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AN EXPERIMENTAL INVESTIGATION ON REPLACEMENT OF NATURAL SAND BY MANUFACTURE SAND

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ABSTRACT:

This chapter presents an overview of literature on the variousexperiments conducted by many authors on the replacement of fine aggregateby quarry dust, manufactured sand and the results thereof highlighting thesignificance of using the manufactured sand for replacing the natural sand inconcrete. It includes the literature about mix design, fresh concrete properties,strength, durability aspects, micro structures and the structural behavior ofconcrete with the replacement of fine aggregate by manufactured sand.

Reported that knowledge gained from researchshould be used by quarry operators to optimize the performance of theirequipment and to achieve lower quantities of

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quarry fines.Jeffrey et al (2003) found that the generation of quarry fines is due to the extraction and processing operations in a quarry. There are severalparameters that influence the production of fines, which are relevant to therock characteristics and the involved processes. However, careful design andoptimization of extraction and processing could minimize the finesproduction.

1. INTRODUCTION

1.1 GENERAL

Concrete is a artificial material, which has a wider application in construction industry. The basic ingredient of concrete is cement, fineaggregate, coarse aggregate and water. The fine aggregate was partially replaced due to the increasing cost of raw material and is demand .In this project an attempt has been made to search effect of partial replacement of fine aggregate with copper slag and m-sand. The property of hardened concrete are studied performing compressive strength test, tensile and flexural test.

1.2 FINE AGGREGATE

The fine aggregate shall consist of natural sand or, subject to approval, other inert materials with similar characteristics,or combinations having hard,strong,durable particles. Fine aggregate from different sources shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix, without permission from the engineer.

The most desirable fine aggregate grading depends on the work,the richness of the mixture, and the maximum size of coarse aggregate. In leaner mixtures, or when small size of coarse aggregates are used. In general if the water cement ratio is kept constant and the ratio of fine aggregate is chosen correctly, a wide range grading used.

1.3 REQUIREMENTS OF GOOD FINE AGGREGATE

1. It should provide sufficient strength to concrete.
2. It should be easily workable.
3. It should be uniform in size.
4. Good abrasion resistance.

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5. Restrictions on deleterious constituents.

1.4 ADVANTAGES OF FINE AGGREGATE

1. Ingredients of concrete are easily available in most of the places.

2. Unlike natural stone concrete is free from defects and flaws.

3. Concrete can be manufactured to desired strength with economy.

4. It can be cast to any desired shape.

5. Casting of concrete can be done in working site economical.

6. Maintenance cost of concrete is almost negligible.

7. The deterioration of concrete is not applicable with age.

8. Concrete makes a building fire safe due to its non-combustible nature.

9. Concrete can withstand high temperatures.

10. Concrete is resistance to wind and water therefore, it's a very useful storm shelters.

1.5 DISADVANTAGES OF FINE AGGREGATE

1. Compared to other building materials, the tensile strength of concrete is relatively low.

2. Concrete is less ductile.

3. Due to increased consumption of binder compared to other type of concrete.

4. The quantity of binder in concrete can be reduced by pulverizing some of the sand users of plasticizers

1.6 OBJECTIVE

1. To study the literature reviews on concrete.

2. To find low cost materials of byproducts.

3. To compare the properties of materials with fine aggregate which has similar properties of fine aggregate.

4. To find the proportion of mix and testing of mixture and casting.

5. Testing and comparison of results and suggestions.

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3. METHODOLOGY

3.1 GENRAL

The cost of fine aggregate is about 12-15% of total construction cost.so this experimental study suggests the use of by products as a replacement material which reduces the cost of fine aggregate. So that the cost of fine aggregate can be saved.

This study begins with the searching of waste products which has the similar properties like fine aggregate.And this study extended up to testing of properties of available by products.

After that the available by products are mixed with the proportion of 30%, 40% and 50%.At the end of the testing the mixture had the important properties for good wearing material as copper slag and m-sand.

Then the mixture is used for replacement instead of fine aggregate in concrete as a percent of 30%, 40% and 50%.Then the samples are tested for compression, tension and flexural test.

And the result were obtained is compared with the fine aggregate and the mixture is suggested for use.

Then the fresh concrete is tested for slump to determine the workability and area of usage of concrete in different environmental condition.

At last the results are analyzed and tabulated. Based on the result suggestions are given to make use of this study result.

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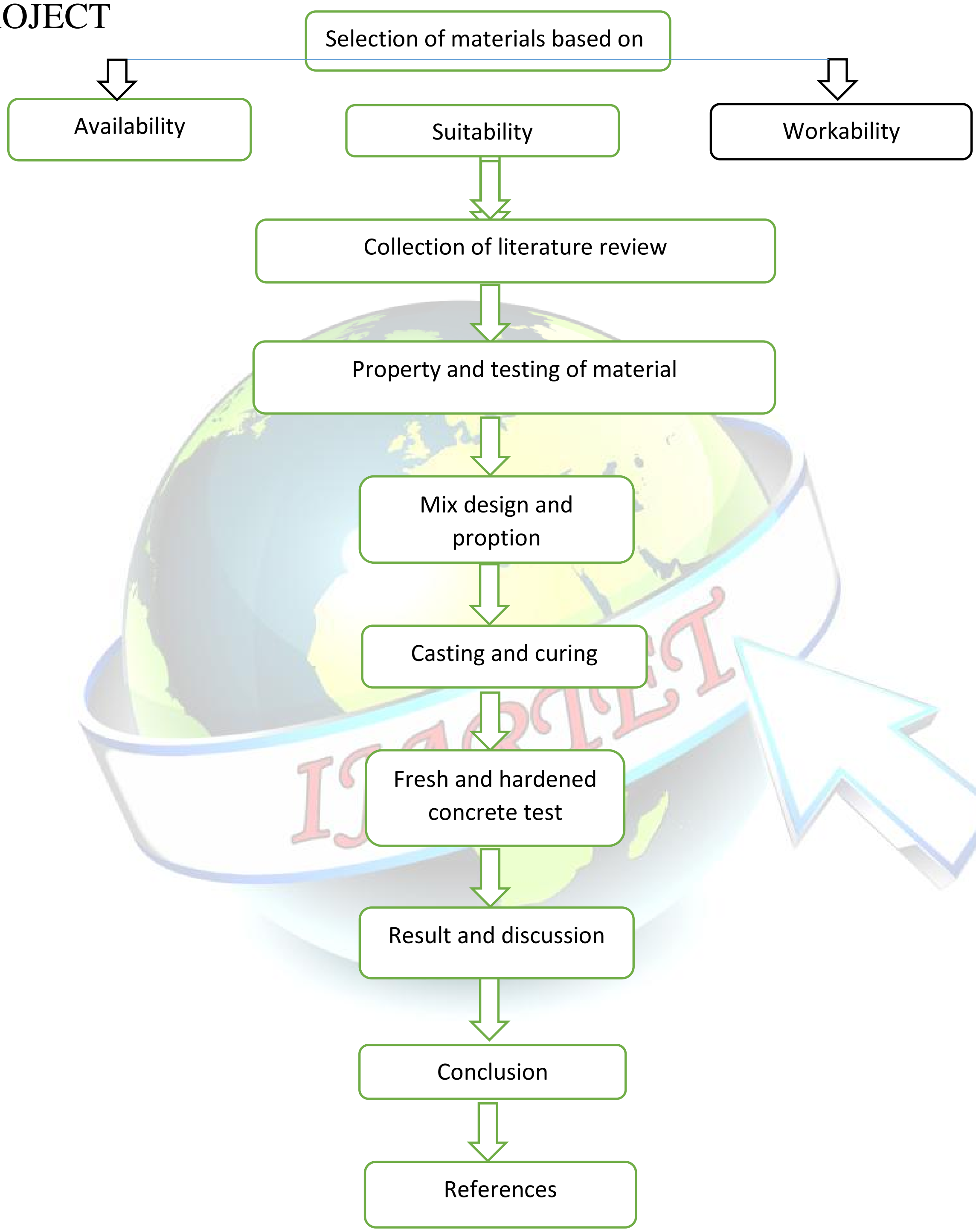
3.2 FLOW CHART OF PROJECT



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4. STUDY OF MATERIAL

4.1 GENTRAL

Concrete is an artificial material, which is made up of cement, fine aggregate, coarseaggregate, and water. In this project an attempt has been made to replace natural fine aggregate by waste material like copper slag and M-sand. Hence the properties of material have can arrived by conducting laboratory tests and the results are presented in this chapter.

4.2 CEMENT

Cement is a binding material in concrete which binds the other materials to forms a compact mass. Generally,OPC is used for all Engineering construction works. The specific gravity of all grades of OPC is 3.15. OPC is available in three grades .In this project work, 53 grades OPC cement is used for experimental study. Physical properties of 53 grade OPC are given in table 4.1

Table 4.1 Physical properties of 53 grade ordinary Portland cement

Physical properties	OPC used	Requirements as per IS 12269:1987
Standard Consistency	30%	--------
Initial Setting Time	31 Minutes	Min. 30 Minutes
Final Setting Time	550 Minutes	Max. 600 Minutes
Specific Gravity	3.15	3.15

4.3 SAND

A concrete with better quality can be made with sand consisting of rounded grains rather than angular grains. River or Pit sand must be used and not sea sand as it contains salt and other impurities. In this study, river sand has been used as fine aggregate.

Table 4.1.1 Classification of fine aggregate

IS Sieve Designation	% passing for Zone I	% passing for Zone	% passing for Zone	% passing for Zone

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		II	III	IV
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-95	75-100	90-75
600 micron	15-34	35-59	60-75	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-15	0-10	0-10	0-15

Function of sand

In concrete, sand acts as a filling materials, which fills the gaps between coarse aggregate. This will provide carbon dioxide required for the hydration. This will provide carbon dioxide required for the hydration .This gives additional strength to concrete and prevents it from shrinkage and cracking due to creep etc.

4.4.TESTS ON FINE AGGREGATE

1) Sieve Analysis

2) Moisture Content

3) Bulk Density

4) Fineness Modulus

5) Water Absorption

6) Sand Replacement Method

4.4.1. SIEVE ANALYSIS

During sieving the sample is subjected to horizontal or vertical movement in accordance with the chosen method. This causes a relative movement between the particles and the sieve; depending on their sizethe individual particles either pass through the sieve mesh or are retained on the sieve surface. The likelihood of a particle passing through the sieve mesh is determined by the ratio of the particle size to the sieve openings, the orientation of the particle and the number of encounters between the particle and the mesh openings. As explained later, the likelihood of passage and therefore the associated quality of the sieved sample also depends on the sieve movement parameters and the sieving time. Standardized sieves in accordance with ISO 3310 or ASTM E11 are normally used for a sieve analysis.

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These standards describe the technical requirements for the sieves and methods for checking them. The choice of test sieve (diameter and mesh) depends mainly on the amount of sample and its particle size distribution. The number of sievesand the steps between the nominal mesh openings should be selected so that as much as possible of the whole range of sizes contained in the sample is separated into fractions. Information about this can also be found in the main and secondary series of ISO 3310 and ISO 565. Although the majority of the sieves used have a diameter of 200 mm or 203 mm/8", sieves with a diameter of 100 to 400 mm are also used. At the customer's request the manufacturer can provide an acceptance report or a test sieve calibration certificate. The latter is particularly important if the test sieve is to be calibrated within the context of test agent monitoring

S.no	% of replacement	No. of cubes for 7 days	No. of cubes for 14 days	No. of cubes for 28 days	Total no. of cubes
1.	0	3	3	3	9
2.	30	3	3	3	9
3.	40	3	3	3	9
4.	50	3	3	3	9

6.EXPERIMENTAL PROGRAME

6.1 CASTING AND CURING OF CUBES

For the above mix proportions, the concrete cubes were cast with the moulds. Here manual mixing was done with the aggregates and cement. The cubes of dimensions 150 x 150 x150 mm were cast for each design mixes. The cubes were cast for ordinary concrete and partial replacement of fine aggregate concrete for 7,14 and 28 days compressive strength test.

Table 6.1 No. of cubesfor 7,14 and 28 days for compressive test

Total no.of cubes = 36

6.2 Casting and curing of cylinders :

For the above mix proportions, the concrete cylinders were cast with the moulds. Here machine mixing was done with the aggregates and cement. The cylinders of dimensions 150 x 30 cm were cast for each design mixes. The cylinders were cast for ordinary concrete and partial replacement of

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fine aggregate concrete for 7,14 and 28 days split tensile .

Table 6.2 No. of cylinderfor 7,14 and 28 days for compressive test

S. no	% of replacement	No. of cylinders for 7 days	No.of cylinders for 14 days	No. of cylinders for 28 days	Total no.of cylinders
1.	0	3	3	3	9
2.	30	3	3	3	9
3.	40	3	3	3	9
4.	50	3	3	3	9

Total no.of cylinders = 36

6.3 Casting and curing of prism :

For the above mix proportions, the concrete prisms were cast with the moulds. Here machine mixing was done with the aggregates and cement. The prisms of dimensions 150 x 150 x750 mm were cast for each design mixes. The priams were cast for ordinary concrete and partial replacement of fine aggregate concrete for 7,14 and 28 days flexural strength.

Table 6.3 No. of prismsfor 7,14 and 28 days for compressive test

S. no	% of replacement	No. of prisms for 7 days	No. of prisms for 14 days	No. of prisms for 28 days	Total no.of prisms
1.	0	3	3	3	9
2.	30	3	3	3	9
3.	40	3	3	3	9
4.	50	3	3	3	9

Total no.of prisms = 36

RESULTS AND DISCUSSIONS

7.1 SLUMP TEST

Table 7.1 slump test result

MIX DESIGN	SLUMP IN CM
Conventional Concrete	29
30% replacement	28
40% replacement	28
50% replacement	26

The above table results were obtained from the slump test of concrete and mix has the same workability like conventional concrete.

Slump Test:

The mould for slump test is in form ofcone with bottom diameter 20 cm top diameter 10 cm and height 30 cm. The mould is filled with fresh concrete in four layers, each approximately one quarter of the mould. Each layer shall be tamped with 25 strokes of the rounded end of the tamping rod.After the top layer has been rodded and top surface has been levelled, the mould is removed from the concrete by raising it slowly in vertical direction. The concrete subsides and the slump is measured immediately by determining the difference between the height of the mould and height of the mould and of the highest point of the specimen being tested. The test determines the consistency of fresh concrete and given comparable results in the case of wet mixes.

TYPES OF SLUMP:

1) True Slump
2) Shear Slump
3) Collapse Slump

Fig. 7.1 slump test of concrete

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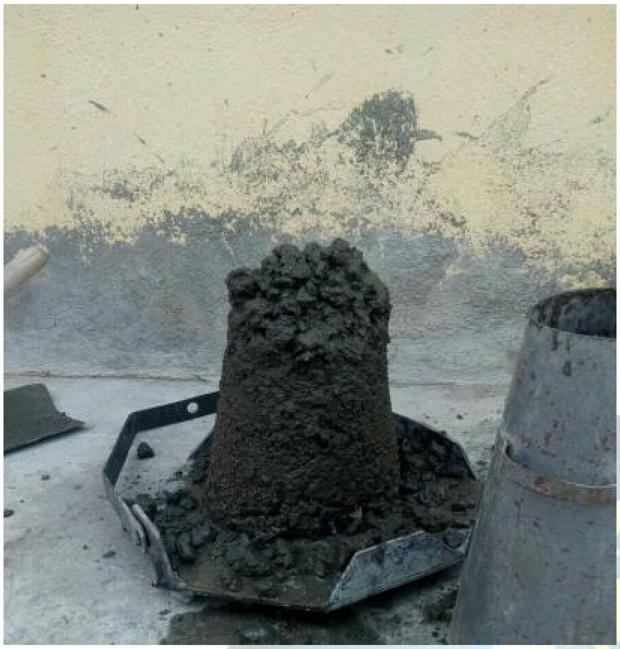

7.2 TEST ON HARDENED CONCRETE

As the hardening of the concrete takes time, one not comes to know the actual strength of concrete for some time. This is an inherent disadvantages in conventional test. But mostly when correct materials are used and careful steps are taken at every stage of the work, concrete normally give the required strength.

7.2.1 Compressive strength of concrete

The compressive strength of concrete has determined by conducting tests on 150 x 150 x 150 mm cube specimens at 7 and 28 days of curing as per IS:519-1959

The test specimen are to be tested in compression testing machine of 1000kn capacity.

Compression Strength = load applied /Area of contact

For all the specimen, the value of compressive strength is tabulated.

Fig 7.2.Mixing Proportions

Table 7.1. Compressive strength of cubes

7TH DAY TEST:

MIXING	SAMPLE-I	SAMPLE-II (KN)	AVERAGE (KN)	STRENGTH (N/M

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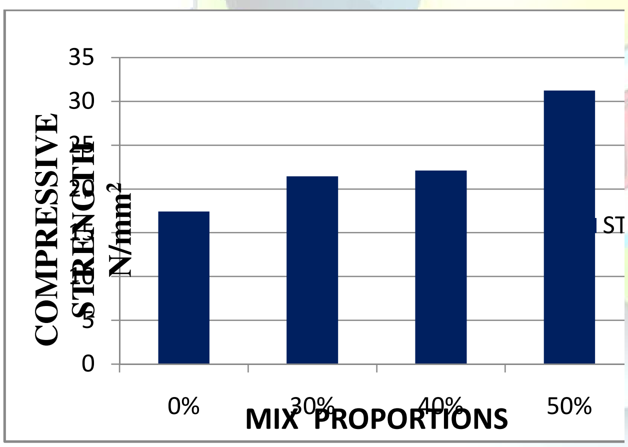
	(KN)			M^2)
0 % Repla cemen t	395	390	392.5	17.44
30% Repla cemen t	480	485	482.5	21.44
40 % Repla cemen t	500	495	497.5	22.11
50 % Repla cemen t	700	705	702.5	31.22



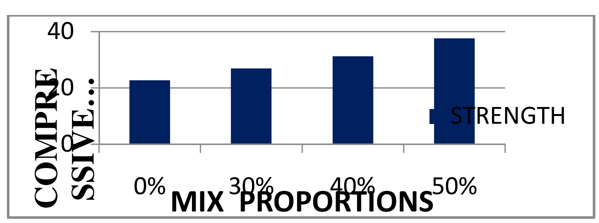
DISCUSSIONS

From the result the compressive strength varies from 17 N/MM^2 to 31 N/MM^2 At the 50% replacement gives the maximum strength of 31N/MM^2.

14TH DAY TEST:

Table 7.2.14th day compressive strength

MIXI NG	SAM PLE- I (KN)	SAM PLE- II (KN)	AVE RAG E (KN)	STRE NGT H (N/M M^2)
0 % Repla cemen t	510	514	512	22.75
30% Repla cemen t	600	610	605	26.88
40 % Repla cemen t	700	705	702.5	31.22
50 % Repla cemen t	850	845	847.5	37.66



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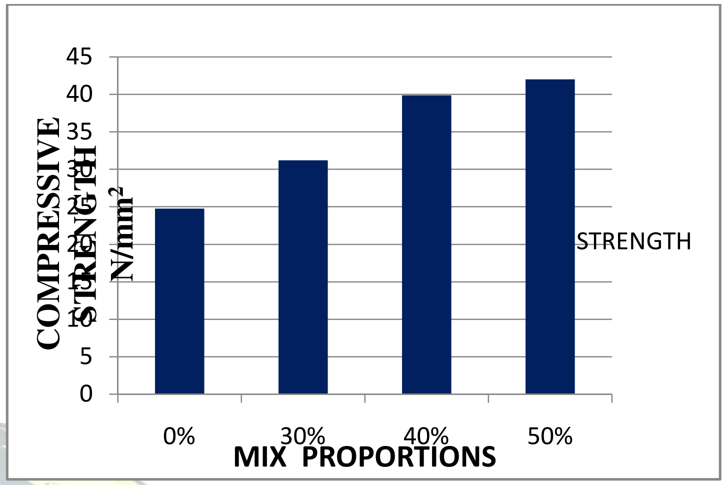
DISCUSSION:

From the result the compressive strength varies from 22 N/MM^2 to 37 N/MM^2 At the 50% replacement gives the maximum strength of 37N/MM^2.

28TH DAY TEST:

Table 7.3. 28th day compressive strength

MIXING	SAMPLE-I (KN)	SAMPLE-II (KN)	AVERAGE (KN)	STRENGTH (N/MM^2)
0 % Replacement	560	555	557.5	24.77
30% Replacement	700	705	702.5	31.22
40 % Replacement	900	895	897.5	39.88
50 % Replacement	950	940	945	42



DISCUSSION:

From the result the compressive strength varies from 24 N/MM^2 to 42 N/MM^2 At the 50% replacement gives the maximum strength of 42N/MM^2

Fig 7.3. – Compression test on cube

7.3 Split tensile Strength

Direct tensile strength of concrete is determined owing to difficulty in preparation of test specimen and applying axial tensile load. Split tensile strength is an indirect method 0f finding out of the tensile strength of concrete. The specimen shal be cylindrical in shape 15 cm diameter,30 cm long. The test is carried out by placing a specimen horizontaly between the loading surfaces of a compression testing

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machine and the load is applied until failure of the cylinder, along the vertical diameter.

$$F_t = 2P / \pi l d$$

Where,

P is the compressive load on the cylinder

L is the length of cylinder

D is its diameter

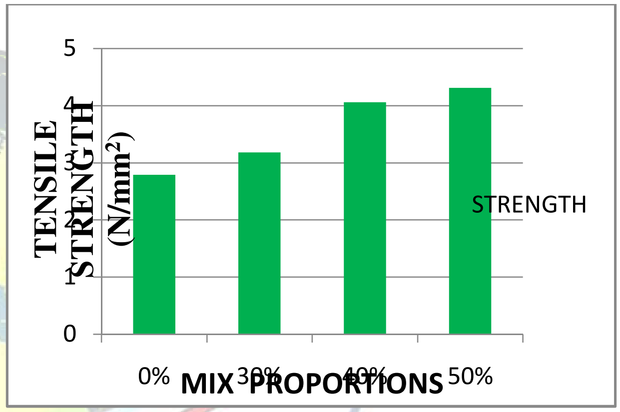
7TH DAY TEST:

Table 7.4 – 7th day tensile strength

28TH DAY TEST:

Table 7.6 – 28th day tensile strength

MIXING	SAMPLE-I (KN)	SAMPLE-II (KN)	AVERAGE (KN)	STRENGTH (N/MM^2)
0 % Replacement	195	200	197.5	2.79
30% Replacement	230	220	225	3.18
40 % Replacement	285	290	287.5	4.06
50 % Replacement	310	300	305	4.31



DISCUSSION:

From the result the tensile strength varies from 2.79 N/MM^2 to 4.3N/MM^2 At the 50% replacement gives the maximum strength of 4.3 N/MM^2.

7.4 Flexural strength of concrete

Determination of flexural strength is essential to estimate the loads at which concrete numbers may crack. The bearing surface of the supporting and loading rollers were wiped clean and any loose sand or other material were removed from the surface of the

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specimen where they are to make contact with the rollers. The specimen was then placed in the machine in such a manner that the load was applied to the uppermost surface as cast in the mould ,along two lines spaced 16.67% cm apart. The axis of the specimen was carefully aligned with the axis of the loading device. No packing was used between the bearing surface of the specimen and the rollers.The load was applied without shock and increasing contionously. The appearance of the fractured faces of concrete and the type of failure was noted.

The flexural strength of specimen was expressed as the modulus of rupture a f_b.Then **a** is distance between line of fracture and the nearer support the line of fracture measured on the centerline of the tenstile side of the specimen.

If a > 20cm

Modulus of rupture f_b = (p x 1) (b xd2)

If a > 20

F_b = (3p x a) (b x d2)

If < 17

Discard the specimen

Where,

B = ensured width in the specimen

D = measured depth in cm of the specimen at the point of failure

L = length in cm

P = maximum load

If **a** is less than 17 cm for a 15 cm specimen , or less than 11 cm for a 10 cm specimen, the results of the test be discarded.

7TH DAY TEST:

Table 7.7– 7th day flextural strength

MIXING	SAMPLE-I (KN)	SAMPLE-II (KN)	AVERAGE (KN)	STRENGTH (N/MM^2)
0 % Replacement	30	31	30.5	4.6
30% Replacement	33	31	32	5.12
40 % Replacement	45	38.5	41.75	6.68

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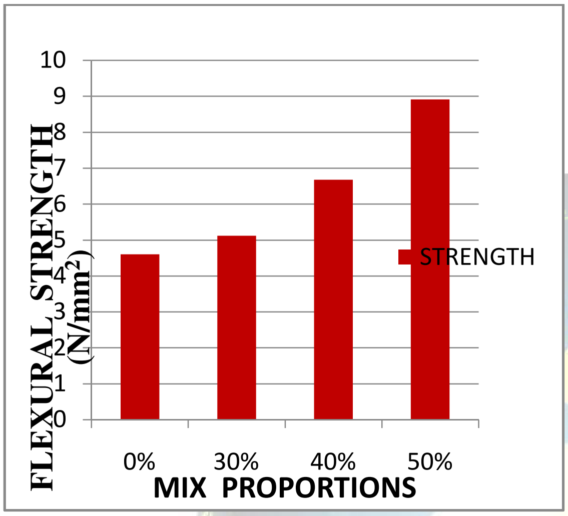
50 % Replacement	50	51	50.5	8.91



	(KN)	(KN)	(KN)	(N/MM²)
0 % Replacement	32	38	35	5.6
30% Replacement	40	39	39.5	7.02
40 % Replacement	47	43	45	8.4
50 % Replacement	59	58	58.5	10.4

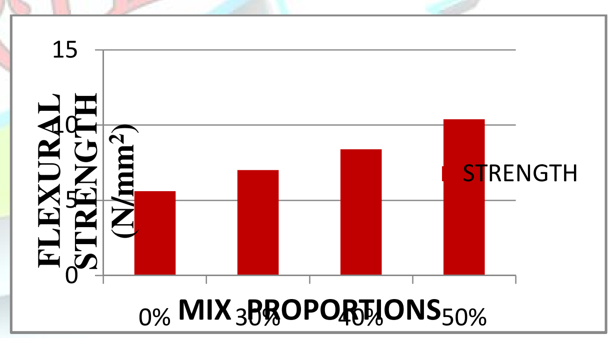
DISCUSSION

From the result the tensile strength varies from 4.6 N/MM² to 8.91N/MM² At the 50% replacement gives the maximum strength of 8.9 N/MM².

14TH DAY TEST:

Table 7.8– 14th day flextural strength

MIXING	SAMPLE-I	SAMPLE-II	AVERAGE	STRENGTH



DISCUSSION:

From the result the tensile strength varies from 5.6 N/MM² to 10.4 N/MM² At the 50%

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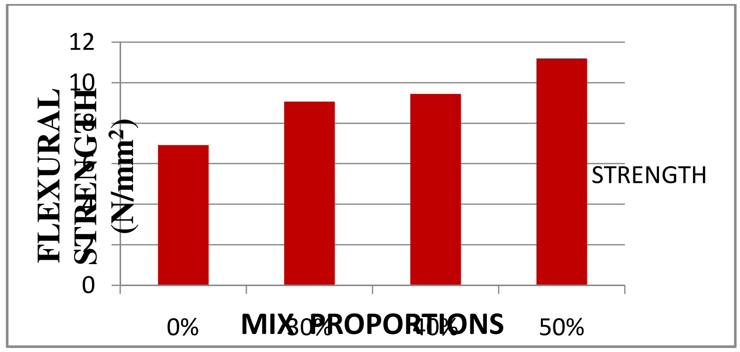
replacement gives the maximum strength of 10.4 N/MM^2.

28TH DAY TEST:

Table 7.8– 28th day flextural strength

MIXING	SAMPLE-I (KN)	SAMPLE-II (KN)	AVERAGE (KN)	STRENGTH (N/MM^2)
0 % Replacement	42	40	41	6.92
30% Replacement	52	50	51	9.06
40 % Replacement	58	54	56	9.45
50 % Replacement	62	64	63	11.2



DISCUSSION:

From the result the tensile strength varies from 6.92N/MM^2 to 11.2N/MM^2 At the 50% replacement gives the maximum strength of 11.2 N/MM^2.

CHAPTER 8

CONCLUSION

1.According to our experimental study, strength of concrete in compression,tension, and flexure will keep on increasing by increase in replacement percentage up to50% after that it loses its strength gradually. So we can use the mixture in concrete by an optimum replacement of 50%.

2. Since M1, M2, M3 and M4 mixes have similar strength it can be used for any RC works, Its shows that the cost towards the purchasing of fine

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aggregate can be reduced up to 50% without any compromises in strength.

3. We can use the 50% replacement of fine aggregate by mixture in any reinforced concrete section without any loss in strength.

4. Since the M5 mix have 20% lesser strength when compared to conventional or up to M4 mix it can be used for any single storied or comparatively lesser loads bearing structures.

5. But 81-100% of mixture is not suitable for reinforced concrete section where the section has to carry more loads.

6. For the replacement 81% to 100% is suggest for plain concrete structures like concrete wall, compound wall etc..

7. And the same replacement can be used for floor slabs, flooring walls,and as a mortar for plastering.

8. And coming to the flexural strength of concrete it shows the same results up to M4 mix. And the deviations of M5 & M6 mix from the conventional concrete are gradually increased which indicates that's the flextural strength is decreasing keep on increasing in replacement above 80%.

9. So that this experimental study suggests that the replacement of fine aggregate shall be increased up to 50% to achieve the same strength of conventional concrete with reduction in cost.

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