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AN INNOVATIVE AND EXPERIMENTAL STUDY ON REUSE OF DEMOLISHED CONCRETE WASTE

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ABSTRACT

Nowadays the greatest crisis faced by the construction industry is the availability of sand. As the digging of river sand destroys the river bed and causes danger for people using the river, digging of river sand has been made illegal in most rivers. So, getting river sand is really expensive nowadays as its availability is very limited. So, more importance is now given nowadays for replacement of river sand as fine aggregate. Mostly used nowadays in Kerala is M-Sand. In our project weare trying to replace sand with crushed used (demolished) concrete. The concrete created with this aggregate showed almost the same strength of concrete with natural sand. This is not only much cheaper than river sand and M sand, but also helps to decrease the disposal of construction wastes, which environmentalists say degrades the land. So, in the end use of this crushed concrete is beneficial not only to the contractor but also to our environment. This is an experimental study to see the feasibility of C&D wastes as fine aggregate in concrete.

Keywords: Demolished Concrete Waste, Concrete Recycling, Sustainable Construction, Waste Reuse and Environmental Impact.

1. INTRODUCTION

Concrete is everywhere. Wherever humans have inhabited, concrete is there. Homes, schools, hospitals, offices, roads and footpaths all make use of concrete. Concrete is an excellent material to make long-lasting and energy-efficient buildings. However, even with good design, human needs change and potential waste will be generated. Changes in infrastructure planning and needs result in the generation of construction and demolition waste (C&D Wastes): an estimated 900 million tons every year in India, Europe, the US and Japan. Building and constructions is a cyclic process and the recycling of these wastes has several advantages. C&D wastes are based upon the building materials. As in worldwide first these wastes are used for land filling. Concrete reuse is primarily related to a project's location. Demolition of old and deteriorated buildings and traffic infrastructure, and their substitution with new ones, is a frequent phenomenon today in a large part of the world. The main reasons for this situation are changes of purpose, structural deterioration, rearrangement of a city, expansion of traffic directions and increasing traffic load, natural disasters (earthquake, fire and flood), etc. For example, about 850 million tons of construction and demolition waste are generated in the EU per year, which represent 31% of the total waste generation [1]. In the USA, the construction waste produced from building demolition alone is estimated to be 123 million tons per year [2].

The most common method of managing this material has been through its disposal in landfills. In this way, huge deposits of construction waste are created, consequently becoming a special problem of human environment pollution. For this reason, in developed countries, laws have been brought into practice to restrict this waste: in the form of prohibitions or special taxes existing for creating waste areas. On the other hand, production and utilization of concrete is rapidly increasing, which results in increased consumption of natural aggregate as the largest concrete component. For example, two billion tons of aggregate are produced each year in the United States. Production is expected to increase to more than 2.5 billion tons per year by the year 2020 [2]. This situation leads to a question about the preservation of natural aggregates sources; many European countries have placed taxes on the use of virgin aggregates. Sustainable construction rather than a fancy idea now is a necessity. Concrete industry, which uses 12.6 billion tons of raw materials each year, is the largest user of natural resources in the world [1]. On the other side when a building is demolished after its use, for repairs or for deterioration it generates large amount of C&D, which conventionally and till today is used for land filling.

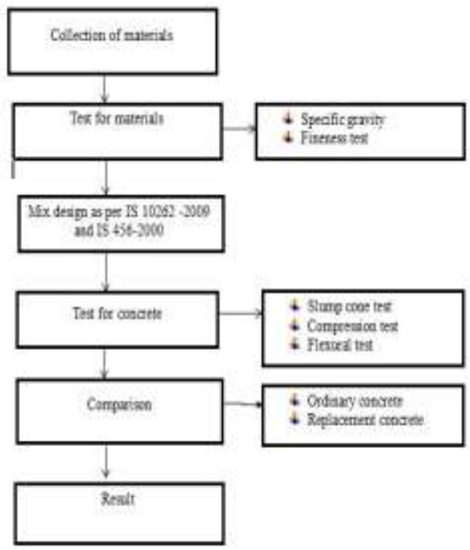
2. LITERATURE REVIEW

SARAH FALIH3, SHERIN HASSAN2: Said that incorporation of demolition concrete aggregate as coarse aggregate in concrete is quite feasible, it resulted in reduction of density and water absorption and enhancing compressive strength of concrete at certain level of demolition aggregate. The observations also led to a conclusion that there is some unreacted cement within the demolition aggregate used. Moreover, central composite design seemed more applicable compared to the conventional concrete design to study, model and optimize the impact of concrete design parameters on DACs properties. The recent work and the future work on other aspects of recycling demolition aggregate concrete may contribute to reducing its negative impact on environment by minimizing waste disposal loads sent to the landfills, and conservation of natural aggregate, in addition to give the opportunity to establishment of concrete waste recycling plants, as well as the corresponding guidelines for using the demolition concrete waste in concrete industry for structural applications.

J. Vengadesh Marshall Raman1, M. Sriram2: Recycled aggregate concrete is found to be 42% greater water absorption than that of natural aggregate. The initial slump of recycled aggregate concrete was marginally affected by the higher water absorption of recycled fine aggregate. Beyond 30% replacement levels of concrete containing recycled fine aggregate shows 20-40% lower compressive strength is developed at the ages of 7, 28 and56 days. Both tensile splitting and flexural strength are slightly decreased with the increase of the replacement ratio. The reduction in strength is 15% and 20% when compared to the reference concrete.

Yadhu G* and S Aiswarya Devi: There have been several possible applications of C&D wastes in construction industry. However, probably due to lack of systematic studies, enough data is still not available for its wide spread use in construction. Test results indicate that the concrete made using crushed C&D wastes gives almost as much as strength as normal concrete (about 30.66N/mm2 for 28 days) (Figures 1-5). From the above study, it is concluded that the crushed C&D wastes can be used as a replacement for conventional sand as fine aggregate. Further studies should be done to know how extensively we can use the crushed C&D wastes in construction. Using crushed C&D wastes in fresh concrete not only decreases the C&D wastes in the country, but also it will decrease the use of river sand and M Sand, which are both becoming hard to come by, and also it will make the construction much cheaper. Even though more research is to be done on this topic, but the

3. METHODOLOGY



4. TESTING OF MATERIAL

The materials used for concrete are fine aggregate, conventional coarse aggregate, cement and were tested for their properties to decide about their suitability for using them in concrete.

4.1 FINENESS TEST

The fineness of cement has an important bearing on the rate of hydration and on the rate of gain of strength and also on the rate of evolution of heart. Finer cement offers a greater surface area for hydration and hence faster the development of strength. The fineness of grading has increased over the year. But now is has got nearly stabilized. Different cement is ground to different fineness. Maximum number of particles in a sample of cement should have a size less than about 100 microns. The smallest particle in a size of about 10 microns. The particle size fraction below 3 microns has been found to have the predominant effect on the strength at one day while 3–25-micron faction has a major influence on the 28 days strength increase in fineness in of cement of cement is also found to increase the shrinkage of concrete. In commercial cement it is suggested that there should be about 25-30 percent of less than 7 micron in size. Fineness of cement is tested in
two ways.

By sieve
By air permeability method

4.2 SIEVE TEST

IS 2386(1)-1963 recommended the sieve analysis. This test consists of the simple operation of dividing aggregate into fraction, each consisting of particles of the same size. The sieves used for the test have square openings sieve as are described by the size of their openings as 80mm, 63mm,50mm, 40mm,25mm,20mm,16mm,12.5mm,10mm,6.3mm,4.75mm,3.35mm,2.36m m,1.70mm,1.18mm, 850µ,600µ,425µ,300µm,212µm,150µm and 75µm. All the sieves are mounted in frames one above the other in ascending order. The used for coarse aggregate are of sizes 80mm ,40mm,20mm, 10mm,4.75mm,2.36mm,1.18mm,600µm,300µm, 150µm.All the sieves are mounted on a sieve shaker. Aggregate of known quantity is placed over the top sieve, and after sieving thought the test sieves, the residue in each sieve is weighted the percentage of weight retained to the total weight is calculated, from which the percentage passing is determined.

Fineness of the cement obtained = 2.5%

4.3 STANDARD CONSISTENCY TEST

400 gm of cement was weighted and it was first mixed with 25% of water by its weight and filled in Mould within five minutes. Now the vacates Mould was placed in the glass plate and it was filled with paste and shakes to expel the entrapped air if any. The surface of the paste was leveled on the top of the Mould with trowel. Now the plunger was fixed in the moving rod and the Mould was kept under the plunger. Now the plunger was made to touch the surface of the paste and then it was allowed to fall under its own weight. When the plunger comes to rest, the depth of penetration was noted. If it was added was the consistency of cement. If not, the test was repeated by taking the fresh sample and mixed with water content increasing the percentage by 1%

Normal consistency of cement = 31%

PROPERTIES	ACTUAL VALUES
Specific gravity	3.15
Normal consistency	31%
Initial setting	45 minutes
Fineness modulus	2. 5%

Table: 1 Properties of Cement

4.4 FINE AGGREGATE

Fine aggregate shall consist of natural sand or manufactured sand or a combination. Fine aggregate should be selected so as reduce the water demand hence rounded particles are thus preferred to crush rock fines where possible. For the fine aggregate river sand conforming to IS 383-1987 was used. It passing through 2.36mm IS sieve with a specific gravity of 2.63 and this was come under zone. 5.3.1 Sieve analysis of sand Sieve analysis is carried out to determine the fineness modulus and drawing the grading curve of fine aggregate by sieving as per is code.

Sieve size (mm)	Weight of Retained (gms)	% of weight retained	Cumulative % Weight retained	% passing
10	0	0	0	100
4.750.	40	4	4	96
2.360	110	11	15	85
1.180	150	15	30	70
0.600	220	22	52	48
0.300	300	30	82	18
0.150	145	14.5	96.5	3
Silt	35	3.5	100	0
			∑F = 320	

Description	Trial 1 (gms)	Trial 1 (gms)
Weight of Empty pycnometer (W1)	457	458
Weight of Empty pycnometer + sand (W2)	657	654
Weight of empty pyconometer + sand + water (W3)	1284	1283
Weight of empty pyconometer + water(W4)	1159	1162
Specific gravity	2.65	2.64

Specific gravity of sand = $\frac{W2-W1}{(W2-W1)-(W3-W4)} = 2.65$

Table: 2 Specific Gravity of Sand

4.5 COARSE AGGREGATE

A maximum size of 12mm is usually selected as coarse aggregate used in concrete. Aggregate should be strong and free of internal flaws or fractures. Aggregate of high intrinsic strength are generally preferred. Granites, basalt, lime stones are being successfully used in concrete.

Sieve size (mm)	Weight of Retained (gms)	% of weight retained	Cumulative % Weight retained	% passing
100	0	0	0	100
63	0	0	0	100
40	0	0	0	100
20	1436	28.72	28.72	71.28
12.5	2524	50.48	79.2	20.8
6.73	780	15.6	94.8	5.20
4.75	135	2.7	97.5	2.5
Silt	125	2.5	100	0
			∑F = 400.32	

Description	Trial 1 (gms)	Trial 1 (gms)
Weight of Empty pycnometer (W1)	850	850
Weight of Empty pycnometer + coarse aggregate (W2)	1500	1450
Weight of empty pyconometer + coarse+ water (W3)	2670	2680
Weight of empty pyconometer + water(W4)	2250	2260
Specific gravity	2.8	2.7

Specific gravity of coarse aggregate = $\frac{W2-W1}{(W2-W1)-(W3-W4)}$ = 2.8

Table 3: Specific gravity of coarse Aggregate

4.6 C and D waste

Sieve size (mm)	Weight of Retained (gms)	% of weight retained	Cumulative % Weight retained	% passing
10	0	0	0	100
4.750	45	4.5	4.5	94.5
2.360	31.5	31.5	36	64
1.180	280	28	64	36
0.600	200	20	84	16
0.300	109	10.9	94.9	5.1
0.150	51	5.1	100	0
Silt	0	0	100	0
			∑F = 443.4	

Description	Trial 1 (gms)	Trial 1 (gms)
Weight of Empty pycnometer (W1)	457	458
Weight of Empty pycnometer + coarse aggregate (W2)	795	750
Weight of empty pyconometer + coarse+ water (W3)	1360	1283
Weight of empty pyconometer + water(W4)	1152	1162
Specific gravity	2.6	2.55

Specific gravity of sand = $\frac{W2-W1}{(W2-W1)-(W3-W4)}$ = 2.6

Table 4: Specific gravity of C&D

5. RESULT AND DISCUSSION

5.1 WORKABILITY

Workability value for concrete is obtained by carrying out slump cone test. The variation in the slump value arises due to the increase in the percentage of red soil and quarry dust. For conventional concrete, the slump value is higher workability value get reduced when the percentage of replacement of red soil and quarry dust with sand. The slump value shows slightly high variation when there is an increase in the percentage mineral admixture.

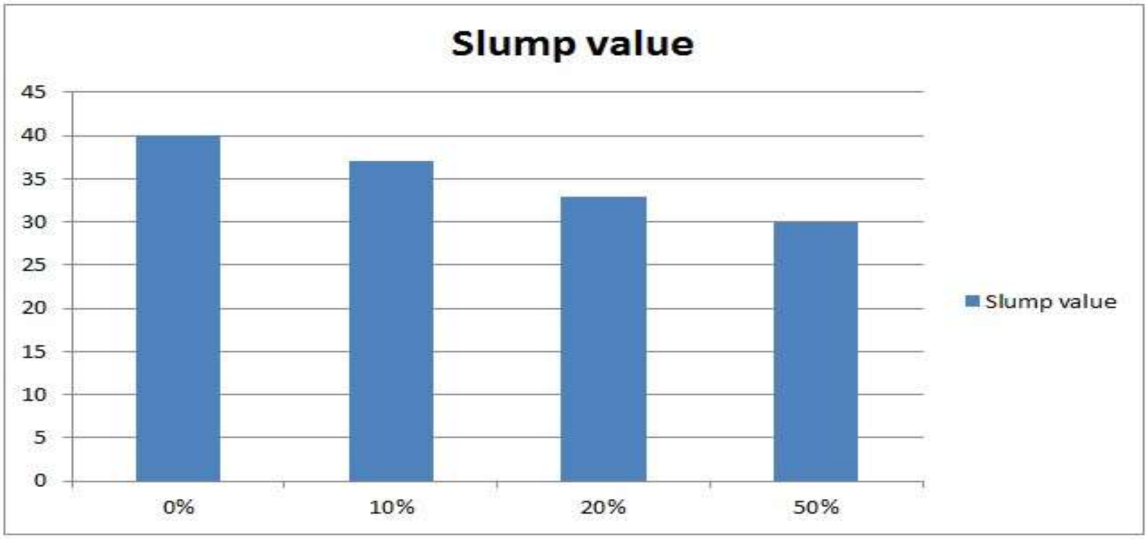


Figure: 1 Slump Value

7.3 COMPRESSIVE STRENGTH TEST

The hardened concrete sample were tested for strength determination as per IS 516-1959 "METHODS FOR TEST FOR STRENGTH OF CONCRETE". Concrete cubes of size 150mm×150mm×150mm were cast with and without granite dust and steel slag. After 24 hours, the specimens were demolded and subjected to curing for 7, 14, 28 days in portable water. After curing, the specimens were tested for compressive strength using universal testing machine. The maximum load at failure was taken.

The tests were carried out on a set of triplicate specimens and the average compressive strength values were given.

Figure: 2 Compression testing

7.4 FLEXURAL STRENGTH TEST

The ultimate load was taken and the average flexural strength was calculated using the equation.
Flexural strength (N/mm2) = 3PL/ (4BD2) Where, P=Ultimate load at failure (N)
L=Length of the beam specimen (mm), D=Depth of the beam specimen (mm). B=Breadth of the beam specimen (mm).

Figure: 3 Flexural Strength Test

7.5 COMPRESSIVE STRENGTH FOR CONVENTIONAL CONCRETE TABLE

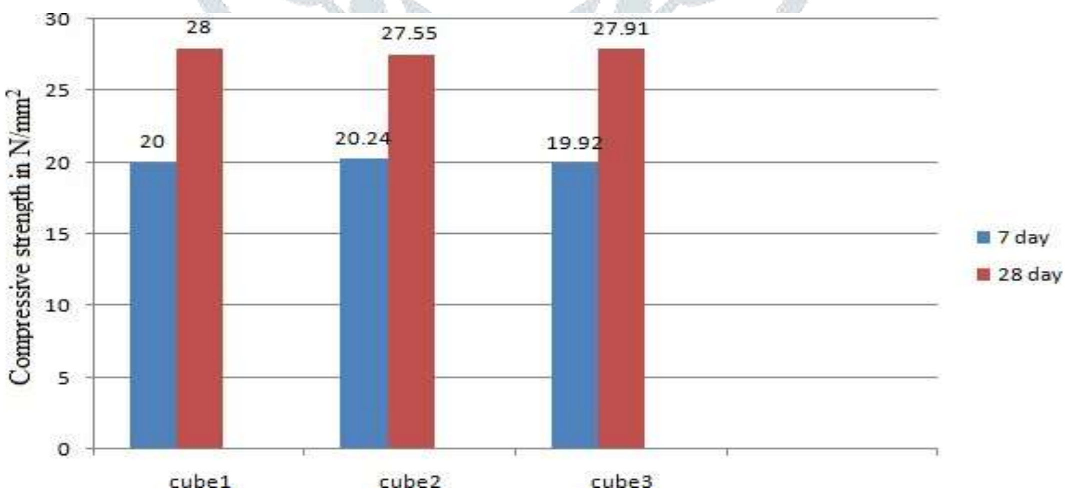


Figure :4 Compressive Strength For 7 Days & 28 Days

7.6 FLEXURAL STRENGTH FOR CONVENTIONAL CONCRETE

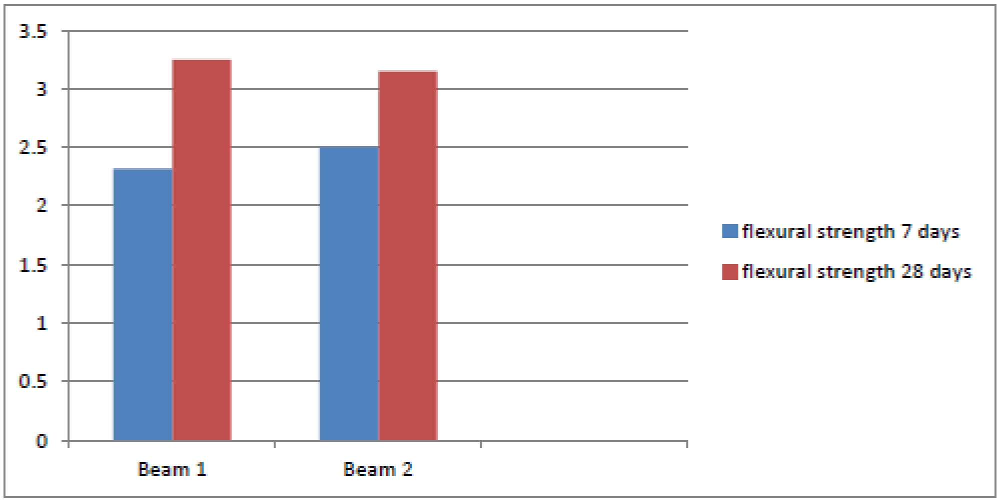


Figure 5 Flexural strength for 7 days & 28 days

7.7 COMPRESSIVE STRENGTH AND FLEXURAL STRENGTH ON REPLACEMENT CONCRETE

Fine aggregate was partially replaced by C & D waste (10%, 20% & 50%)

Finally, we prepared mixing of replacement concrete and also tested compressive strength and Flexural strength at 7days and 28 days of curing respectively.

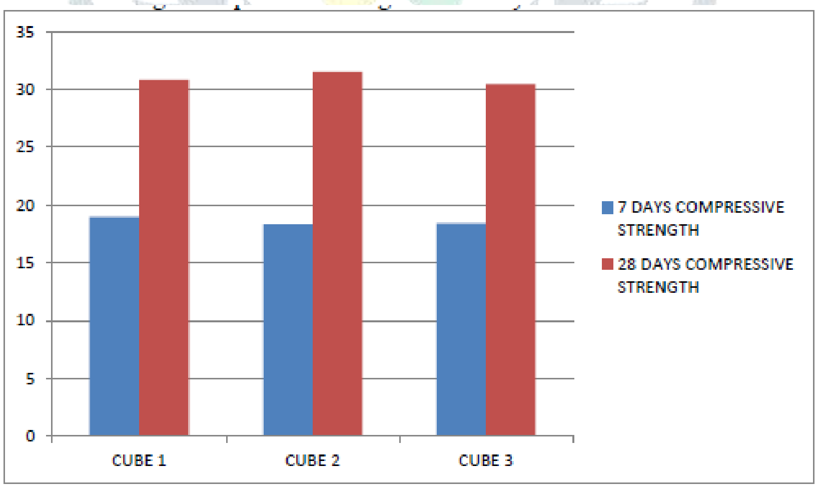
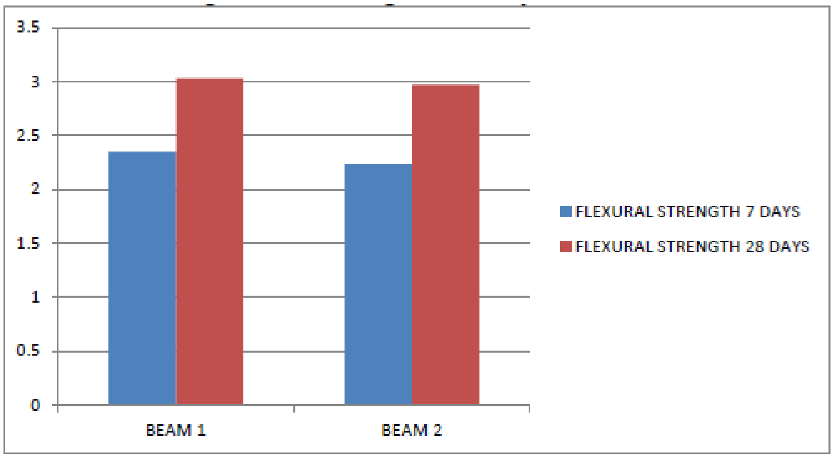
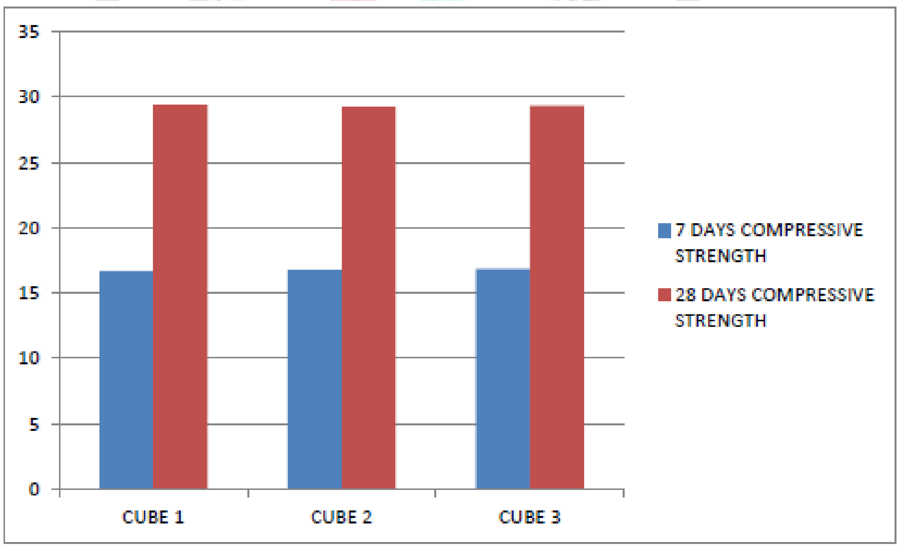


Figure :6 Compressive strength for 7 days & 28 days

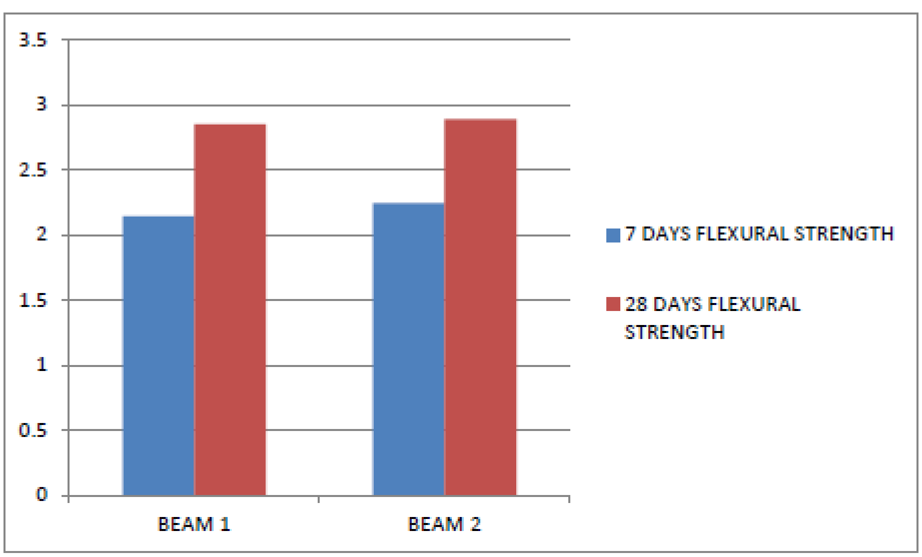
7.8 FLEXURAL STRENGH OF CONCRETE AND DEMOLISHION WASTE (10%) CONCRETE FOR 7 DAYS AND 28 DAYS



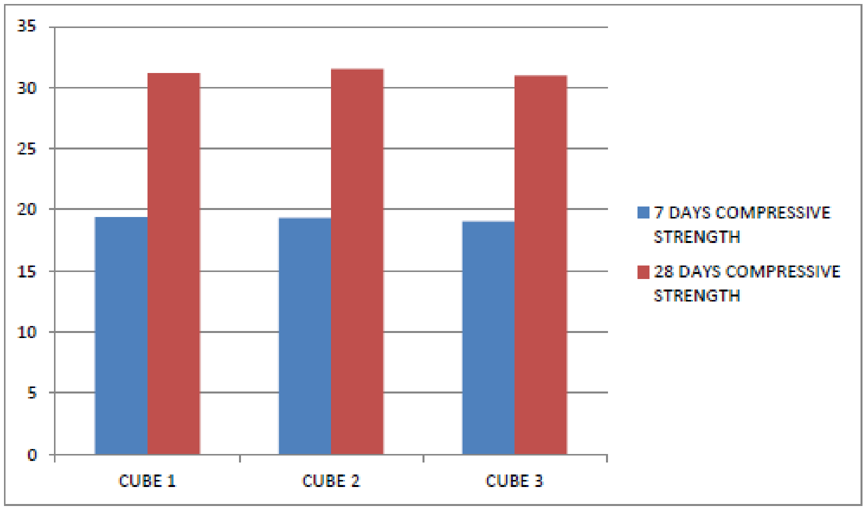
PRESSIVE STRENGH OF CONCRETE AND DEMOLISHION WASTE (20%) CONCRETE FOR 7 DAYS AND 28 DAYS



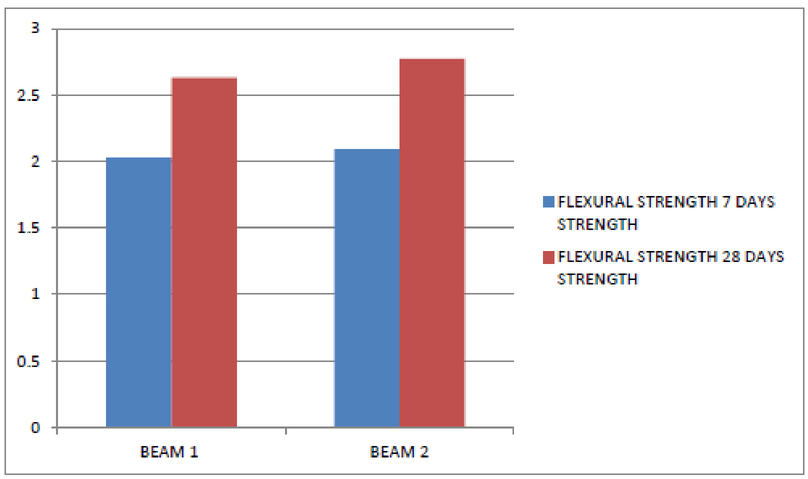
7.9 FLEXURAL STRENGH OF CONCRETE AND DEMOLISHION WASTE (20%) CONCRETE FOR 7 DAYS AND 28 DAYS



7.10 COMPRESSIVE STRENGH OF CONCRETE AND DEMOLISHION WASTE (50%) CONCRETE FOR 7 DAYS AND 28 DAYS

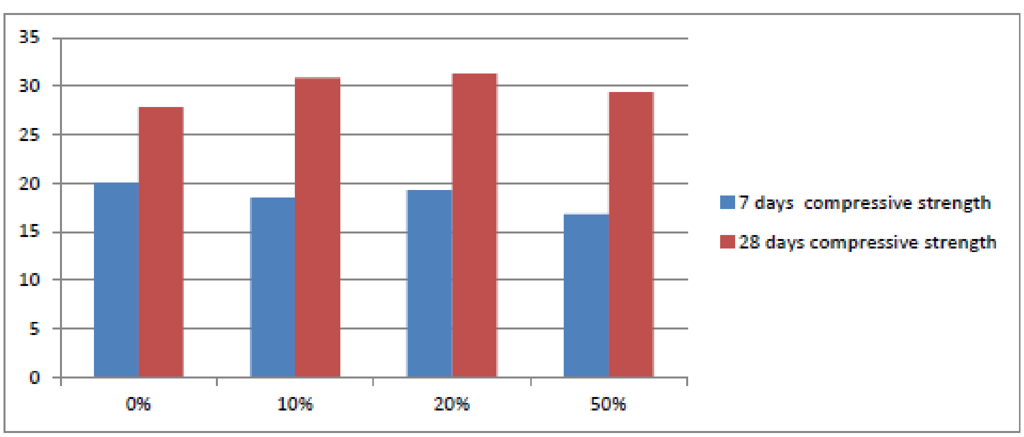


7.11 FLEXURAL STRENGH OF CONCRETE AND DEMOLISHION WASTE (50%)

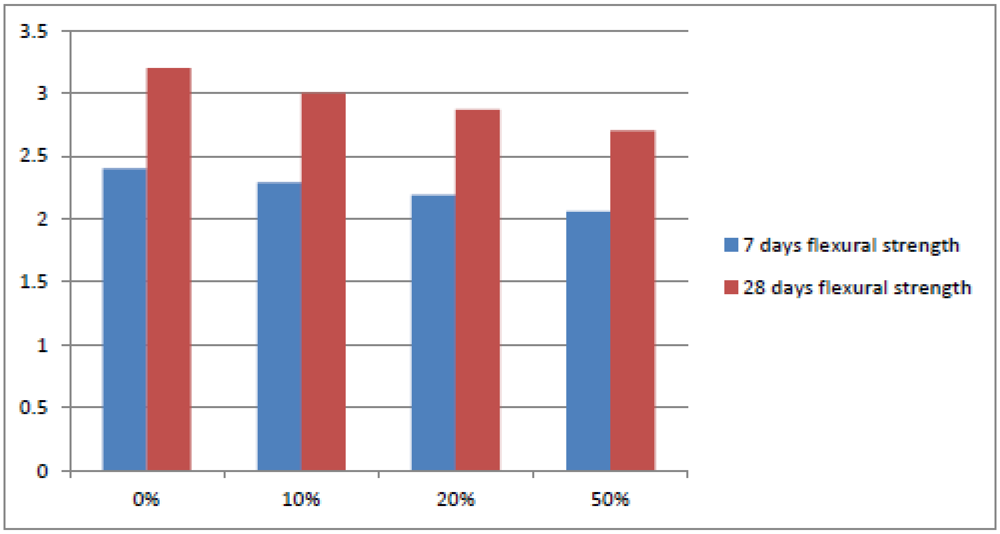


7.6 COMPARISON TABLE

COMPARISON OF AVERAGE COMPRESSIVE STRENTH FOR 7 DAYS AND 28 DAYS



COMPARISON OF AVERAGE FLEXURAL STRENTH FOR 7 DAYS AND 28 DAYS



8. CONCLUSION

The following conclusion have been drawn based on the experimental investigation carried out on concrete mixture
Higher compressive strength is obtained for 20% concrete and demolished waste added concrete.
The slump value is decreased in order to increase the percentage of C&D waste.
The flexural strength is decreased in order to increase the percentage C&D waste.
Compressive strength increases about 15.42% compared to conventional concrete while adding 20% of C&D waste.
The annual sand demand for the construction industry in India is nearly 8 million cubic meters and all is obtained from major rivers. This present demand is expected to be 10 million cubic meters within next three years.
As a part of preliminary work, the various material needed to be used for the further study, were obtained and their physical properties were determined.
The various percentage of partial replacement C&D waste concrete and testing method on concrete has been discussed in this my project.
A review of literature was done which was helpful in getting a better idea on the topic

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