required:
1. A wire bin of not in excess of 6.3 mm work or a punctured compartment of advantageous size with thin wire holders for suspending it from the adjust.
2. A thermostatically controlled broiler to keep up temperature of 100 °C to 110 °C.
3. A holder for filling water and suspending the crate.
4. A water/air proof compartment of limit like that of the bin.
5. An adjust of limit around 5 kg. weight exact to 0.5 gm, and of such a sort and shape as to allow weighing of the example compartment when suspended in water.
6. A shallow plate and two dry permeable garments.

Theory and Scope:

The particular gravity of an aggregate is thought to be a measure of quality or nature of the material. The particular gravity test helps in the recognizable proof of stone. Water retention gives a thought of quality of aggregate. Aggregates having more water ingestion are more permeable in nature and are by and large thought to be unacceptable unless they are observed to be worthy in view of quality, effect and hardness tests.

Procedure:
1. Around 2 kg of the aggregate example is washed altogether to expel fines, depleted and then put in the wire bin and drenched in refined water at a temperature between 22 °C to 32 °C with a front of no less than 50 mm of water over the highest point of the crate. Quickly after submersion the captured air is expelled from the example by lifting the bushel containing it 25 mm over the base of the tank and enabling it to drop 25 times at the rate of around one drop for each second. The container and the aggregate ought to remain totally inundated in water for a time of 24 hours

2. The crate and the example are then weighed while suspended in water at a temperature of 22 °C to 32 °C. In the event that it is important to exchange the bin and the example to an alternate tank for weighing. They ought to be jarred 25 times as portrayed above in the new tank to expel air before weighing. This weight is noted while suspended in water W1 gm. The bin and the aggregate are then expelled from water and permitted to deplete for a couple of

minutes. After which the aggregates are exchanged to permeable garments. The unfilled container is then come back to the tank of water. jarred 25 times and weight in water W2 gm.

3. The aggregates put on the spongy garments are surface dried till no further dampness could be expelled by this material. At that point the aggregates are exchanged to the second dry material spread in a solitary layer secured and permitted to dry for no less than 10 minutes until the point when the aggregates are totally surface dry. 10 to a hour drying might be required. The aggregates ought not be presented to the climate, coordinate daylight or some other wellspring of warmth while surface drying. A delicate current of unheated air might be utilized amid the initial ten minutes to quicken the drying of aggregate surface. The surface dried aggregate is then measured W3 gm. The aggregate is set in a shallow plate and kept in a stove kept up at a temperature of 110 °C for 24 hours. It is then expelled from the stove, cooled in an impermeable compartment and measured W4 gm.

4. Two tests are done and the normal incentive to the closest entire number is accounted for as aggregate scraped area esteem.

Observation and calculation:

Weight of immersed aggregate suspended in water with the crate = W1 g
Weight of container suspended in water = W2 g
Weight of immersed aggregate in water = (W1-W2) = Ws g.
Weight of immersed surface dry aggregate in air = W3 g
Weight of broiler dried aggregate = W4 g
Weight of water equivalent to the volume of the aggregate = (W3-Ws) g
Particular Gravity = (Weight of aggregate/Weight of equivalent volume of water)
= W4/(W3-Ws)
Water absorption = percent by weight of water retained in wording stove dried weight of aggregates.
= [(W3-W4)/W4]x100

6.2 Determination of specific gravity of fine aggregates :-

Aim of the Experiment:-

To determine specific gravity of fine aggregates.

Apparatus:-

1. An adjust of limit at least 3kg, comprehensible and exact to 0.5 gm and of such a sort as to allow the weighing of the vessel containing the aggregate and water.

2. A very much ventilated oven to keep up a temperature of 100ºC to 110ºC

3. Pycnometer of around 1 littre limit having a metal funnel shaped screw top with a 6mm gap at its pinnacle. The screw top should be water tight.

4. A methods providing a current warm air.

5. A plate of region at the very least $32cm^2$.

6. A sealed shut holder sufficiently vast to take the example.

7. Channel papers and pipe.

Methodology:-

1. Take around 500g of test and place it in the pycnometer.

2. Empty refined water into it until the point when it is full.

3. Dispose of the entangled air by pivoting the pycnometer on its side, the opening in the summit of the cone being secured with a finger.

4. Wipe out the external surface of pycnometer and measure it (W)

5. Exchange the substance of the pycnometer into a plate, mind being taken to guarantee that all the aggregate is exchanged.

6. Refill the pycnometer with refined water to a similar level.

7. Discover the weight (W1)

8. Drink water from the example through a channel paper.

9. Place the example in oven in a plate at a temperature of 100ºC to 110º C for 24±0.5 hours, amid which period, it is blended every so often to encourage drying.

10. Cool the example and measure it (W2)

Observation:-

Obvious particular gravity = (weight of dry example/weight of equivalent volume of water)

=W2/(W2-(W-W2)

6.3 Determination of compressive strength of pervious concrete :-

AIM:
To determine the cube strength of the concrete of given properties

APPARATUS REQUIRED:
Moulds for the test cubes, tamping rods

PROCEDURE:
1. Calculate the material required for setting up the solid of given extents
2. Blend them completely in mechanical blender until the point when uniform shade of cement is gotten
3. Pour concrete in the oiled with a medium thickness oil. Fill concrete is 3D square forms in two layers every one of around 75mm and slamming each layer with 35 blows equally appropriated over the surface of layer.
4. Fill the moulds in 2 layers every one of around 50mm profound and slamming each layer intensely.
5. Hit off solid flush with the highest point of the moulds.
6. Promptly in the wake of being made, they ought to be secured with wet mats.
7. Examples are expelled from the moulds after 24hrs and cured in water 28 days
8. After 24hrs of casting, barrel examples are topped by flawless concrete glue 35 percent water content on topping mechanical assembly. Following 24 hours the examples are inundated into water for conclusive curing.
9. Pressure trial of 3D square and barrel examples are made when practicable after expulsion from curing pit. Test-example amid the time of their expulsion from the curing pit and till testing, are kept damp by a downer covering and tried in a clammy condition.
10. Place the example halfway on the area characteristics of the pressure testing machine and load is connected ceaselessly, consistently and without stun.
11. Additionally take note of the sort of failure and appearance breaks.

6.4 Determination of flexural strength of pervious concrete :-

AIM:

To determine the strength of the concrete by using flexure test

APPARATUS REQUIRED:

Prism mould, compression testing machine

.

PROCEDURE.

1. Test examples are put away in water at a temperature of 24 to 30 degree Celsius for 48 hours before testing. They are tried quickly on expulsion from the water while they are as yet wet condition.
2. The measurement of every example ought to be noted before testing.
3. The bearing surface of the supporting and loading rollers is wiped and clean, and any free sand or other material expelled from the surfaces of the example where they are to reach the rollers.
4. The example is then put in the machine in such way that the load is connected to the upper most surface as cast in the shape
5. The pivot of example is deliberately lined up with the hub of the loading gadget. No pressing is utilized between the bearing surfaces of the example and rollers.
6. The load is connected without stun and expanding constantly at a rate of the example. The rate of loading is 4kN/min for the 15cm example and 18 kN/min for the 10cm example.
7. The load is expanded until the point when the example fizzles and the most extreme load connected to the example amid the test is recorded

CHAPTER 7

CASTING AND TESTING

7.1 Cement

Ordinary Portland concrete, 43 Grade fitting in with IS: 269 – 1976. Normal Portland bond, 43Gradewas 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. The kind of concrete influences the rate of hydration, with the goal that the qualities at early ages can be impressively affected by the specific bond utilized. It is likewise vital to guarantee similarity of the concoction and mineral admixtures with concrete.

7.2 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. Notwithstanding bond glue – aggregate proportion, aggregate compose impacts concrete dimensional soundness.

7.3 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.

7.4 Water

Casting and curing of examples were finished with the consumable water that is accessible in the school premises.

7.5 Casting process

7.5.1 Size of Test Specimens

Test specimens cubical in shape shall be 15 X 15 X 15 cm.If the largest nominal size of the aggregate does not exceed 2 cm, 10 cm cubes may be used as an alternative. Similarly for beams the size of moulds used was 50 cm X 10 cm X 10 cm. Cubes were casted to perform check on compressive strength of pervious concrete while beams were casted to check the flexural strength of pervious concrete.

7.5.2 Preparation of Moulds

Prier to mixing and casting of specimen one of the most important and time consuming work is preparation of moulds. Moulds should be prepared such that all surfaces of moulds are cleaned and oiled properly and all the bolts are tightened so that it shall not allow any leakage of mortar.

Fig 7.5.2.1: Surface cleaned and Oiled Moulds

Special care should be taken while applying oil. Excessive amount of oil can lead to presence of bug holes on the surface of concrete after demoulding. A suitable brush or cloth should be used while applying oil on the surface of moulds. Also type of oil used is very important as the purpose of oil is to provide necessary lubrication so that concrete may not stick to the surface of moulds and it should be easy to demould the specimen. If suitable oil is not used then it may break your specimens and whole procedure is to be repeated again. The oil used in this study was Waste Black Oil easily available at any workshop at no cost or very minimal charges.

7.5.3 Mixing

All of the mixing of concrete was done by hand mixing only. All of the ingredients of Pervious Concrete like cement, coarse aggregate and fine aggregate were first weighed as per mix design proportion and then mixed on floor which was prepared for saturated surface dry condition so that floor shall not absorb any water from the mix neither shall it release more water into the mix. All 3 ingredients of Pervious Concrete were first mixed in dry condition so that all aggregates were properly mixed with cement in order to have homogeneous mixture as shown in figure 6.2 below.

Fig 7.5.3.1: Homogeneous dry mix

After the homogeneous dry mix was obtained, water was added into the mix. 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.

Fig 7.5.3.2: Homogeneous wet mix after adding water

After the mixing of concrete, well cleaned and oiled moulds were filled with concrete and hand compacted. Here, Table Vibrator is not recommended as it was noted that under effect of vibration cement slurry settles down and makes the concrete impervious. Each mould was filled in three layers and hand compacted after each layer with help of tamping road.

(A) Beam moulds prior to filling of concrete

(B) Concrete filled in layers in cube moulds
Fig 7.5.3.3: Placing and compaction of concrete in moulds

After the mould was completely filled and compacted, the top surface of concrete was levelled and any excessive concrete was removed to provide specimen a well finished surface with help of trowel.

(A)

(B)

(C) Levelling and finishing of surface of beams
Fig 7.5.3.4: Levelling (A) and finishing (B) of top surface of concrete

After the moulds were filled with concrete and levelled, the specimens were left for 24 hours before demoulding so that concrete achieves its hardening. After 24 hours of casting, the cubes were demoulded on very next day without any delay

Fig 7.5.3.5: Specimen kept for 24 hours prior to demoulding

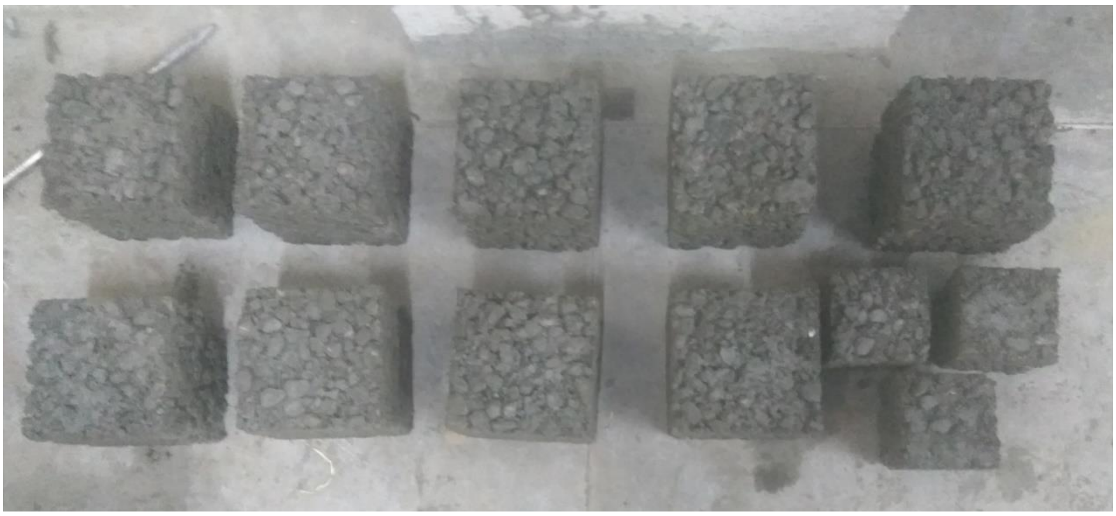


Fig 7.5.3.6: Demoulded cubes

Once all the specimens were demoulded, they were left for curing in water 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 (fig 6.8) to remember the type of mix.

Fig 7.5.3.7: Curing of cube Specimen in ambient conditions

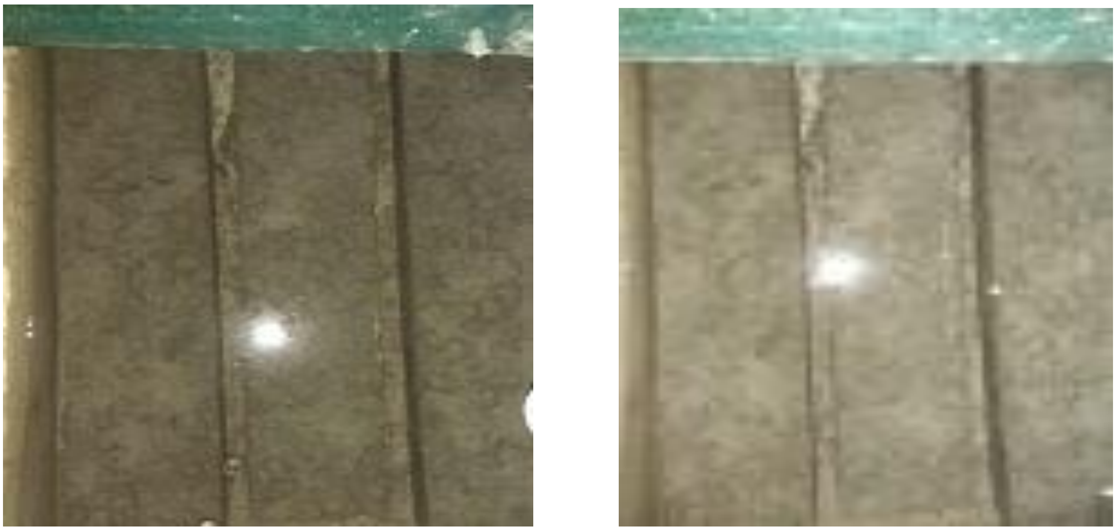


Fig 7.5.3.8: Curing of beam Specimen in ambient conditions

7.6 TESTING OF SPECIMENS:

All the specimen were tested as per directions given in IS 516 (1959). To check compressive strength of concrete using Pervious Concrete cubes, Compression Testing Machine was used where as to perform check on Flexural Strength of beams, Flexural Testing Machine was used. The load for compression testing machine was set as specified in IS 516 i.e. 140 kg/ sqcm / minute. The load shall be applied slowly without shock and increased continuously until the resistance of specimen (Concrete Cube) to increasing load breaks.

Calculation of Load:

Load as per IS Code = 140 kg/sqcm/min

1 Kg = 9.81 N

1000 N = 1 KN

∴ (140 x 9.81 / 1000) = 1.373 KN

1 min = 60 seconds

But load specified in IS 516 is in kg/sqcm/minute

∴ 1.373 x surface area of cube

= (1.373 x 15 x 15) / 60

= 5.148 kn/sec

Similarly, for flexural Strength test, load specified in IS 516 = 180kg/min for 10cm beams that comes out to be 29.42N/sec.

Fig 7.6.1: Compression Testing Machine

Fig 7.6.2: Placing of cube specimen

Fig 7.6.3: Flexural Testing Machine

(A)

(B)

Fig 7.6.4: (A) and (B) shows the placing of beam specimen

CHAPTER 8
TEST RESULTS

8.1 Specific gravity and water absorption result of coarse aggregate :-

Specific Gravity = (Weight of aggregate/Weight of equal volume of water)
= W4/ (W3-Ws)

Water absorption = percent by weight of water absorbed in terms oven dried weight of aggregates.

= [(W3-W4) / W4]x100

Sr. No.	Description	No. of observations	
		1	2
1.	Weight of saturated aggregate suspended in water with the basket = W1 g	2.670	2.680
2.	Weight of basket suspended in water = W2 g	550	550
3.	Weight of saturated aggregate in water = (W1-W2) = Ws g.	2.12	2.13
4.	Weight of saturated surface dry aggregate in air = W3 g	3.377	3.370
5.	Weight of oven dried aggregate=W4 g	3.316	3.320
6.	Specific Gravity	2.63	2.67
7.	Water Absorption	1.83	1.50
8.	Mean Specific Gravity	2.65	
9.	Mean Water Absorption	1.66	

Results:
Specific gravity of given aggregate is 2.65 & Water Absorption of given aggregate is 1.66%

8.2 Specific gravity of fine aggregate result :-

Apparent specific gravity = (weight of dry sample/weight of equal volume of water)

= W2/(W2- (W-W2))

= 307.5/(307.5-(500-307.5))

=2.67

Result

Specific gravity of fine aggregate = 2.67

8.3 Compressive strength results:-

Table 8.3.1: Compressive strength of cubes using no fine aggregates (CA: FA = 5:0)

Sr. No.	Age of Cube (Days)	Weight of Cube (kg)	Density of Cube (kg/m^3)	Compressive Strength of Cube (MPa)
1.	3 days	7.310	2166	6.90
2.	3 days	7.330	2172	7.60
3.	3 days	7.310	2166	7.40
4.	7 days	7.310	2166	8.20
5.	7 days	7.300	2163	8.80
6.	7 days	7.330	2172	9.40
7.	28 days	7.320	2169	10.55
8.	28 days	7.320	2169	11.30
9.	28 days	7.330	2172	11.90

Table 8.3.2: Compressive strength of cube using fine aggregates (CA: FA = 4:1)

Sr.No.	Age of Cube (Days)	Weight of Cube (kg)	Density of Cube (kg/m^3)	Compressive Strength of Cube (MPa)
1.	3 days	7.610	2256	8.53
2.	3 days	7.630	2260	8.88
3.	3 days	7.610	2256	8.10
4.	7 days	7.610	2256	11.87
5.	7 days	7.600	2254	11.82
6.	7 days	7.630	2260	12.88
7.	28 days	7.620	2258	13.55
8.	28 days	7.620	2258	15.70
9.	28 days	7.630	2260	16.66

Table 8.3.3: Compressive strength of cube using fine aggregates (CA: FA = 3:2)

Sr.No.	Age of Cube (Days)	Weight of Cube (kg)	Density of Cube (kg/m^3)	Compressive Strength of Cube (MPa)
1.	3 days	7.980	2364	18.00
2.	3 days	7.940	2352	17.82
3.	3 days	7.980	2364	18.10
4.	7 days	7.980	2364	33.64
5.	7 days	7.970	2361	32.26
6.	7 days	7.990	2367	33.82
7.	28 days	7.990	2367	42.04
8.	28 days	7.970	2361	41.91
9.	28 days	7.980	2364	41.56

8.4 Flexural strength results:-

Table 8.4.1: Flexural strength of beams using no fine aggregates (CA: FA = 5:0)

Sr. No.	Age of Beam (Days)	Weight of Beam (kg)	Density of Beam (kg/m^3)	Flexural Strength of Beam (MPa)
1.	7 days	10.100	2020	2.76
2.	7 days	10.230	2046	2.73
3.	7 days	10.410	2082	3
4.	28 days	10.220	2044	2.99
5.	28 days	10.300	2060	3.26
6.	28 days	10.420	2084	3.5

Table 8.4.2 Flexural strength of beams using fine aggregates (CA: FA = 4:1)

Sr. No.	Age of Beam (Days)	Weight of Beam (kg)	Density of Beam (kg/m^3)	Flexural Strength of Beam (MPa)
1.	7 days	10.250	2050	4
2.	7 days	10.210	2042	3.25
3.	7 days	10.090	2018	3
4.	28 days	10.240	2048	4.20
5.	28 days	10.260	2052	4.30
6.	28 days	10.220	2044	3.90

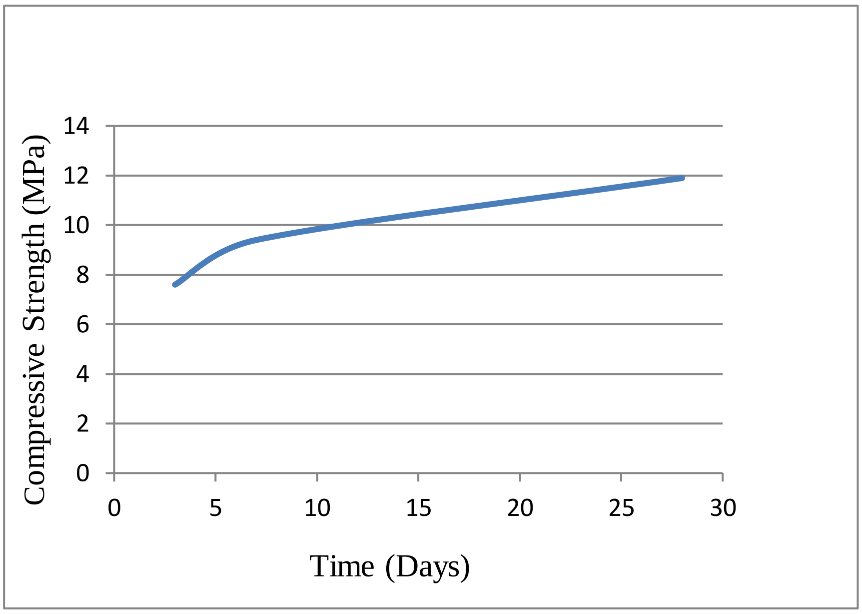
Table 8.4.3 Flexural strength of beams using fine aggregates (CA: FA = 3:2)

Sr. No.	Age of Beam (Days)	Weight of Beam (kg)	Density of Beam (kg/m^3)	Flexural Strength of Beam (MPa)
1.	7 days	10.840	2168	4.6
2.	7 days	10.720	2144	4.5
3.	7 days	10.350	2070	4
4.	28 days	10.440	2088	6
5.	28 days	10.360	2072	5.75
6.	28 days	10.400	2080	5

8.5 Graphs:-

8.5.1 Compressive strength

A) Sample 1 (for CA: FA = 5:0)



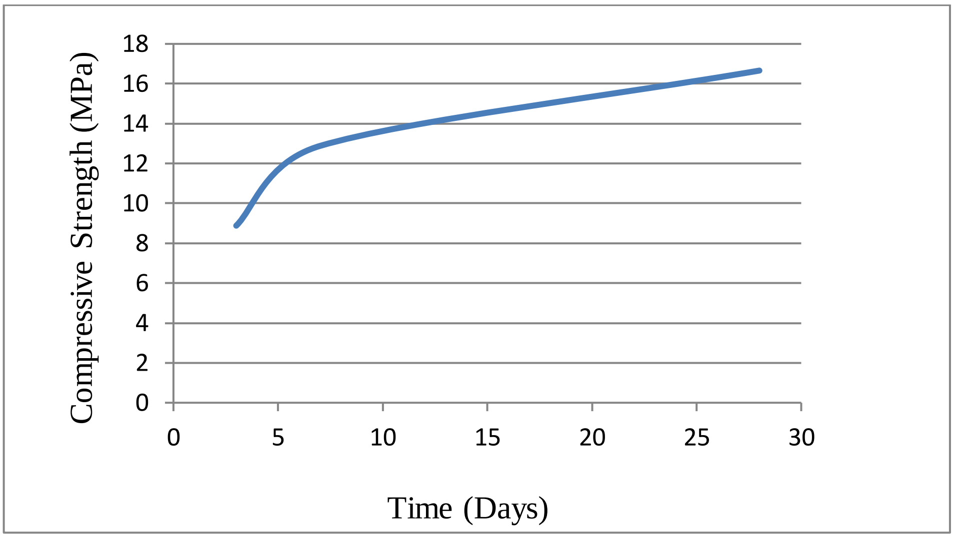
Graph 8.5.1.1: Compressive strength graph for sample 1

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.

Table 8.5.1.1: Compressive strength value for sample 1

Time (Days)	Compressive Strength (MPa)
3	7.6
7	9.4
28	11.9

B) Sample 2 (for CA: FA = 4:1)



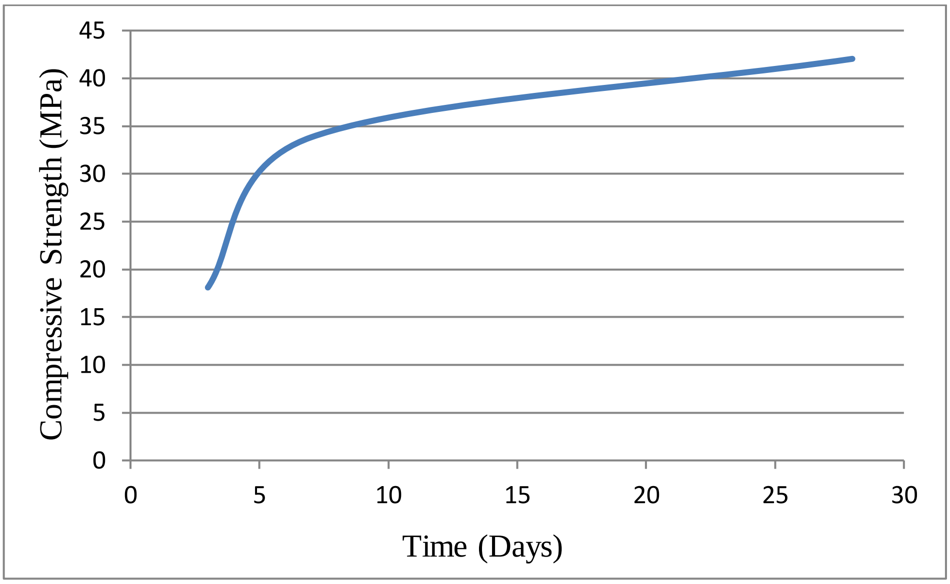
Graph 8.5.1.2: Compressive strength graph for sample 2

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.

Table 8.5.1.2: Compressive strength value for sample 2

Time (Days)	Compressive Strength (MPa)
3	8.88
7	12.88
28	16.66

C) Sample 3 (for CA: FA = 3:2)



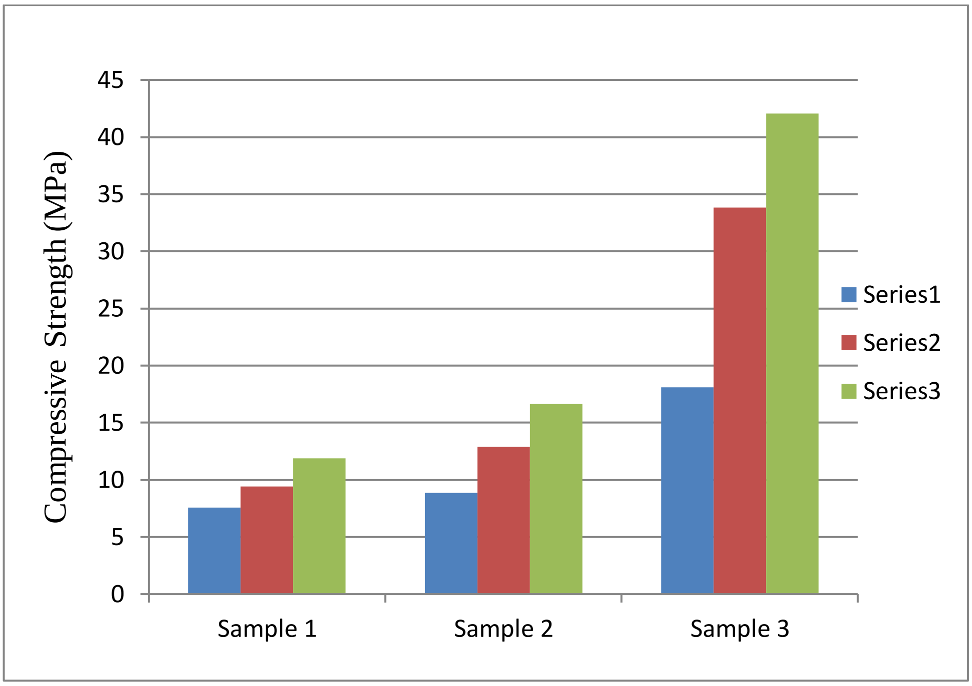
Graph 8.5.1.3: Compressive strength graph for sample 3

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.

Table 8.5.1.3: Compressive strength value for sample 3

Time (Days)	Compressive Strength (MPa)
3	18.1
7	33.82
28	42.04

D) Comparison for compressive strength

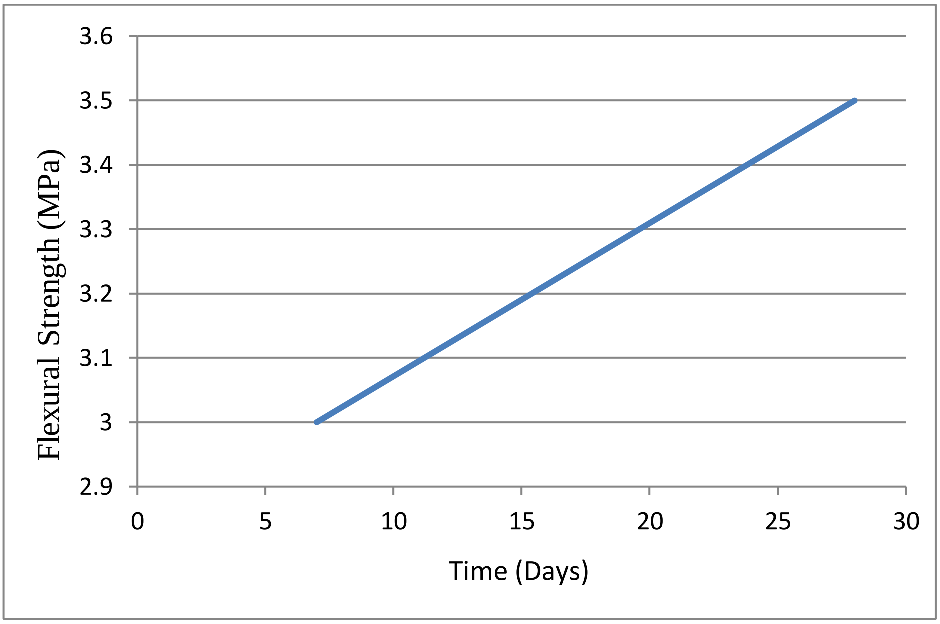


Graph 8.5.1.4: Compressive strength comparison graph

This graph shows the sample1, sample2, and sample3, therefore compressive strength increases from sample 1 to sample 3. Sample 3 shows higher compressive strength as compare to other two samples. And sample 1 shows lower compressive strength as compare to other two sample, but sample 2 having higher compressive strength than sample1 and lower compressive strength than sample 3.

8.5.2 Flexural Strength

A) Sample 1 (for CA: FA = 5:0)



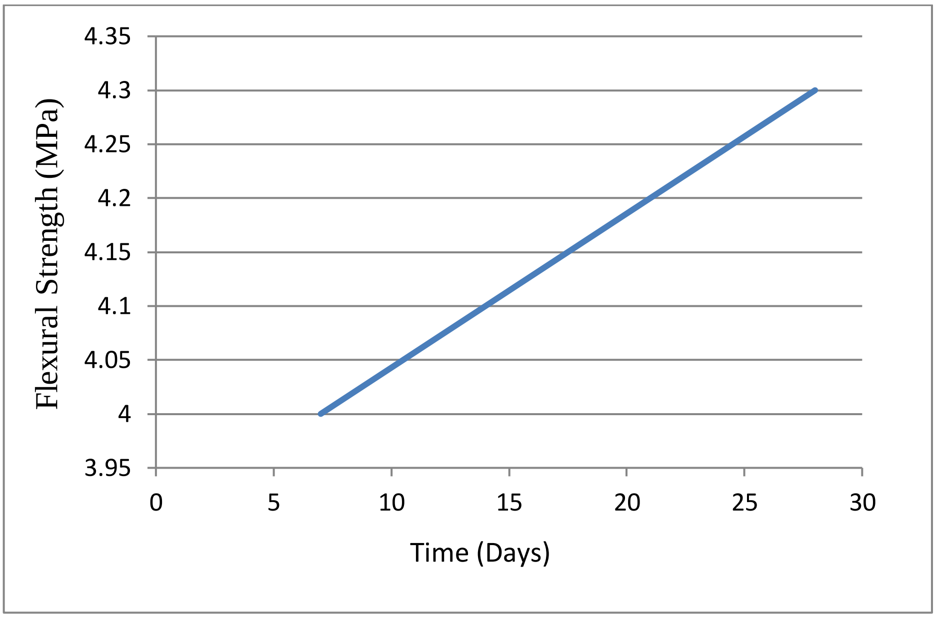
Graph 8.5.2.1: Flexural strength graph for sample 1

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 sample.

Table 8.5.2.1: Flexural strength value for sample 1

Time (Days)	Flexural Strength (MPa)
7	3
28	3.5

B) Sample 2 (for CA: FA = 4:1)



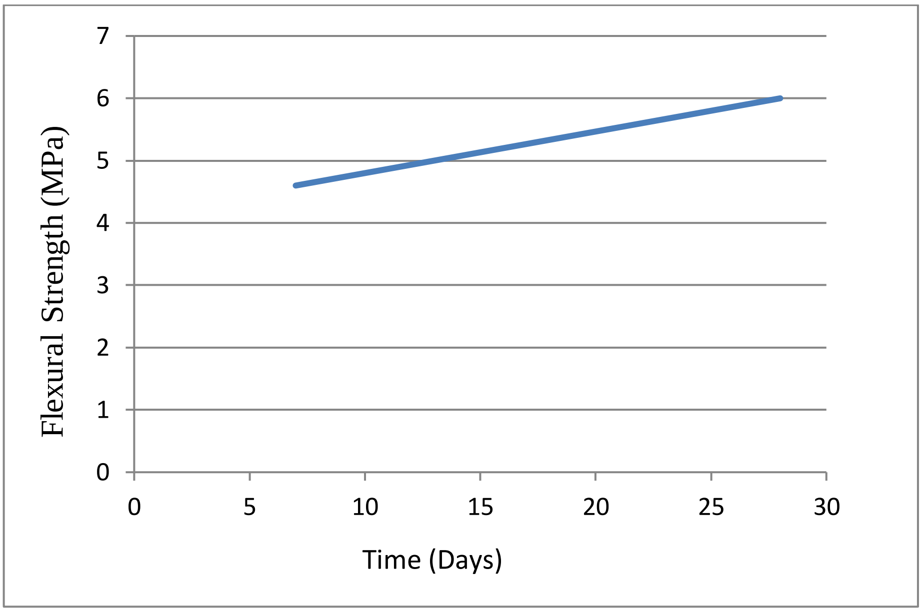
Graph 8.5.2.2: Flexural strength graph for sample 2

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.

Table 8.5.2.2: Flexural strength value for sample 2

Time (Days)	Flexural Strength (MPa)
7	4
28	4.3

C) Sample 3 (for CA: FA = 3:2)



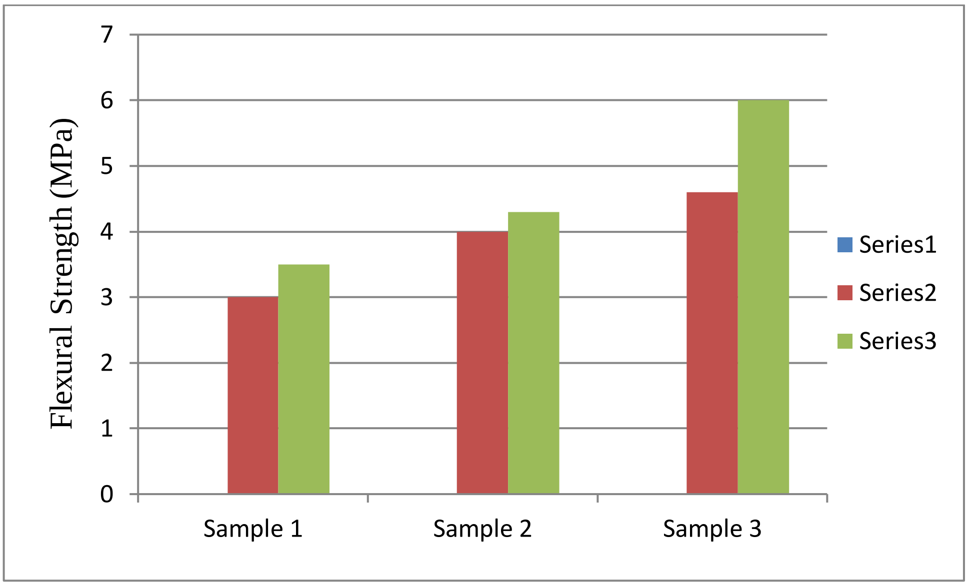
Graph 8.5.2.3: Flexural strength graph for sample 3

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.

Table 8.5.2.3: Flexural strength value for sample 3

Time (Days)	Flexural Strength (MPa)
7	4.6
28	6

D) Comparison for flexural strength



Graph 8.5.2.4: Flexural strength comparison graph

This graph shows the sample1, sample2, and sample3, therefore flexural strength increases from sample 1 to sample 3. Sample 3 shows higher flexural strength as compare to other two samples. And sample 1 shows lower flexural strength as compare to other two sample, but sample 2 having higher flexural strength than sample1 and lower flexural strength than sample 3.

CHAPTER 9
DISCUSSION

9.1 Compressive Strength :-

3 Days:
Experimental observations establish a increase in the compressive strength of M20 grade (from ratio 5:0 to 3:2 of CA:FA) of pervious concrete by 13.8%.

7 Days:
Experimental observations establish a increase in the compressive strength of M20 grade (from ratio 5:0 to 3:2 of CA:FA) of pervious concrete by 25.9%.

28 Days:
Experimental observations establish a increase in the compressive strength of M20 grade (from ratio 5:0 to 3:2 of CA:FA) of pervious concrete by 54.8%.

From the compressive strength results we found that compressive strength increases from ratio 5:0 to 3:2 of coarse aggregate and fine aggregate. Compressive strength of pervious concrete is lower than of conventional concrete. At ratio 4:1 sample shows the porosity and good compressive strength. Strength also increases from 3 days to 28 days. It means strength is directly proportional to time.

9.2 Flexural Strength :-

7 Days:
Experimental observations establish a increase in the flexural strength of M20 grade (from ratio 5:0 to 3:2 of CA:FA) of pervious concrete by 10.7%.

28 Days:
Experimental observations establish a increase in the flexural strength of M20 grade (from ratio 5:0 to 3:2 of CA:FA) of pervious concrete by 21.4%.

From the flexural strength results we found that flexural strength increases from ratio 5:0 to 3:2 of coarse aggregate and fine aggregate. Flexural strength of pervious concrete is lower than of conventional concrete. At ratio 4:1 sample shows the porosity and good flexural strength. Strength also increases from 3 days to 28 days. It means strength is directly proportional to time.

CHAPTER 10
CONCLUSION

From this study several conclusion were made to successfully develop Pervious Concrete of desired physical and Mechanical properties. All of those conclusions are as listed as under:-

1 It was found that content of cement is very important aspect to be considered while designing Pervious Concrete. Excessive amount of cement will form cement slurry when mixed with water and will settle down after the concrete has been placed into the moulds thereby making the base of concrete impervious.

2. It was also found that as the mixture is unable to retain/ hold water while mixing therefore concrete mixer is recommended for heavy concreting. However for small scale work for eg. lab work, Steel or Iron Mixing Tray can be used in order to avoid loss of water.

3. Thirdly, Table Vibrator or any other vibratory compaction method shall not be used while compacting Pervious Concrete as vibration leads to gravitational settlement of cement slurry again making the base of specimen impervious. Only Hand Compaction is recommended as per this study.

4. While oiling the cubes excessive oil should be prevented on the surface of moulds as it leads to formation of bug holes on the surface of concrete cubes. Type of oil used should be checked for its lubricating properties. Oil should not be sticky rather it should be oily. Motor Vehicle Black Oil is recommended in this study.

5. Out of three different mixes on different proportion of cement ie. 479kg/m^3, 446kg/m^3 and 384kg/m^3 it was found that specimens having cement quantity as 384kg/m^3 had greater permeability.

6. Three different mixes were prepared having cement content as 384kg/m^3 of cement – Mix1 having 0% sand, Mix 2 having 15.02% sand and Mix 3 having 30.22% sand. It was found that first two mixes had good permeability while the third mix was impermeable. Out of first two mixes second mix is recommended as it had considerable permeability and good compressive strength as compared to Mix 1 specimens.

7. Lastly, it was concluded that proportion of fine aggregate can be used in development of Pervious Concrete not exceeding 15% in proportion of mix by weight.

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