Study on Reactive Powder of Concrete by Partial Replacement of Cement in Addition With Steel Fiber

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Abstract: ***The main objective of this investigate is to utilize the reactive powder in normal concrete to obtain strength by fully replacement of natural sand to artificial sand to reducing the lack Over excavation of sand pose a serious environmental challenge'. A decade ago sand was a freely available material, with the growth of construction activities the importance of sand has grown, and it has become increasingly expensive. In recent years in India, sand mining has become more widespread and mechanized. The concept of seasonal sand mining is vanishing and mining activities go on in almost every season. Many riverbeds and streambeds are completely denuded of sand, prompting construction companies to look for alternatives to sand such as stone powder. The demand for sand has expanded sand mining in such an uncontrolled manner that it has come under the control of powerful interests with political connections referred to by the press as the 'sand mafia'. The 'sand mafia' has attacked people who have stood in their way, including activists, journalists, administrative officials and police. Some of these attacks, which have occurred across the country, have resulted in deaths. This paper summarizes that the research work on the behavior of concrete while adding of reactive powder of concrete by partial replacement of cement in addition with steel fiber by using test like Compression strength test, Split Tensile Strength test. The experimental investigation gives results that the test results are increasing their strength values up to some initial Percentage replacement of cement by RPC and further replacement are carried out then strength results are falling down.***

Key words: *Cement, Reactive powder, steel fibers, Workability, Compression strength test, Split Tensile Strength test.*

1. INTRODUCTION:-

RPC was first developed by P. Richard and M. Cheyrezy.RPC was first produced in the early 1990's by researchers at Bouygues laboratory in France and the world's first RPC structure, the Sherbrook Bridge in Canada was constructed in July 1997. Concrete is a critical material for the construction of infrastructure facilities throughout the world. A new material known as reactive powder concrete (RPC) is becoming available that differs significantly from traditional concretes. RPC has no large aggregates, and contains small steel fibers that provide additional strength and in some cases can replace traditional mild steel reinforcement. Due to its high density and lack of aggregates, ultrasonic inspections at frequencies ten to twenty times that of traditional concrete inspections are possible.

1.2 Need of study

Within the last decades in civil engineering materials stream, high strength and high performance ingredients have an increasing trend in structural applications .Presently, researches on concrete have revealed for attaining higher performances. Waterenvironment and Nano structural network in a reactive powder concrete. Cement and Concrete Composites to achieve High strength concrete (HSC). HSC is defined as a concrete that has higher durability and strength. Application of artificial neural networks to predict compressive strength of high strength concrete. That meets special combination of uniformity and performance requirements as compared to the conventional concrete that cannot be achieved routinely using conventional ingredients, mixing, placing as well as curing procedures. Predicting the compressive strength and slump of high strength concrete using neural network. Due to significant advances in technological applications, high-performance concrete (HPC) is superior to conventional concrete in terms of density and micro-structure via a refined mixing scheme.

Moreover, ultra-high performance concrete (UHPC) has become a new focus for researchers and the concrete industry since it is characterized by high compressive strength and excellent durability properties. These days, the most widely used UHPC is the so-called Reactive Powder Concrete (RPC) and its derivatives & It became a focus of concern as an alternative to conventional concrete and even steel that has been widely used in engineering practice as a new kind of structural material. To improve the strength, serviceability, and safety of UHPC, nanotechnology principles were applied. Furthermore, for cost reduction and structural aesthetic enhancement, improvements in the compressive strength have allowed concrete structural member size and self-weight to be significantly reduced. Ultra- high strength concrete (UHSC) and reactive powder concrete (RPC) were among many UHPCs currently available on the market. Reactive powder concrete (RPC) is first developed in France as a new type of ultrahigh strength concrete to offer mechanical and durability related advantages from crushed quartz (excluding the coarse aggregate), cement, quartz powder, silica fume, super plasticizer, and steel fiber. Its application has been increasing for works that need high class of concrete such as in bridge and military engineering works. RPC is made from fine matrix with short steel fibersand is characterized by high doses of fine-grained cement and a low water–cement ratio. As compared to ordinary cement-based materials, the primary improvements of RPC include the particle size homogeneity, porosity, and microstructures. RPC is characterized by high silica fume content and very low water to cement ratio. Reactive Powder Concrete is developed by the combined effort of three companies namely Bouygues, Lafarge and Rhodia working in France with 170–230 MPa compressive strength and 25–60 MPa flexural strength using steel fibers, highly durable and aesthetically pleasant appearance

2.LITERATURE REVIEW:-

Infrastructure development is main criteria for any developing country. The key factor for infrastructure development is waste management in an efficient way. Control in Co2 emission and recycling waste materials need to be carried out for this healthy environment. Concrete plays a vital role in infrastructure development. Cement and fine sand are some of the main ingredients for concrete. Production of cement emits large amount of Co2 into atmosphere. Natural river sand is get depleted due to immense usages. Hence there are various experiment was carried out by the inventors for alternative supplementary cementitious material in concrete.

There are various investigation are carried on concrete for a partial percentage replacement of cement by reactive powder for various grades of concrete and also taking the Workability test, concrete strength test like compression strength test ,split tensile strength test .Due to percent Replacement there is an increase in the strength of concrete up to certain %replacement level. Also there is certain variation in the various test result due to Material properties and mixing techniques and other parameters. The following literature has been reviewed,

1) Akaram Ali, Aleem Aijaz, Mohammad Arsalan.(Mar-2018), "a study on nylon fiber reinforced concrete by partial replacement of cement with metakaolin".

This research work is done on nylon fiber reinforced concrete by partial replacement of cement with metakaolin. The nylon fiber are very useful as it has variety of applications like its high strength, durability, tensile strength but its disposal pose a serious threat in environment. In present study, various proportions of nylon fiber are added in concrete and its effect on workability, compressive strength and tensile strength is reported. The paper states that nylon fiber material of diameter 0.35mm and length of 50mm with aspect ratio of 143 will be used in different percentage from 0.5 to 1.5% by weight in cement. After adding certain properties like compressive strength, split tensile strength, flexural strength will be studied**.**

2) Jaya Saxena, Prof. Anil Saxena (February 2015), "Enhancement the Strength of Conventional Concrete by using Nylon Fiber"

In this research paper ,they have carried study of nylon fiber using in concrete they have conclusion of strength parameter as follows The test carried out at 7 days, 14 days and 28 days, the comparison is made between the conventional concrete with different proportion and with different proportion nylon fiber. The compressive strength of nylon fiber mixed with conventional concrete is increased. When we used the nylon fiber in conventional concrete in various proportions 0.2%, 0.25% and 0.3% of volume of concrete the result obtained by the compressive strength is increased. In conventional concrete, cement replaced by 10%, 20% and 30% with fly ash. The comparative study of all mixed the result obtained. In conventional concrete 10% fly ash, 90% cement, and 0.2%, 0.25% and 0.3% nylon fiber getting the good strength of concrete.

3) R. Selvaraj, R. Priyanka. (September-2015), "Reactive Powder Concrete with and without Fibers"

In this paper, the present research work an RPC in focused a utility of RPC and also to study the characteristic strength parameter with the incorporation of fibers such as sisal, coir, polypropylene and human hair as integral reinforcing material. RPC mixtures without reinforcing fibers were also studied. They have found no of Inclusions non-ferrous fibers reduce the compressive strength of concrete both in cube and cylinder strength. Inclusion of fibers drastically improves the tensile strength of RPC both in split tensile strength and flexural tensile strength. The shear strength of RPC has enhanced by the addition of fibers in RPC. Though the fibers like coir and sisal mixed in RPC, the water absorption is not increased compared to control RPC. PCs are highly workable and hence moulded to different shapes and sizes. Also, these RPCs are nailable, screwable and cuttable and therefore, this material can be used as an alternative material for wood in addition to structural uses.

4) Mr.Anjan Kumar M U, Dr. Asha Udaya Rao, Dr. Narayana Sabhahit (May-2013), "Reactive Powder Concrete Properties with Cement Replacement Using Waste Material"

This paper presents the Reactive Powder Concrete (RPC) is composed of very fine powders (cement, sand, quartz powder and silica fume), steel fibers (optional) and superplasticizer. A very dense matrix is achieved, and this compactness gives RPC ultra-high strength and durability properties. In this paper the study of, performance of reactive powder concrete without quartz powder and containing fly ash and GGBS as a replacement for cement at the percentage of 5% (RPC1), 10% (RPC2) and 15% (RPC3) by each is investigated. They have compare the results of cement replaced mixture, specimen without cement replacement (RPC) are also casted. Performance of the various mixes is tested by the compressive strength, flexure strength and modulus of elasticity. The results show improvement in compressive strength, flexural strength and modulus of elasticity in cement replaced mixes.

5) Hamid Pesaran Behbahani, Behzad Nematollahi, Majid Farasatpour. (December 2011), "Steel Fiber Reinforced Concrete: A Review."

This paper presents an overview of the mechanical properties of Steel Fiber Reinforced Concrete (SFRC), its advantages, and its applications. During the last decade's incredible development have been made in concrete technology. One of the major progresses is Fiber Reinforced Concrete (FRC) which can be defined as a composite material consisting of conventional concrete reinforced by the random dispersal of short, discontinuous, and discrete fine fibers of specific geometry. Unlike conventional reinforcing steel bars, which are specifically designed and placed in the tensile zone of the concrete member, fibers are thin, short and distributed randomly throughout the concrete member. Among all kinds of fibers which can be used as concrete reinforcement, Steel Fibers are the most popular one. The performance of the Steel Fiber Reinforced Concrete (SFRC) has shown a significant improvement in flexural strength and overall toughness compared against Conventional Reinforced Concrete. Of investigation is the behavior of concrete while adding of waste with different proportions of Hypo sludge in concrete by using tests like compressive strength and split strength. The mix design was carried out for M25 grade concrete as per IS: 10262-2009.

2.2. SUMMARY OF LITERATURE-

From above Literature Following points are to be concluded that –

1. The paper states that nylon fiber material of diameter 0.35mm and length of 50mm with aspect ratio of 143 will be used in different percentage from 0.5 to 1.5% by weight in cement.

2. The comparative study of all mixed the result obtained. In conventional concrete 10% fly ash, 90% cement, and 0.2%, 0.25% and 0.3% nylon fiber getting the good strength of concrete.

3.Inconventional concrete, cement replaced by 10%, 20% and 30% with fly ash.

4. In this paper, the present research work an RPC in focused a utility of RPC and also to study the characteristic strength parameter with the incorporation of fibers such as sisal, coir, polypropylene and human hair as integral reinforcing material.

5. In this paper the study of, performance of reactive powder concrete without quartz powder and containing fly ash and GGBS as a replacement for cement at the percentage of 5% (RPC1), 10% (RPC2) and 15% (RPC3) by each is investigated.

2.3. Objectives:

The main objective of this investigate is to utilize the reactive powder in normal concrete to obtain strength by fully replacement of natural sand to a artificial sand to reducing the lack Over excavation of sand pose a serious environmental challenge'. A decade ago sand was a freely available material, with the growth of construction activities the importance of sand has grown, and it has become increasingly expensive. In recent years in India, sand mining has become more widespread and mechanized. The concept of seasonal sand mining is vanishing and mining activities go on in almost every season. Many riverbeds and streambeds are completely denuded of sand, prompting construction companies to look for alternatives to sand such as stone powder. The demand for sand has expanded sand mining in such an uncontrolled manner that it has come under the control of powerful interests with political connections referred to by the press as the 'sand mafia'.The 'sand mafia' has attacked people who have stood in their way, including activists, journalists, administrative officials and police.

2.4 Methodology:

The Reactive powder was collected from Mumbai located at Bombay Ammonia & Chemicals Company 2nd Floor, 204/B, Neelam Centre, Hind Cycle Road, Worli, Mumbai, Maharashtra 400025. The representative samples of Reactive powder were tested in 'Bombay Ammonia & Chemicals same time when material requested with report. After testing we have got results which were matching with the chemical properties of cement. Then, mix design was prepared for M25, M30 M35 concrete according to IS 10262-2009. Test samples were prepared containing different proportions of Reactive powder and tested to get optimum strength by partial replacement of cement by Reactive powder using steel fiber and crushed sand.

3.1THEORETICAL FORMULATION-

The materials used for preparation of hypo sludge concrete were

1. Cement 2.Fine aggregates (crushed sand) 3.Coarse aggregates 4.Water 5. Reactive powder

All the materials are taken as per standard to meet the requirements to make test samples and mixed according to the mix design. The materials are described as following.

1. Cement: The cement used is an Ordinary Portland Cement (OPC). The Ordinary Portland Cement of 53 grade (OPC) conforming to IS: 12269-2013 is used.

2. Fine Aggregates (crushed Sand): Crushed stone dust falling within the grading Zone II sand, grading limits specified by IS 383 code and manufactured from the hard rock is suitable as fine aggregate in masonry mortars. Also, IS-2116 and IS 383 codes permit the use of crushed stone fine aggregate in masonry mortars. The maximum quantity of silt in sand shall not exceed 8%.

3. Coarse Aggregate: Locally available coarse aggregate having maximum size of 20 mm was used in the present work confirming to IS-383-1970.

4**. Water**-Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. In present work tap water is used for both mixing and curing and also P.H. 6.9

5.Reactive powder (Silica fume)

It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles. It is an airborne material with spherical particles less than 1 μm in diameter, the average being about 0.1 μm. This makes it approximately 100 times smaller than the average cement particle.

6. Steel fibers- It should have good aspect ratio and should be able to improve ductility. Its length 25mm. It should be straight used in this research.

4. PARAMETRIC INVESTIGATION

4.1-: Experimental Procedure:-

A mix of various grades is M25, M30 M35 was designed as per Indian Standard method and the same was used to prepare the test samples. To reduce the quantity of cement, partial replacement of cement is done with Reactive powder in 5%, 7.5% 10% and the samples were prepared. For Compressive strength test there are total 189 no. of Cubes for all grades are casted and testing is carried on 7, 14, and 28 days, for split tensile strength test 108 no of cylinders are casted for all grades and testing is done on 7days and 28 days.

Design mix proportions-

Table 4.1-Mix Proportions Of M25

Grade	M25
Proportion	1:1.96:3.19
W/c Ratio	0.50
Cement	372
Fine Aggregate	727.32
Coarse aggregate	1186.68
Water	186

Table 4.2-Mix Proportions Of M30

Grade	M30
Proportion	1:1.54:2.835
W/c Ratio	0.45
Cement	413
Fine Aggregate	648.85
Coarse aggregate	1171.33
Water	186

Table 4.3-Mix Proportions Of M35

Grade	M35
Proportion	1:1.35:2.43
W/c Ratio	0.45
Cement	488
Fine Aggregate	660.25
Coarse aggregate	1184.98
Water	220

4.2-Result and Discussion

4.2.1-Workability:-

Workability of Normal concrete and Concrete Mixed with reactive powder for various Percentages is measured beforecasting of samples. The Workability of concrete goes on decreasing as % increase of reactive powder in concrete.

a) Slump cone Test-

Following are the test result obtained from slump cone test for various grade and % replacement of cement by reactive powder

Table-4.4 Result of Workability Test (slump Cone Test)

GRADE/ %Replacement	M25	M30	M35
0%	110	95	90
5%	85	80	86
7.5%	70	65	78
10%	65	60	75

b) Compacting Factor test-Following are the test result obtained from compacting factor test for various grade and % replacement of cement by hypo sludge.

Table 4.5 Test result of workability (Compacting Factor Test)

GRADE/RPC %Replacement	**M25**	**M30**	**M35**
0%	**0.92**	**0.88**	**0.85**
5%	**0.88**	**0.84**	**0.82**
7.5%	**0.82**	**0.80**	**0.78**
10%	**0.78**	**0.75**	**0.70**

The Above test result shows the Workability of concrete by two methods mainly slump cone Test and compacting Factor Test. The following observations are to be concluded from above table 4.4 and 4.5

a) from table as increase in reactive powder %(5 to10%) in concrete the values of slump cone test and compacting factor test are to be goes on reducing.

b) As compare to the grade the values of slump cone test and compacting factor test are also reducing as grade increases.

4.2.2. Compressive Strength Test-

The below test result shows the compressive strength Test for grade M25, M30, and M35 for 7, 14 and 28 days. The following observations are to be concluded from above table 4.6 and table 4.7 to 4.8

a. For normal plain concrete, the compressive strength at 28 days is to be come as per acceptance criteria clause no.16.1 & table no 11 of IS 456-2000,

b. As the % of RPC increases from 5% to 7.5% and 1 % steel fiber the value of compressive strength are increases than the normal concrete strength for every grade of concrete.

c. When the RPC % increases 10% and 1.5 % steel fiber above 10% the values of compressive strength are goes on reducing, but for 7.5% and 1% of steel fiber replacement of RPC the values of compressive strength are more than the required grade.

d. For replacement of Natural sand into M-sand the compressive strength slightly decrease from 50 %, 75%, 100%.

Table 4.6 Test Result of Compressive Strength test for M25 Grade

M-sand %	STEEL %	DAYS	RPC IN % REPLACEMENT OF CEMENT(COMPRESSIVE)			
			0 %	5%	7.5%	10%
50	1	7	18.43	26	27.11	24.04
		14	22.76	31.38	33.34	31.76
		28	26.23	34.11	37.08	34.88
	1.5	7	18.00	23.41	25.66	24.09
		14	22.44	27	29.44	28.06
		28	26.20	31.32	33.43	31.67
75	1	7	17.65	24.22	26.55	24.04
		14	21.22	29.38	31.00	28.00
		28	26.00	33.00	35.00	32.05
	1.5	7	16.00	21.07	23.00	22.3
		14	20.14	25.33	27.44	25.66
		28	25.08	27.00	30.03	28.18
100	1	7	15.00	22.45	24.66	23.24
		14	19.06	27.12	29.54	26.87
		28	25.00	31.56	32.08	29.65
	1.5	7	14.12	21.22	22.28	21.6
		14	19.00	25.08	26.54	25.65
		28	25.02	27.55	29.00	27.65

Table 4.7 Test Result of Compressive Strength test for M30Grade

M-sand %	STEEL %	DAYS	RPC IN % REPLACEMENT OF CEMENT(COMPRESSIVE)			
			0 %	5%	7.5%	10%
50	1	7	21.00	29.45	30.03	28.11
		14	26.63	34	37.39	35.02
		28	33.89	40.99	44.00	41.37
	1.5	7	20.00	28.00	29.98	28.34
		14	25.01	33.05	35.22	33.85
		28	32.00	39.03	42.34	40.33
75	1	7	19.76	27.43	29.09	27.33
		14	24.00	32.00	35.11	33.34
		28	31.44	39.00	42.00	40.05
	1.5	7	19.00	25.54	27.04	26.06
		14	23.11	30.34	33.54	31.31
		28	31.00	37.22	39.67	38.33
100	1	7	20.00	26.34	28.46	26.98
		14	23.60	31.22	33.74	31.00
		28	32.00	37.00	40.65	37.87
	1.5	7	19.22	24.32	26.21	25.01
		14	22.08	30.00	31.03	30.04
		28	31.00	35.55	37.19	35.89

Table 4.8 Test Result of Compressive Strength test for M35 Grade

M-sand %	STEEL %	DAYS	RPC IN % REPLACEMENT OF CEMENT(COMPRESSIVE)			
			0 %	5%	7.5%	10%
50	1	7	26.00	35.00	37.65	35.64
		14	32.00	44.09	46.76	44.78
		28	36.00	47.45	49.34	48.05
	1.5	7	24.00	35.00	37.65	35.64
		14	30.00	44.09	46.76	44.78
		28	35.01	47.45	49.34	48.05
75	1	7	23.22	33.00	35.43	33.54
		14	29.42	40.11	43.00	41.08
		28	36.11	43.00	47.23	44.41
	1.5	7	23.00	31.24	33.62	32.11
		14	29.10	37.00	41.19	39.06
		28	36.04	41.31	45.86	43.42
100	1	7	22.61	30.22	32.55	31.06
		14	29.00	39.04	41.75	39.65
		28	35.57	42.00	45.87	43.06
	1.5	7	22.50	29.08	31.56	29.93
		14	28.00	37.32	38.76	37.65
		28	35.23	40.68	43.65	41.63

4.2.3 Split Tensile Strength Test

The Above test result shows the Split Tensile Strength Test for grade M25, M30, and M35 for 7and 28 days. The following observations are to be concluded from above table 4.21

a. For normal plain concrete, the Split tensile strength test on 28 days is to be come as per acceptance criteria of IS 456-2000.

b. As the % replacement of cement by RPC increases from 5% to 7.5% and 1.5% steel fiber the value of Split Tensile strength test are increases than the normal concrete strength for M25 M0 &35 grade of concrete.

c. As the % replacement of cement by RPC increases from 5% to 7.5% and 1% steel fiber the value of Split Tensile strength test are decrease than the normal concrete strength for M25 M0 &35 grade of concrete.

d. As the % replacement of cement by RPC increases to 10% the value of Split Tensile Strength test are to be decrease than the normal concrete strength for M25, M30, and M35 grade of concrete.

e. For replacement of Natural sand into M-sand the Split Tensile Strength slightly decrease from 50 %, 75%, 100%.

Table 4.9 Test Result of Split Tensile Strength Test for M25 grade

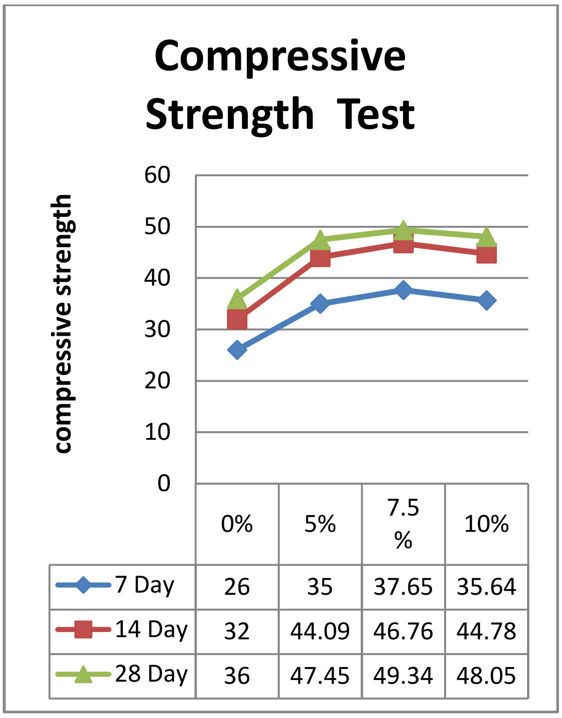
M-sand %	STEEL %	DAYS	RPC IN % REPLACEMENT OF CEMENT(COMPRESSIVE)			
			0 %	5%	7.5%	10%
50	1	7	2.10	2.39	2.67	2.53
		28	2.60	3.14	3.51	3.35
	1.5	7	2.16	2.76	2.86	2.78
		28	2.63	2.84	2.98	2.91
75	1	7	2.08	2.17	2.45	2.31
		28	2.41	2.69	3.09	2.86
	1.5	7	2.13	2.22	2.70	2.47
		28	2.43	3.31	3.65	3.54
100	1	7	2.03	2.15	2.65	2.18
		28	2.33	2.74	2.96	2.82
	1.5	7	2.05	2.26	2.49	2.34
		28	2.37	3.15	3.32	3.11

Table No 4.10 Test Result of Split Tensile Strength Test for M30 Grade

M-sand %	STEEL %	DAYS	RPC IN % REPLACEMENT OF CEMENT(COMPRESSIVE)			
			0 %	5%	**7.5%**	10%
50	1	7	2.30	2.61	2.72	2.65
		28	2.90	3.84	4.37	4.05
	1.5	7	2.36	2.80	2.99	2.82
		28	2.94	4.06	4.41	4.18
75	1	7	2.33	2.59	2.72	2.61
		28	2.92	3.73	3.96	3.81
	1.5	7	2.40	2.71	2.90	2.78
		28	2.96	3.93	4.47	4.09
100	1	7	2.28	2.34	2.66	2.56
		28	2.84	3.66	3.76	3.66
	1.5	7	2.29	2.61	2.84	2.78
		28	2.87	3.74	4.09	3.87

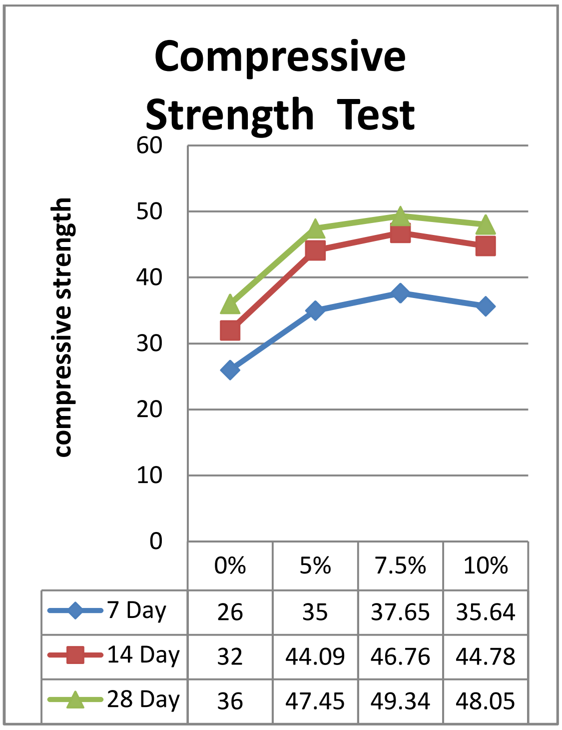
Table No 4.11 Test Result of Split Tensile Strength Test for M30 Grade

M-sand %	STEEL %	DAYS	RPC IN % REPLACEMENT OF CEMENT(COMPRESSIVE)			
			0 %	5%	7.5%	10%
50	1	7	2.71	3.36	3.76	3.49
		28	3.33	4.52	4.76	4.63
	1.5	7	2.77	3.53	3.76	3.56
		28	3.48	4.76	4.95	4.83
75	1	7	2.65	3.72	4.14	3.96
		28	3.27	4.16	4.64	4.38
	1.5	7	2.73	4.07	4.34	4.14
		28	3.37	4.32	4.75	4.45
100	1	7	2.64	2.90	3.18	2.95
		28	3.24	4.06	4.37	4.16
	1.5	7	2.68	3.04	3.23	3.11
		28	3.31	4.25	4.76	4.45



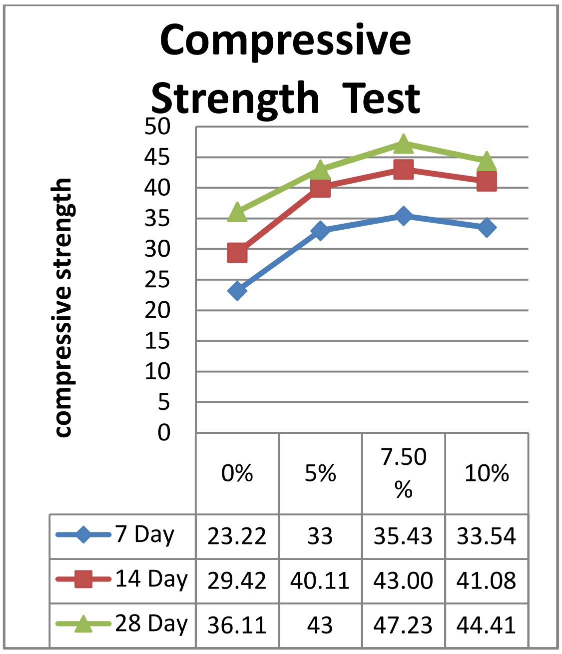
	0%	5%	7.5 %	10%
7 Day	26	35	37.65	35.64
14 Day	32	44.09	46.76	44.78
28 Day	36	47.45	49.34	48.05

Chart no 1-Chart for Compressive strength test on concrete cubes for M35 Grade having (M-Sand-50% and steel fiber-1%)



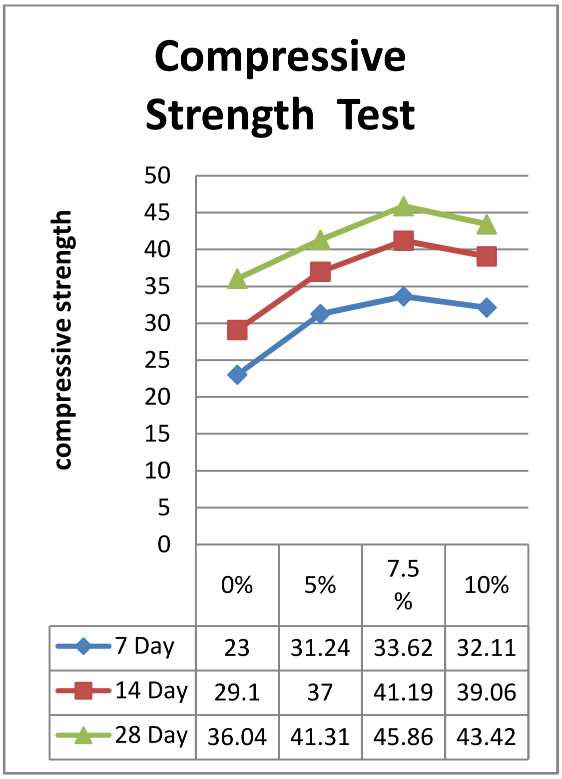
	0%	5%	7.5%	10%
7 Day	26	35	37.65	35.64
14 Day	32	44.09	46.76	44.78
28 Day	36	47.45	49.34	48.05

Chart no 2-Chart for Compressive strength test on concrete cubes for M35 Grade having (M-Sand-50% and steel fiber-1.5%)



	0%	5%	7.50 %	10%
7 Day	23.22	33	35.43	33.54
14 Day	29.42	40.11	43.00	41.08
28 Day	36.11	43	47.23	44.41

Chart no 3-Chart for Compressive strength test on concrete cubes for M35 Grade having (M-Sand-75% and steel fiber-1%)



	0%	5%	7.5 %	10%
7 Day	23	31.24	33.62	32.11
14 Day	29.1	37	41.19	39.06
28 Day	36.04	41.31	45.86	43.42

Chart no 4-Chart for Compressive strength test on concrete cubes for M35 Grade (M-Sand-75% and steel fiber-1.5%)

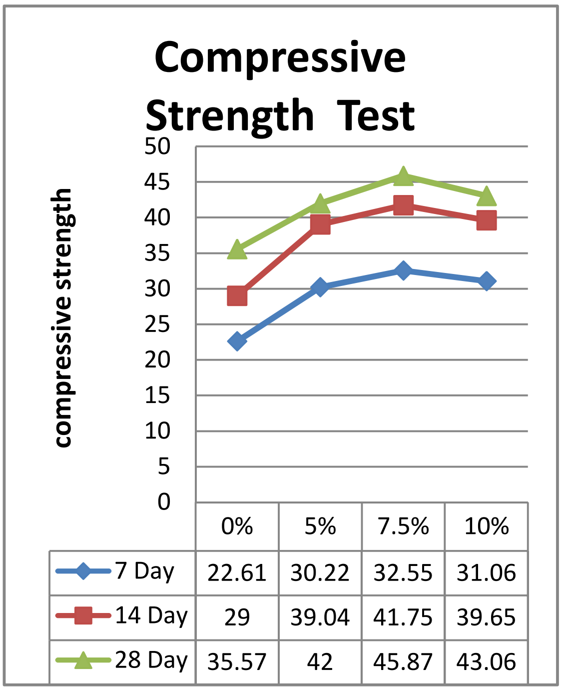


Chart no 5-Chart for Compressive strength test on concrete cubes for M35 Grade (M-Sand-100% and steel fiber-1%)

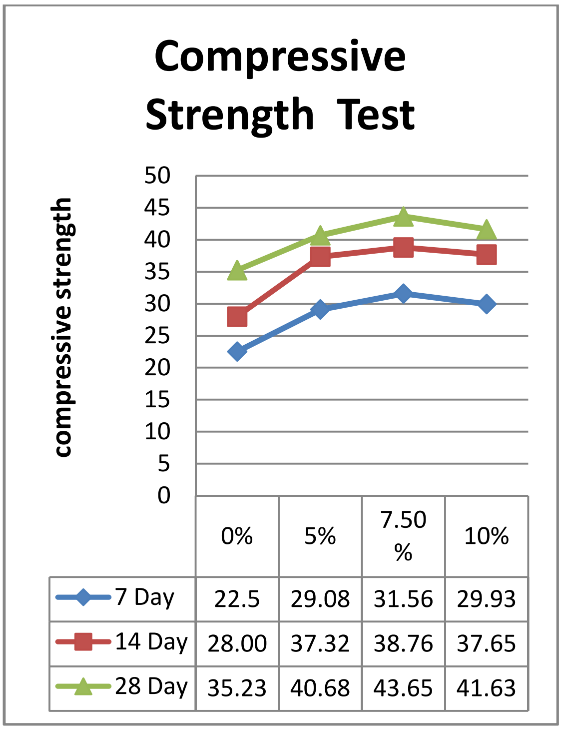


Chart no 6-Chart for Compressive strength test on concrete cubes for M35 Grade (M-Sand-100% and steel fiber-1.5%)

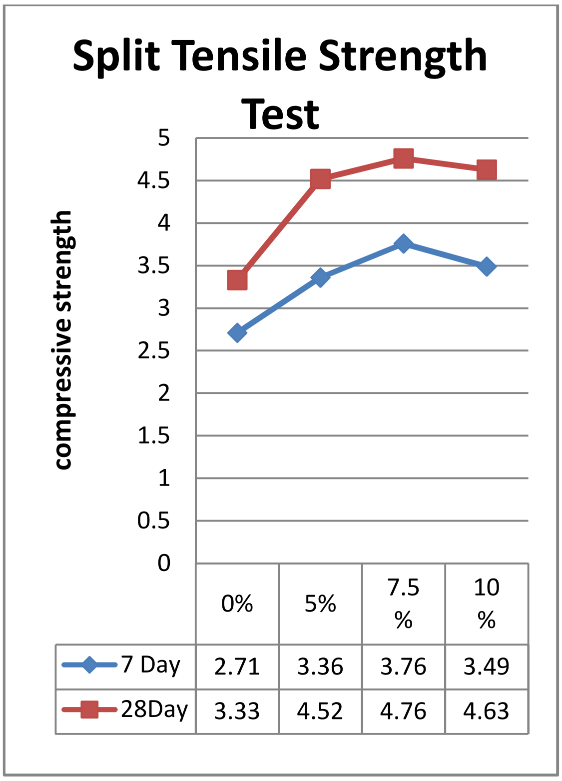


Chart no 7-Chart for Split tensile strength test on concrete cubes for M35 Grade (M-Sand-50% and steel fiber-1%)

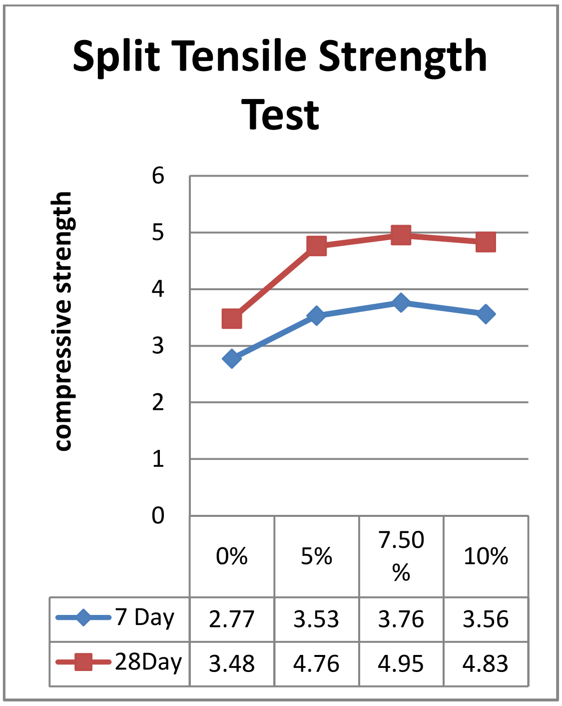


Chart no 8-Chart for Split Tensile strength test on concrete cubes for M35 Grade (M-Sand-50% and steel fiber-1.5%)

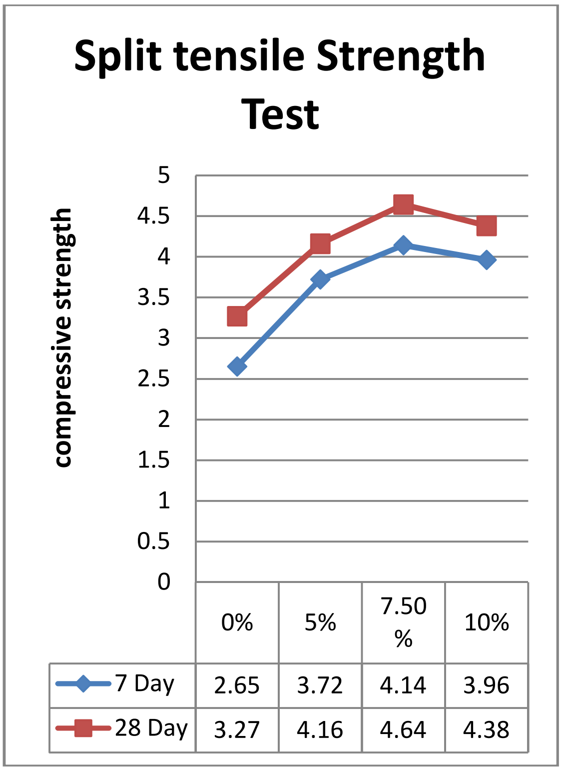


Chart no 9-Chart for Split Tensile strength test on concrete cubes for M35 Grade (M-Sand-75% and steel fiber-1%)

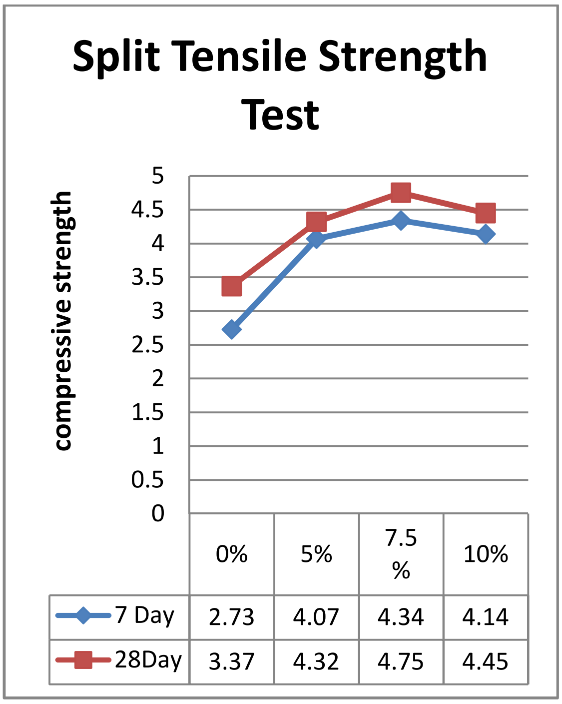


Chart no 10-Chart for Split Tensile strength test on concrete cubes for M35 Grade (M-Sand-75% and steel fiber-1.5%)

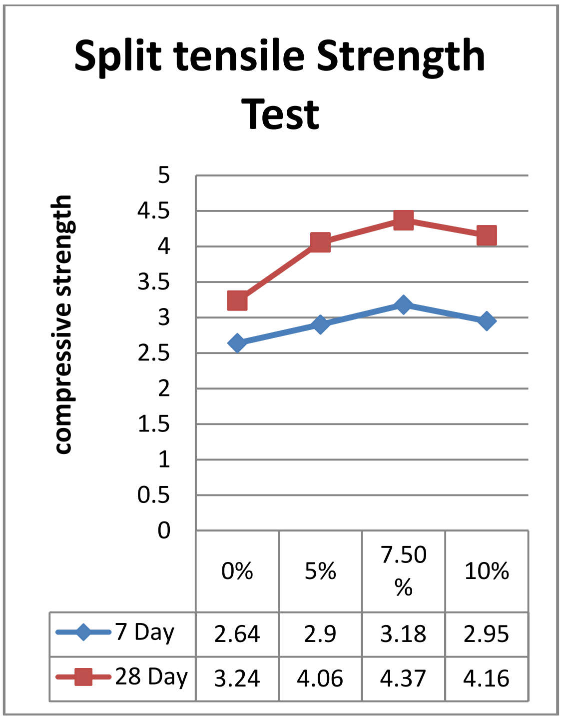


Chart no 11-Chart for Split Tensile strength test on concrete cubes for M35 Grade (M-Sand-100% and steel fiber-1%)

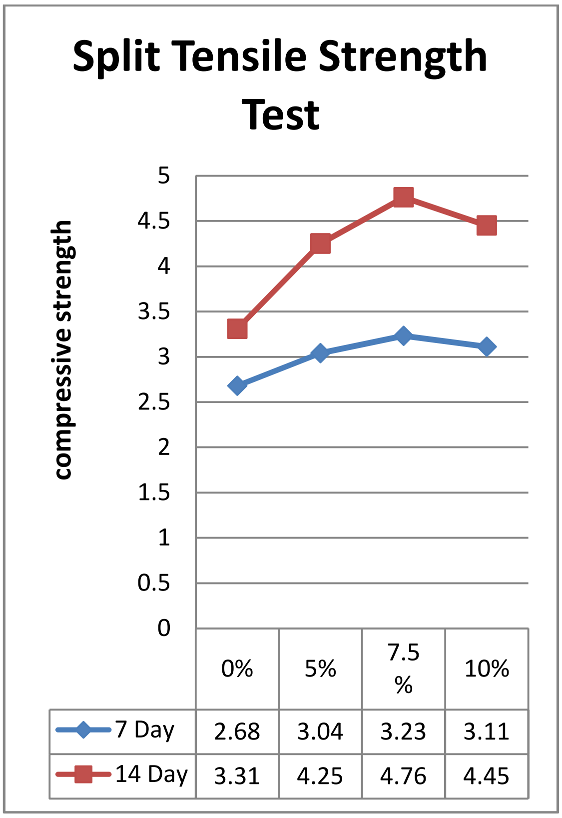


Chart no 12-Chart for Split Tensile strength test on concrete cubes for M35 Grade (M-Sand-100% and steel fiber-1.5%)

4.3 Cost Analysis-

Cost analysis is carried out for the optimum proportion of percentage of reactive powder, steel fiber & M- Sand in concrete. This project was carried out in our college campus. The cost is compared to the conventional concrete.

- **Cost Analysis For M25 Grade Concrete**

Cost of Materials

Cost of cement per bag = Rs. 340

Cost of sand per m^3 = Rs. 2200

Cost of coarse aggregate per m^3 = Rs. 720

Table-4.24 Cost Analysis of Normal Plain Concrete (M25 Grade)

Description	Qty.(kg /m^3)	Cost (Rs.)	Cost of material (Rs.)
Cement	372	6.8 /kg	2529.6
RPC	-	-	-
Sand	727.32	2200/m^3	1006.82
Coarse aggregate	1186.68	720/m^3	474.67
	Total cost=		4011.09

- **Cost of Material of 7.5%Partially Replaced Concrete/M^3**

Cost of cement per bag = Rs. 340

Cost of sand per m^3 = Rs. 2200

Cost of RPC per kg = Rs. 25/kg

Cost of coarse aggregate per m^3 = Rs. 720

Cost of steel fiber per kg = Rs. 25/kg

Table-4.24 Cost Analysis of 7.5%RPC mixed Concrete (M25)

Description	Quantity (kg/m^3)	Cost (Rs.)	Cost of material (Rs.)
Cement	334.8	5.6/kg	1874.88
RPC	37.2	0.5/kg	18.6
Sand	768.384	2116.40/m^3	1063.43
Coarse aggregate	1177.63	705.46/m^3	437.252
Total cost			3394.162

5. CONCLUSION AND FUTURE SCOPE FOR STUDY.

A) CONCLUSION

Following conclusion are drawn from experimental investigations

1. The slump decreased when a higher amount of RPC content was included. The RPC exhibited a high water-absorption capability. Consequently, when a higher amount of RPC was included in the mixture, it required more water to achieve a given Target slump.
2. Several factors could lead to adverse effects on the workability of RPC concrete. The amount of RPC replacement, RPC physical properties, and the carbon content of the RPC would be the main reasons for the reduction of concrete workability.
3. Effects of RPC on hardened concrete.

   The compressive strength value increases up to 7.5%& 1% of steel fiber replacement and above 7.5%1.5%steel fiber replacement of cement by RPC the values of compressive strength test values are decreasing.

   The split tensile test was carried out for 7 and 28 days, respectively. The values of test result are increase up to 7.5%& 1.5%steel fiber replacement and above 7.5%& 1%steel fiber replacement of cement by RPC the values of split tensile strength values are goes on reducing for thesplit tensile strength tests.
4. The increase in compressive strength spilt tensile test values with increase RPC content is due to content of Silica &Magnesia content in the RPC.
5. Using 100 % of Natural sand verses manufactured sand it causes less damage to the environment as compared to natural sand and also has better quality as compared to natural sand because it is manufactured in a controlled environment.
6. M-Sand does not contain an organic and soluble compound that affect cement setting time & it is cheaper economical and eco-friendly material.
7. Reinforcing concrete with Steel fibers results in durable concrete with a high flexural strength, improved abrasion, and spalling and impact resistance.
8. Considerably this type of concrete will be used for construction of building component effectively with less consumption of cement and natural sand 100% replace to M-Sand.
9. The concrete RPC up to 7.5% reduces the cost up to Rs. 695.5 for **M25**Grade concrete, Rs774.375. for **M30** Grade concrete &Rs. 915 for **M35** Grade concrete**.**
10. Compressive Strength for **M25** Grade concrete for normal concrete is when 100% replacement of sand 1 % steel fiber **25 N/mm2** and for optimum % of RPC is strength **32.08 N/mm2.**
11. CompressiveStrength for **M30** Grade concrete for normal concrete is when 100% replacement of sand 1 % steel fiber **32 N/mm2** and for optimum % of RPC is strength **40.65 N/mm2.**

12. CompressiveStrength for **M35** Grade concrete for normal concrete is when 100% replacement of sand 1 % steel fiber35.57 **N/mm2** and for optimum % of RPC is strength **45.87 N/mm2.**

13. Split Tensile strengthfor **M25** Grade concrete for normal concrete is when 100% replacement of sand 1.5 % steel fiber **2.37 N/mm2** and for optimum % of RPC is strength **3.32 N/mm2.**

14. Split Tensile strength for **M30** Grade concrete for normal concrete is when 100% replacement of sand 1.5 % steel fiber **2.87 N/mm2** and for optimum % of RPC is strength **4.09 N/mm2.**

15. Split Tensile strength for **M35** Grade concrete for normal concrete is when 100% replacement of sand 1.5 % steel fiber **3.31N/mm2** and for optimum % of RPC is strength **4.76 N/mm2.**

B) FUTURE SCOPE FOR STUDY

Through this study we have already come to the conclusion that RPC would be the best cementitious product to replace the cement in concrete mix. . RPC in near future is the best solution to produce the concrete and addition to that natural sand is whole replaced to manufactured sand. As the concrete forms the major component of any structure without which the structure could not be finished and also it has big financial value too. Developers now a day's looking to save the money by producing the concrete with replacement of some of its ingredient and without affecting its quality. Apart from this we should also look seriously towards the effect of fire and temperature on RPC concrete. RPC, also known as microsilica, is an amorphous polymorph of silicon dioxide, silica. It is a by-product of the carbothermic reduction of high purity quartz in electric arc furnaces in the production of silicon and ferrosilicon alloys .Already we have come across these products like fly ash which is used widely in construction industry. So we shall be rest assure that our research subject possess high significance and future of concrete belongs to the RPC.

Hence, Following Point should be considered for better performance of RPC in concrete.

1. From above conclusion for better workability test result of concrete mixed with RPC we can add the admixture like Plasticizer and super plasticizer in proper amount in concrete.
2. It has been noted that at 7.5% and above 7.5% the test results are likely to fall high dosages, particle packing is complete for the most part and excess silica fume is adding more surface area, and thus increases the water demand. The setting time can be optimized by adding alumina content.
3. This Project work has been carried out for PCC work, therefore for R.C.C work RPC.
4. Replacement of Natural sand with different proportion of M-sand as like 50 %, 75% 100% also check for 30%,60% Etc. With RPC can be carried out.
5. Improvement in the Compressive strength can be observed beyond 7.5%replacement with good quality of RPC and 100% M-sand and 1% steel.
6. Improvement in the Spilt Tensile strength can be observed beyond 7.5%replacement with good quality of

RPC and 100% M-sand And 1.5% steel.

7. Replacement of fresh coarse aggregate with different proportion of recycled coarse aggregate with RPC can be carried out.
8. Combination of fly ash and RPC with different proportion can be utilized for plain concrete or reinforced cement concrete.

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