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REPLACEMENT OF RIVER SAND BY M-SAND PARTIALLY AND COMPLETELY IN CONCRETE FOR M_{50} GRADE

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ABSTRACT

It's great to see initiatives exploring alternatives to traditional construction materials like sand. The use of manufactured sand as a substitute for natural sand in concrete has gained attention due to concerns over the environmental impact of excessive sand mining from riverbeds. Manufactured sand is one among such materials to replace river sand, which can be used as an alternative fine aggregate in mortars and concretes. Manufactured sand is a term used for aggregate materials less than 4.75mm and which are processed from crushed rock or gravel. That's a commendable project focus. Too effectively study the influence of manufactured sand on the compressive strength and durability of concrete and assess its prospects as a replacement for natural sand in India, Initially, different natural and manufactured sand samples to be used in the concrete mixes were collected and their physical properties were studied. M50 grade concrete having three mix proportions for both natural and manufactured sand (i.e. 100% RS+0% MS; 50% RS+50%MS; and 0%RS+100%MS) were prepared for concrete using a water cement ratio of 0.36 and cement contents of 450 kg/m^3. The properties of these mixes have then been assessed both at the fresh, hardened and durability state.

Keywords: Construction Material; Compressive strength; Durability, M-sand; super plasticizer (SNF);

1. INTRODUCTION

Concrete is the most widely used material of construction. A huge quantity of concrete is consumed by construction industry all over the world. Conventionally concrete is mixture of cement, sand and aggregate. Properties of aggregate affect the durability and performance of concrete, so fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river or pit sand. In India, the conventional concrete is produced by using natural sand which is obtained from the riverbeds as fine aggregate and these resources are depleting very fast. Due to various reasons good sand is not readily available and it should be transported from long distances. Transportation is a major factor in the delivered price of construction sand. Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial structures etc., to meet the requirements of globalization, in the construction of buildings and other structures concrete plays the major role and a large quantum of concrete is being utilized. River sand, which is one of the constituents used in the production of conventional concrete, has become highly expensive and also scarce. In the backdrop of such a bleak atmosphere, there is large demand for alternative materials from quarry waste. However, the intensive construction activity is resulting in a growing shortage and price increase of the natural sand in the country. It is agreed that river sand which is available today is deficient in many aspects, to use directly for concrete production.

1.2. MANUFACTURED SAND

Manufactured Sand is defined in IS 383-1980 As "Fine aggregate produced by crushing hard stone". This means that it is a controlled crusher dust which does not have more than 20% passing 150-micron sieve and not more than 15% passing 75-micron sieve. Due to the forecast shortfall in the supply of natural sands and the increased activity in the construction sector manufactured sand may play a significant role as an ingredient in concrete production.

2.OBJECTIVES

The main objectives of the project are:

To determine if a suitable workability and strength can be achieved in concrete containing manufactured sand as a partial or complete replacement for natural sand.

To perform an experimental study on Mechanical and Durability properties of concrete using M-sand.

To determine the Workability test of concrete.

To determine the Hardened properties of concrete for 28 days.

To determine the Durability properties of concrete.

To conduct a cost comparison of concrete with and without M-sand in different proportions.

3.LITERATURE REVIEW

3.1 CEMENT

Cement used in construction are sometimes named after their commonly reported place of origin, such as Roman cement, or for their resemblance to other materials, such as Portland cement, which produces a concrete resembling the Portland stone used for building in Britain. The term **cement** is derived from the Latin word **Cementum**, which is meant stone chippings such as used in Roman mortar not-the binding material itself (**Encyclopedia Britannica, 2001**). Cement, in the general sense of the word, described as a material with adhesive and cohesive properties, which make it capable of bonding mineral fragments in to a compact whole. The first step of reintroduction of cement after decline of the Roman Empire was in about 1790, when an Englishman**, Smeaton**, found that when lime containing a certain amount of clay was burnt, it would set under water. This cement resembled that which had been made by the Romans. Further investigations by J. Parker in the same decade led to the commercial production of natural hydraulic cement.

3.2 AGGREGATES

Aggregates were first considered to simply be filler for concrete to reduce the amount of cement required. However, it is now known that the type of aggregate used for concrete can have considerable effects on the plastic and hardened state properties of concrete. They can form 80% of the concrete mix so their properties are crucial to the properties of concrete. Aggregates can be broadly classified into four different categories: these are heavyweight, normal weight, light weight and ultra-lightweight aggregates. However, in most concrete practices only normal weight and lightweight aggregates are used. The other types of aggregates are for specialist uses, such as nuclear shielding provided by heavyweight concrete and thermal insulation using lightweight concrete (**Neville A.M., 1986**).

3.3 MANUFACTURED SAND (M-SAND)

Aggregate content is a factor, which has direct and far-reaching effects on both the quality and cost of concrete. Unlike water and cement, which do not alter in any particular characteristic except in the quantity in which they are used, the aggregate component is infinitely variable in terms of shape and grading. When it is required to construct a major structure, the supply of high-quality aggregate for concrete, both coarse and fine, are of extreme importance. Now looking for viable alternatives to natural sand is a must and not a necessity. Due to short of supply of natural sands and the increased activity in construction sector, the time has come, for manufactured sand to play a significant role as an ingredient in concrete.

3.4 WATER

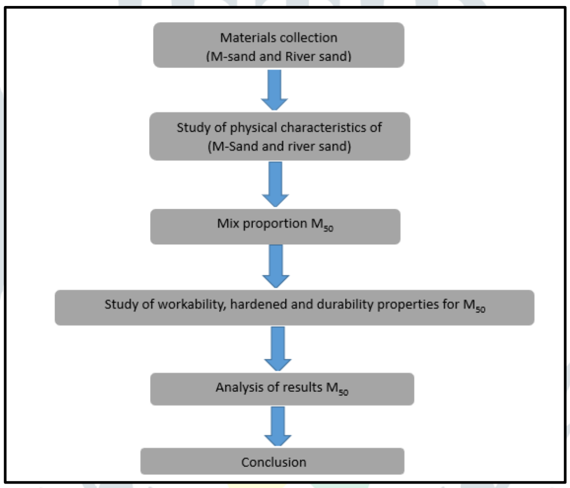
Water is a key ingredient in the manufacture of concrete. Water used in concrete mixes has two functions: the first is to react chemically with the cement, which will finally set and harden, and the second function is to lubricate all other materials and make the concrete workable (**Taylor W.H.,1977**). Although it is an important ingredient of concrete, it has little to do with the quality of concrete (**Sidney Mindess.,2003**). One of the most common causes of poor-quality concrete is the use of too much mixing water. Fundamentally "the strength of concrete is governed by the nature of the weight of water to the weight of water to the weight of cement in a mix, provided that it is plastic and workable, fully compacted, and adequately cured" (**Taylor W.H.,1977**).

3.5 ADMIXTURES

Admixtures are materials other than cement, aggregate and water that are added to concrete either before or during its mixing to alter its properties such as workability, curing temperature range, setting time or color. These days a mix without admixture are an exception. Admixture is a chemical product which is added to the concrete mix in quantities not larger than 5% by mass of cement during mixing or during an additional mixing operation prior to the placing of concrete, for the purpose of achieving a specific modification to the normal properties of concrete (**Neville A.M., 1986**). Admixtures are capable of imparting considerable physical and economic benefits with respect to concrete production. It is an established fact that the use of admixtures results in concomitant savings, for example, in the cost of labor required to effect compaction and in improving durability without the use of additional measures (**Neville A.M., 1986**).

4. METHODOLOGY

The detailed methodology of the project is represented in terms.



5. MATERIALS USED

The properties of various materials used in making the concrete are discussed in the following sections.

CEMENT - Ordinary Portland cement of 53 grade satisfying all the requirements of **IS 12269:1987** was used in making the concrete slab panels and cubes in the experimental work.

NATURAL (RIVER) SAND - The natural sand conforming to zone I as per **IS 383:1970** was used for the experimentation after washing it with clean water.

MANUFACTURED SAND - M-sand was used as partial replacement of fine aggregate. It was collected from SSV Blue metals, villupuram. The Manufactured sand conforming to zone I as per **IS 383:1970** was used for the experimentation after washing it with clean water.

COARSE AGGREGATE - Crushed stone aggregate of 20mm was obtained from local quarry site were used for the experimentation. It was collected from Hardware stores, villupuram. In order to design and make a concrete mix, the aggregates properties had to be assessed. In order to do this a number of tests were carried out on the above materials. The performed tests include: Sieve analysis, Water Absorption capacity, Specific gravity etc.

WATER - A tap water, which is free from acid and organic substance, supplied from the sewerage authority in Surya group of institutions vikravandi used for all concrete mix.

CHEMICAL ADMIXTURES -In order to improve the workability of high-performance concrete, super plasticizers in the form of Sulphated Napthalene Formaldehyde (SNF) complies with **IS 9103:1999** and **ASTM C 494** type F as a high range water reducing admixture, supplied by RHEObuild 1125(BSF) constructions was used. These super plasticizers are used from 0.8% to 1.2% of binder (cement). This had 40% active solids in solution. The specific gravity is 1.22. It is a brown liquid instantly dispensable in water. However, it was expected for this research work that larger dosages of super plasticizers would be required to achieve a suitable workability especially in the case of high proportion of manufactured sand to natural ones.

6. DESIGN MIX

6.1 DESIGN MIX

6.1.1 Mix proportion adopted:

M50 grade of concrete is designed using IS code method (**IS 10262:1982**) of mix design and proportions were obtain after applying necessary correction to suit field conditions.

6.1.2 DESIGN MIX FOR M50 GRADE

6.1.2.1 Mix series I – control concrete mix (0% replacement with M-sand)

The first mix was prepared using 53 grade Ordinary Portland cement (OPC) for normal concrete strength using a water cement ratio of 0.36 and cement content of 450 kgm^3. Admixtures were used depending on the requirement of the mix when the proportion of the manufactured sand increases. C: C.A: F.A, 1: 2.54: 1.64

Grade	w/c	Cement (kg)	C.A (kg)	F.A (kg)		Free water(kg)	Admixture
			20mm	R.S	M.S		
M50	0.36	450	1146	739	-	160	0.8% of binder

Ratio:

450 kg	1146 kg	739 kg

Fig :1 Mix proportion summary for M50 grade of concrete (0%replacement with M-sand)

6.1.2.2 Mix series II-(50% replacement with M-sand)

The second mix is also prepared using 53 grade Ordinary Portland cement (OPC) for high concrete strength using a water cement ratio of 0.36 and cement content of 450 kgm^3. The number of admixtures used is 0.8% of binder, depending on the requirement of the mix and increases with the increased percentage of manufactured sand. C: C.A: F.A, 1: 2.54:1.65

Grade	w/c	Cement	C.A	F.A		Free water	Admixture
		(kg)	20mm	R.S	M.S	(kg)	%
M50	0.36	450	1146	369	375	160	0.8% of binder

Ratio:

450kg	1146 kg	370kg 375kg 745kg

Fig: 2 Mix proportion summaries for M50 grade of concrete (50%replacement with M-sand)

6.1.2.3 Mix series III – (100% replacement with M-sand)

The third mix was prepared using 53 grade Ordinary Portland cement (OPC) for high concrete strength using a water cement ratio of 0.36 and cement content of 450 kg. The number of admixtures used is 1% of binder, depending on the requirement of the mix and increases with the increased percentage of manufactured sand. C: C.A: F.A, 1: 2.54: 1.67

Grade	w/c	Cement (kg)	C.A (kg)	F.A (kg)		Free water (kg)	Admixture
			20mm	R.S	M.S		
M50	0.36	450	1146	-	750	160	0.8% of binder

Ratio:

450kg	1146 kg	750 kg

Fig: 3 Mix proportion summaries for M50 grade of concrete (100%replacement with M-sand)

7.TESTING PROCEDURE

7.1. SLUMP TEST

Clean the internal surface of the mould and apply oil.

Place the mould on a smooth horizontal non- porous base plate.

Fill the mould with the prepared concrete mix in 4 approximately equal layers.

Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.

Remove the excess concrete and level the surface with a trowel.

Clean away the mortar or water leaked out between the mould and the base plate.

Raise the mould from the concrete immediately and slowly in vertical direction.

Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.

7.2. COMPRESSIVE STRENGTH OF CONCRETE.

Compressive strength is the capacity of a material or structure to withstand axially directed pushing forces. By definition, the compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely.

Compressive strength = Load / Area

The calcium-silicate-hydrate (C-S-H) gel is the most important cementing component of concrete. It is responsible for the engineering properties of concrete including setting, hardening and strength development, it penetrates easily in M-sand due to rough surface than river sand particles which results more strength.

During the crushing process the manufactured sand have irregular shapes and more fine particles which are filling gap between coarse particle and makes concrete solid also contributing to improved strength compared to river sand control mix. The test was carried out to obtain compressive strength of concrete at the age of 7, 14 and 28 days. The cubes were tested using Compression Testing Machine.

7.3. FLEXURAL STRENGTH OF CONCRETE

A good bond is essential for improving strength of concrete composite. The M-sand contains more micro fines as compared to river sand which provides larger area of contact also particle shape of artificial sand is cubical, angular which helps to improve frictional properties that increases flexural strength of concrete.

Flexural strength, also known as **modulus of rupture,** bend strength or fracture strength, a mechanical parameter for brittle material, is defined as a materials ability to resist deformation under load. It is measured in terms of stress. The symbol is denoted by$\boldsymbol{\sigma}$.

As per IS 516,

$$\sigma = FL / bd^2$$

Where,

F is the load (force) at the fracture point

L is the length of the support (outer) span

B is width

D is thickness

The flexural strength of concrete was determined by bending test. To find flexural strength two beam specimens of size 700 x 150 x 150 for each of the 3 mixes were tested after 28days curing under universal testing machine with two-point loading.

7.4. RAPID CHLORIDE PENETRATION TEST

Reinforced concrete structures are exposed to harsh environments yet is often expected to last with little or no repair or maintenance for long periods of time (often 100years or more). To do this, a durable structure needs to be produced. For reinforced concrete structure, one of the major forms of environmental attack is chloride ingress, which leads to corrosion of the reinforcing steel and a subsequent reduction in the strength, serviceability, and aesthetics of the structure. This may lead to early repair or premature replacement of the structure, a common method of preventing such deterioration is to prevent chlorides from penetrating the structure to the level of the reinforcing steel bar by using relatively impenetrable concrete. The ability of chloride ions to penetrate the concrete must then be known for design as well as quality control purposes. The penetration of the concrete by chloride ions, however, is a slow process. It cannot be determined directly in a time frame that would be useful as a quality control measure. Therefore, in order to assess chloride penetration, RCPT test method is used.

8. EXPERIMENTAL PROCEDURE

This test method covers the determination of the electrical conductance of concrete to provide a rapid indication of its resistance to the penetration of chloride ions. This method is applicable to concretes in which a correlation has been established between the coulomb value and the amount of chloride ingress.

Test method - The test method involves obtaining a 100mm (4 in.) diameter core or cylinder sample from the concrete being tested. A 50 mm (2 in.) specimen is cut from the sample.

The side of the cylinder specimen is coated with epoxy, and after the epoxy is dried, it is put in a vacuum chamber for 3 hours. The specimen is vacuum saturated for 1 hour and allowed to soak for 18 hours. It is then placed in the test device. The left-hand side (-) of the test cell is filled with a 3%NaCl solution. The right-hand side (+) of the test cell is filled with 0.3N NaOH solution. The system is then connected and a 60-volt potential is applied for 6 hours. Readings are taken every 30 minutes. At the end of 6 hours the sample is removed from the cell and the number of coulombs passed through the specimen is calculated.

Apparatus - Concrete specimen disc, RCPT cell and display monitor PVC tape, silicon grease, vacuum desiccators, flask, beaker de-ionized water or distilled water, boiled or de-aerated water, electronic balance.

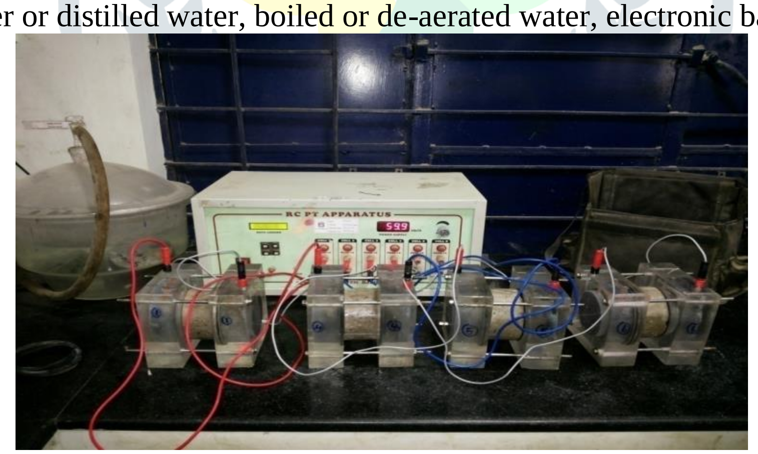


Fig: 4 Rapid Chloride Penetration Test Setup

8.1 PROCEDURE

Remove the specimen from the water, blot of excess water and transfer it to sealed container, which will maintain the 95% or higher relative humidity.

Cover exposed face of specimen with impermeable material such as rubber or plastic sheeting. Place rubber stopper in cell filling hole to restrict moisture movement.

Apply the silicon grease to the gasket and place the specimen in the RCPT cell. Insert samples and clamp the two halves of the test cell together to seal.

Fill 0.3N NaOH solution in red color cell and 3% NaCl solution in black cell.

Attach black banana pin to black plug as well as cell and red banana pin to red plug and cell.

Turn on power supply on, set to 60±volt and record initial current reading.

During the test, the air temperature around the specimens shall be maintained in the range of 68° to 77° F.

Read and record current at least every 3 min. if a voltmeter is being used in combination with a shunt resistor for the current reading.

Terminate test after 6 hour and not down the total charge passed.

The total charge passed is a measure of the electrical conductance of the concrete during the period of the test. The current is recorded at 30 min interval, the following formula, based on the trapezoidal rule can be used to calculate the average current flowing through one cell.

$$Q = 900(I0+2I30+2I60+2I90+2I120+\ldots+2I300+2I330+I360)$$

Where,

Q = current flowing through one cell (coulombs),

I_0 = current reading in amperes immediately after voltage is applied (amperes),

I_t = current reading in amperes at t minutes after voltage is applied (amperes)

9.RESULTS AND DISCUSSION

9.1 PHYSICAL PROPERTIES OF CEMENT

The physical properties of cement are shown

Specific gravity: 3.15

Normal consistency: 6mm

Initial setting time: 30 minutes

Final setting time: 5hrs 30 minutes

9.1.1 PHYSICAL PROPERTIES OF FINE AGGREGATE

Standard test	M-sand	R-sand	Test method
Specific gravity	2.69	2.65	
Water absorption (%)	2.23	1.3	
Bulk density(kg/m^3)	1877	1747	IS 2386(part III)

Fig: 5 Physical properties of fine aggregate

9.1.2 SIEVE ANALYSIS OF FINE AGGREGATE

The results of sieve analysis for manufactured sand and natural (river) sand have been presented

IS sieve Mm	Weight Retained in (g)	%Retained	Cumulative % retained	Cumulative %retained
4.75	0.015	1.5	1.5	98.5
2.36	0.170	1.7	18.5	81.5
1.18	0.245	24.5	43	57
600	0.135	13.5	56.5	43.5
300	0.170	17	73.5	26.5
150 microns	0.200	20	93.5	6.5
Pan	0.065	6.5	100	0

Fig: 6 Sieve analysis for M-sand

IS sieve mm	Weight Retained in (g)	%Retained	Cumulative % retained	Cumulative %retained
4.75	0.035	3.5	3.5	96.5
2.36	0.040	4	7.5	92.5
1.18	0.165	16.5	24	76
600	0.265	26.5	50.5	49.5
300	0.335	33.5	84	16
150 microns	0.135	13.5	97.5	2.5
Pan	0.025	2.5	100	0

Fig: 7 Sieve Analysis for R-sand

IS sieve mm	Percentage passing of Sand		Grating limits of sand
	M-sand	R-sand	
4.75	98.5	96.5	90-100
2.36	81.5	92.5	60-95
1.18	57	76	30-70
600	43.5	49.5	15-34
300	26.5	16	5-20
150 microns	6.5	2.5	0-10
Pan	0	0	0

Fig: 8 Comparison of sieve analysis of river sand with manufactured sand

NOTE: Material passing through 600-micron sieve decided the grading zone.

The results of sieve analysis, as excepted, have shown that manufactured sand has larger amount of fine materials than the natural sand. The results of all sieve analysis for all aggregate samples used in the concrete mix.

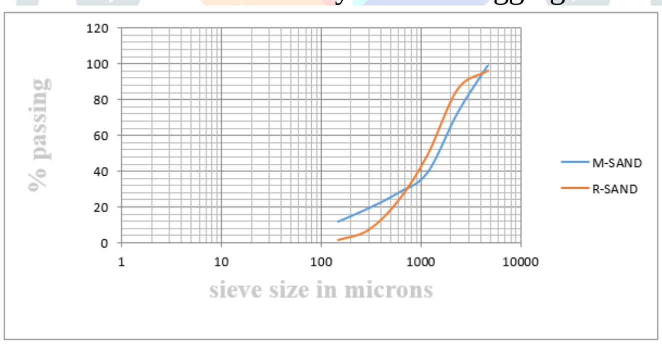


Fig: 9 Sieve analysis for natural sand and manufactured sand

9.1.3 PHYSICAL PROPERETIES OF COARSE AGGREGATE

Standard test	20mm	Test method
Specific gravity	2.74	IS 2386(part III)
Water absorption (%)	0.50	

Fig: 10 Physical properties of coarse aggregate

9.1.4 SIEVE ANALYSIS OF COARSE AGGREGATE

The result of sieve analysis for 20mm aggregate have been presented.

IS sieve	Weight retained in (g)	% retained	Cumulative % retained	Cumulative % passing
25	0.035	0.7	0.7	99.3
20	0.170	3.4	4.1	95.1
10	4.78	95.6	99.7	0.3
4.75	0.010	0.2	99.9	0.1
Pan	0.005	0.1	100	0

Fig: 11 Sieve Analysis for 20 mm coarse aggregate

9.2 FRESH CONCRETE

The results of the slump test carried out on the fresh concrete gave us an indication of the workability of the concrete. Slump retention was carried out for a period of 2 hrs. For each of the mix (control mix (0%), 50% and 100% replacement with M-sand) with 4 consecutive trials each of 30 min within the total periods of 2 hrs. The results of the slump tests carried out are tabulated below

Grade	w/c	mix	Observed slump(mm)				
			0 min	30 min	60 min	90 min	120min
M50	0.36	0%	210	190	165	120	90
		50%	200	180	170	85	-
		100%	205	195	160	90	-

Fig: 12 Fresh concrete properties (slump test results) for M50

Slump retention test carried out on the fresh concrete gave an indication of the workability of the concrete. As can be seen from the mix results for a water cement ratio of 0.36, a minimum slump of 85mm is observed, which is considered as a high workability.

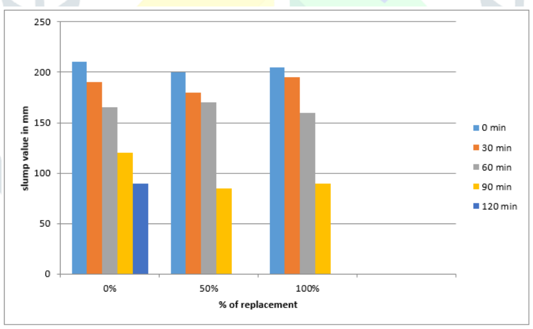


Fig: 13 Comparison of slump values with various mix proportions of M50 grade of concrete

From the above graph it is evident that usage of m-sand has greater impact in retention at about 1 hr. 30 min, which showed a sudden drop in the slump value. And it is evident that only the admixture has to use in more percentage than for a normal concrete to get required slump retention.

9.3 HARDENED CONCRETE

Mix proportions by M-sand	Compressive strength in n/mm^2		
	7days	14days	28days
0%	41.5	49.5	53.9
50%	42	52.1	57.7
100%	43.5	53	58.4

Fig: 14 Mean Compressive strength of concrete at 7th, 14th, 28th days (M50)

From the result table, it is observed that, a compressive strength of cement concrete increases after replacing a fine aggregate by manufacturing sand at 7, 14 and 28 days from the above table it is evident that all the mix ratio have satisfied the M50 grade of concrete and the result does not vary more than 15%

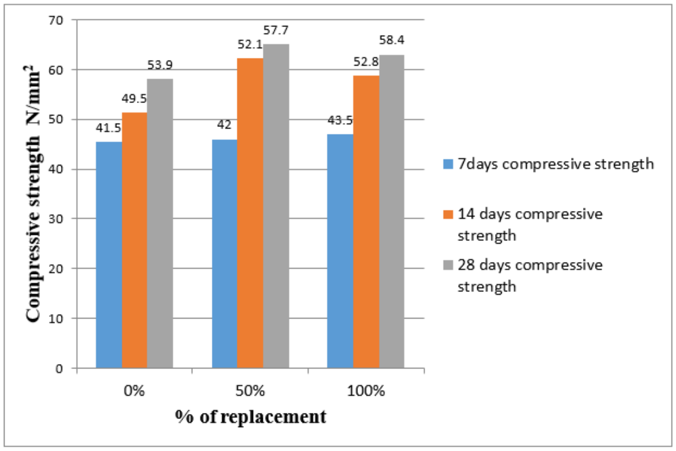


Fig: 15 Compressive strength comparison at 7th, 14th and 28th days (M50)

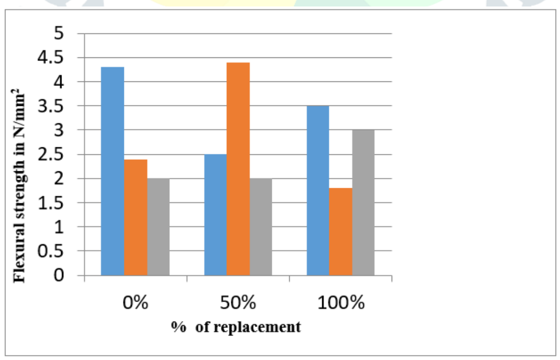
From the above graph, it can also be concluded as the 50% replacement has produced good results when compared to the other two mixes. The average flexural strength for concrete with M-sand and natural sand were reported.

S. no	Concrete mix	Grade of concrete	Minimum value 0.7 √ fck	Average modulus of rupture in n/mm^2
1.	Control	M50	4.94	6.91
2.	50%			6.8
3.	100%			6.4

Fig: 16 Mean flexural strength of concrete at 28th day (M50)

Results have demonstrated that, the flexural strength of plain cement concrete with manufactured sand as fine aggregate increased than cement concrete with natural river sand as fine aggregate. There was no crushing failure. All specimens are failed in pure bending zone, no shear cracks were seen.

From the above table it can also be concluded as that 50% replacement has produced good results in flexural strength



9.4 RAPID CHLORIDE PENETRATION TEST

Sample	28th days chloride penetrability in coulombs	remarks
	M50	
Control (0%)	4056.3	high
50%	3114.1	moderate
100%	3012.2	moderate

Fig: 17 The test results of the RCPT are tabulated as shown below

Charge passed (coulombs)	Chloride ion penetrability
>4,000	High
2,000-4,000	Moderate
1,000-2,000	Low
100-1,000	Very low
<100	Negligible

Fig: 18 RCPT ratings (per ASTM C1202)

It is evident that in controlled concrete, the chloride ion permeability is high, whereas for concrete using M-sand based mixes is medium. It may be concluded that the concrete using M-sand is durable compared to normal concrete.

RAPID CHLORIDE PENETRATION TEST TABULATION READINGS

S.NO	Control		
	SAMPLE 1		
	T	M	B
1	153	197	124
2	179	165	137
3	188	167	155
4	200	187	160
5	208	187	164
6	216	188	172
7	218	194	176
8	219	200	164
9	220	191	164
10	227	204	167
11	212	196	175
12	219	191	171
13	219	203	168
Average	4009.8		

S.NO	50%		
	SAMPLE 1		
	T	M	B
1	104	136	136
2	102	147	151
3	106	159	158
4	120	164	159
5	118	162	164
6	122	168	167
7	126	176	172
8	122	183	168
9	129	189	168
10	130	171	168
11	124	176	168
12	126	176	168
13	130	175	169
Average	3026.4		

S.NO	100%		
	SAMPLE 1		
	T	M	B
1	104	128	123
2	114	134	136
3	119	152	140
4	127	163	147
5	128	168	152
6	131	168	159
7	132	172	168
8	133	176	171
9	133	176	172
10	132	178	174
11	132	178	180
12	132	178	180
13	136	178	180
Average	3275.7		

10. C

M-sand is satisfying the requirements of fine aggregate such as strength gradation, shape, angularity etc. The VSI technology adopted for the manufacture of M-sand assures the quality of fine aggregate. The result of the hardened properties of the mix shows that there is consistent in the strength of plain concrete when natural sand is replaced by artificial sand. The sharp edges of the particles in artificial and provide better bond with cement than the rounded particles of natural sand resulting in higher strength. A mean compressive strength of 65.1 N/mm^2 was obtained on 50% replacement in M50 whereas 100% resulted in 63 N/mm^2 replacements indicating that proportion of M-sand and river sand would result in improved compressive strength. Flexural strength of concrete has not been affected due to the addition of M-sand and have satisfied minimum modulus of rupture in all the mixtures. The usage of M-sand has resulted in a drastic reduction in the slump beyond 1hr 30 min. And it is evident that the percentage of admixture has to be increased for a mix with M-sand compared to normal concrete mix with river sand. The result of RCPT test have proved, the addition of M-sand makes the concrete durable, the cost analysis of three mixes indicates that the increase in cost is only 1.64% for 50% replacement. There is no significant variation in cost when manufactured sand is used, besides the strength being increased by 12.04%. The replacement of natural sand with artificial sand will help in conserving the natural resources of sand and maintain the ecological balance of the nature. It also offers important economic advantages in regions where the availability of natural sand is scarce. Manufactured sand offers a viable alternative to the natural sand if the problem associated with the workability of the concrete mix can be resolved by using super plasticizers.

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