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RESEARCH ARTICLE

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A STUDY ON STRENGTH AND DURABILITY CHARACTERSTICS OF CONCRETE USING SYNTHETIC FIBRES

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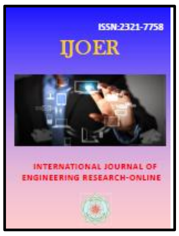

ABSTRACT

Rapid industrial development causes serious problems all over the world such as depletion of Natural Aggregates and it creates enormous amount of waste material from construction and demolition activities. On the other hand, river sand is another major problem. One of the way to reduce this problem is to utilize Demolished Coarse Aggregate (DCA), Demolished Fine aggregate (DFA), and Water in the production of concrete.

KEY WORDS: DCA, DFA, and NOVCON Fiber.

1. INTRODUCTION

India, a huge quantity of construction and demolition wastes is produced every year. These waste materials need a large place to dump and hence the disposal of wastes has become a severe social and environmental problem. On the other hand scarcity of natural resources like river sand and wash water is another major problem which results in increasing the depth of river bed resulting in drafts and also changes in climatic conditions. Hence it becomes necessary to protect and preserve the natural resources. The possibility of Demolished Coarse Aggregate (DCA), Demolished Fine Aggregate (DFA), and Water in the construction industry thus increases the importance.

In addition to the environmental benefits in reducing the demand of load for depositing the wastes, the Demolished Coarse Aggregate (DCA), Demolished Fine Aggregate (DFA), Water and can also help to conserve natural material Fine Aggregates to reduce the cost of waste treatment prior to disposal.

Demolishing of concrete is important it helps to promote sustainable development in the protection of natural resources, and reduces the disposal of demolition waste from the old concrete. Unprocessed DCA is useful to be applied as many types of general Bulk fill bank Protection, Sub – Basement, Road Construction, Noise Barriers and Embankments. Processed DCA can be applied to new concrete for Pavements, shoulders, median barriers, sidewalks, curbs and gutters, and bridge foundations. It can also be applied to Structural Grade Concrete, Soil- Cement Pavement Bases, Lean Concrete and Bituminous Concrete.

1.1. DEMOLISHED AGGREGATES:

Demolished Aggregate is generally produced by two stages crushing of Demolished Concrete, screening and removal of contaminants such as reinforcement, wood, plastic etc. Concrete made with such aggregate is called as Demolished Coarse Aggregate (DCA) RILEM Committee 121-DRG has published.

GROUP I:

Demolished differ from the Conventional Aggregates mainly in two factors:

a. Demolished Aggregates are not derived from any natural source, but are derived from construction and Demolished wastes.

b. Demolish Aggregates (when not tested)have the aggregate with attached mortar. Demolish Aggregates are also mortar parts from the concrete

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which further constitutes and can shape like aggregates.

Fig.1.Concrete Rubble

Fig. 2. Manual crushing

Fig.3. Crushed All in one

Advantages of Demolished Aggregates:

1. Environmental Gain: The major advantage is based on the environmental gain. Construction and demolition waste makes up to around 40% of the total waste each year (estimate around 14 million tons) going to land fill. Through recycled these material, it can keep diminishing the resources of Urban Aggregate. Therefore, Natural Aggregate can be used in higher grade applications.

2. Save Energy: The recycling process can be done on site. A method of Demolishing crushed concrete that used in the construction, known as the "Within-Site Recycling System." Everything can be done on the construction site through this system, from the process of Demolishing Coarse Aggregate, manufacture and use them. This can save energy to transport the demolished materials to the recycling plants.

3. **Cost:** Secondly is based on the cost. The cost of Demolished Coarse Aggregate is cheaper than the Aggregate available in market. It depends on the aggregate size limitation and local availability. This is just around one and half of the cost for natural aggregate that used in the construction works. The transportation cost for the Demolishing Coarse Aggregate is reduced due to the weight of Demolishing Coarse Aggregate is lighter than aggregate.

4. Sustainability:

The amount of waste materials used for landfill will be reducing through usage of Demolished Coarse Aggregate. This will reduce the amount of Quarrying. Therefore this will extend the lives of Natural resources.

1.2. FIBER REINFORCED CONCRETE: Fiber reinforced concrete (FRC) may be defined as a composite materials made with Portland cement, aggregate and incorporating discrete discontinuous fibers. The real contribution of the fibers is to increase the toughness of the concrete (defined as some function of the area under the load vs. deflection curve), under any type of loading. That is, the fibers tend to increase the strain at peak load, and provide a great deal of energy.

The type of fibers that is used in the FRC is of two types. They are

1. Natural fibers,
2. Artificial fibers.

1.3.1 NATURAL FIBERS

The fibers which are extracted from the natural resources are called natural fibers. Following are some types of natural fibers

1. Sisal
2. Coir
3. Bamboo
4. Jute
5. Akwara
6. Elephant Grass

1.3.2. ARTIFICIAL OR SYNTHETIC FIBERS

The fibers which are manufactured from the man made sources are called artificial fibers. Some of the natural fibers are

- Steel fibers
- Glass fibers
- Polymer fibers
- Polypropylene fibers

1.3.3. WHY USE OF FIBERS IN CONCRETE:

Synthetic fibers benefit the concrete in both the plastic and hardened concrete. Some of the benefits include

- Reduces plastic settlement cracks
- Reduces plastic shrinkage cracks
- Reduces permeability
- Increases impact and abrasion resistance

- Provides shatter resistance

1.3.4. ADVANTAGES OF FRC:

Use of fibers in the concrete benefits the following

- Improve ductility
- Reduce crack widths and control the crack widths tightly thus improve durability
- Improve impact & abrasion resistance
- Improve freeze-thaw resistance

4. TESTS CARRIED ON MATERIALS

The following tests should be conducted for evaluating the characteristics of raw materials based Indian Standard Code limits for Mix Design. Determination of fineness of cement by dry sieving, specific gravity of cement, compressive strength of cement paste, consistency of cement, initial setting time of cement, final setting time of cement etc.

Tests on aggregates (DCA, DFA &FA): Determination of sieve analysis, water absorption Bulk Density and impact test.

5. MIX DESIGN:

MIX DESIGN FOR PRESENT INVESTIGATION:

In the present work the Indian standard method (IS METHOD) has been used to get proportions for normal strength concrete. The concrete mix design for M_{20} were carried out according to Indian standard recommendation method **As per IS 10262-2009. Here, in this investigation two mix designs are prepared for M20 grade. They are,**

MIX DESIGN-A:CONVENTIONAL CONCRETE.

MIX DESIGN-B:DEMOLISHED CONCRETE.

6. EXPERIMENTAL DETAILS:

6.1 PURPOSE: In the present proposal it is planned to conduct lab investigation using demolished aggregates in various proportions, for M_{20} grade of concrete.

The main purpose of this investigation is to develop confidence among user agencies in India to use demolished aggregate in a desirable proportion in all Civil engineering constructions.

6.2 EXPERIMENTAL PROCEDURE:

The main aim of this research project is to utilize crushed concrete as Coarse Aggregate and as Fine Aggregate and excess cement for the production of concrete. It is essential to know whether the replacement of DCA and DFA in concrete is inappropriate or acceptable. Four types of aggregates are used in this project which include Natural Coarse Aggregate, Natural Fine Aggregate, DCA and DFA. Natural Coarse Aggregate used is microtonal with maximum size of 25 mm. Natural Fine Aggregate used is Tests are carried out on these aggregates to determine the specific gravity, water absorption, sieve analysis, bulk density. After testing, a mix design is produced in accordance with the properties obtained from the test results.

Concrete is then produced with replacement of 0%, and 100% of RCA as well as 100% of DFA with the same mix proportion. Tests conducted on these concretes include the slump of fresh concrete. For the hardened concrete, the 7 days, 28 days compressive strength was determined. And the results at each testing age are reported as an average.

Demolished Coarse Aggregate used in this research is crushed concrete, i.e. DCA. The demolished concrete slab pieces are crushed together using hammer. Since the Natural Aggregate is less than 20mm in size, the recycled concrete is sieved through 20mm sieve and 4.75mm in a mechanical shaker. Demolished Coarse Aggregate passing 20mm and retained on 4.75mm sieve is collected to produce concrete. The Replacing of DFA for natural Fine Aggregate used for producing concrete.

6.2.1. TEST FOR WORKABILITY (SLUMP CONE TEST): (AS PER IS: 7320 – 1974)

APPARATUS:

1.Slump mould with top diameter 100mm & bottom diameter 200mm.

2. Tamping rod should be of steel or their material with 16mm diameter, 0.6m long & rounded at one end or bullet point end.

Fig.8.SLUMPCONE APPARATUS

SAMPLING:

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Take sample from the transit mixer minimum quantity should be 0.02 cu.m. Before taking sample transit mixer should mixed well at least 2 min.

PROCEDURE: Internal surface of the slump cone shall be clean well with oil.

The slump cone placed on a smooth and plain surface.

Metal shall be carefully leveled.

Slump cone should be fit in the center.

The slump cone shall be filled in four layers each approximately one quarter of the height of the mould (each layer 75mm).

Each layer shall be tamped with 25 strokes of the rounded end of the tamping rod.

The stroked shall be distributed in uniform manner over the cross section of the mould.

Bottom layer shall be tamped through cup the depth.

After the top layer has been prodded the concrete shall be struck with trowel or rod.

The slump cone to be lift immediately by raising it slowly and carefully in a vertical direction.

Slump should be leisured immediately by taking the difference between the height of the mould and that of the highest point of the specimen being tested.

The period of test should be 2 min after sampling.

TABLE:6.2.1

S.NO	Degree of workability	W/C ratio	Slump	Name of work
1	Very low	0.45	-	Roads vibrated by power operated machines & mass concrete
2	Low	0.55	25 – 75	Roads vibrated by hands operated machine & RCC, beams & slabs.

RESULT:

For water cement ratio 0.50, slump value is 70mm.

6.2.3. COMPRESSION TEST ON CONCRETE:

(AS PER IS: 455, IS:516)

APPARATUS: Cube mould of size (as per IS: 10086)150mmx150mmx150mm.

Tamping rod should be of steel or other material, 16mm diameter and 0.6m long and rounded at one end or bullet point end.

Compression testing machine or Universal Testing Machine(UTM).

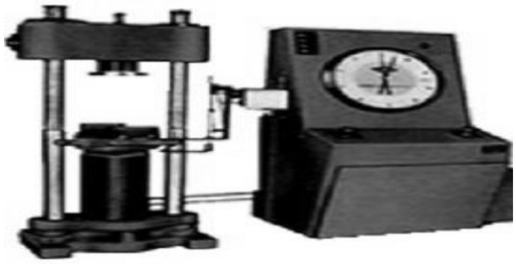

Fig.10.COMPRESSION TESTING MACHINE.

PROCEDURE: Internal surface of the cube mould and all seal joints shall be coated with oil.

The cube mould shall be filled in three layers.

The concrete shall be filled in to the mould in layers approximately 50mm deep.

Each layer should be with 35 strokes of rounded end of the tamping rod.

After the top layer has been loaded, the concrete shall be finished with the top of mould using trowel and covered with glass or metal plate to prevent evaporation

7. TEST RESULTS AND DISCUSSIONS:

Table 7.1 Test Results of Ordinary Portland cement:

S.No	Properties	Test Results
1	Normal consistency (%)	0.305
2	Initial setting time (min)	55
3	Final setting time (min)	510
4	Specific gravity (%)	3.15
5	Fineness of cement (%)	93.67

Table 7.2 : Physical Properties of FA and DFA:

Aggregate Properties	FA	GFA
Specific gravity	2.32	2.45
Water absorption (%)	1	1.5
Bulk density (kg/m^3)	1460	1765
Fineness modulus (%)	3.537	3.8145
Moisture Content (%)	1.5	Nil

Table 7.3: Physical Properties of Gravel and DCA:

Aggregate Properties	NA	DCA
Specific gravity	2.72	2.63
Water absorption (%)	0.5	1.2
Bulk density (kg/m^3)	1469.8	1325.93
Fineness modulus (%)	4.506	5.06
Moisture Content (%)	1.9	4.46

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7.4. DENSITY: The densities for the different cubes are calculated. The density of the cubes is calculated at the age of 28 days. The value of density is going on increasing with the addition of fibers. The values of densities are tabled in this page.

TABLE 7.4 DENSITIES OF THE CUBES FOR M20 GRADE

S.No	Sample description	workability	Density (tones/m3) (28 days)
1	Sample A(conventional aggregate)	1.5	2.84
2	Sample B(Demolition aggregates)	7.0	2.64
3	Sample C(Demolition aggregates+0.2% Fibres)	7.0	2.74
4	Sample D(Demolition aggregates +0.3% fibres)	7.0	2.78
5	Sample E(Demolition aggregates+0.4% fibres)	7.0	2.82
6	Sample F(Demolition aggregates+0.5% fibres)	7.0	2.86
7	Sample F(Demolition aggregates+0.6% fibres	7.0	2.93

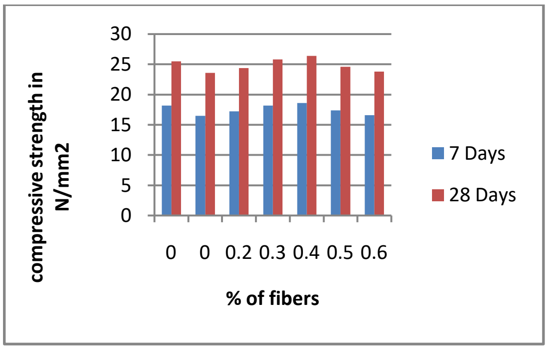
COMPRESSIVE STRENGTH:

The compressive strength for demolished concrete and control concrete were tested at the end of 7 days and 28 days using Compressive Strength Testing Machine. The water cement ratios were taken as 0.50. Two cubes were casted and the average of two test results is taken for the accuracy of the results. The concrete cubes were cured at room temperature.

TABLE 7.5 COMPRESSIVE STRENGTH

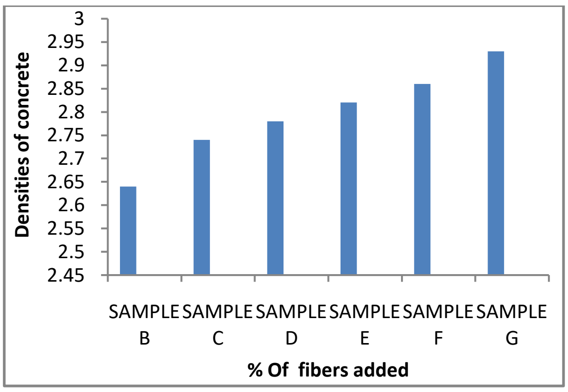
S.NO	GRADE OF CONCRETE	SAMPLE DESCRIPTION	% OF FIBERS ADDED	COMPRESSIVE STRENGTH	COMPRESSIVE STRENGTH FOR
1.	m-20	CONVENTIONAL	0	18.2	25.5
2	m-20	DEMOLISHED	0	16.5	23.6
3	m-20	DEMOLISHED	0.2	17.2	24.4
4	m-20	DEMOLISHED	0.3	18.2	25.8
5	m-20	DEMOLISHED	0.4	18.6	26.4
6	m-20	DEMOLISHED	0.5	17.4	24.6
7	M-20	DEMOLISHED	0.6	16.6	23.8

7.5 BAR GRAPH SHOWING COMPRESSIVE STRENGTH:



DISCUSSION: The compressive strengths of the seven samples are shown in the above graph. The compressive strengths of the samples is differed for the samples, because of the fibers are used. The compressive strength of the samples with 0.4% fibers higher. Compressive strength is reduced after 0.4% of fibers because binding energy of cement decreases.

7.6 **.BAR GRAPH SHOWING DENSITIES**



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DISCUSSION:

The density values of cubes are shown in the graph above. There is a large increase in the densities of cubes because of using of fibers.

Densities of the samples E and F are very high as we used high amount of fibers are used.

8. CONCLUSIONS

Concrete compressive strength mainly depends upon the quality of Demolished Coarse Aggregates. Water absorption depends upon the quantity of Demolished Coarse Aggregates i.e. for fresh concrete it is 0.5 and for Demolished Coarse Aggregates it is 1.2.By previous records concrete with more than 50 percent replacement of Demolished Coarse Aggregates has significantly more shrinkage compared to nominal mix.

The properties of concrete such as modulus of elasticity and shrinkage deformation are lower for Demolished Coarse Aggregates compared to nominal mix. So this Demolished are not recommended for a structure of large deformations. In developing countries like India it is very difficult to dispose this demolished waste because it causes different environmental problems. So by this project it is proved that Demolished Aggregates is used in normal concrete practices. By the use Demolished Coarse Aggregates we can reduce cost. This Demolished Coarse Aggregates is eco-friendly. The scarcity of aggregates can also be reduced. The workability of concrete with Normal and Demolished Coarse Aggregates is almost same I also conclude that the demolition aggregates can be used for the manufacture of high strength concrete if they are efficiently designed and mixed.

By observing the done project, I can conclude that the reuse of the demolished aggregates reduces the waste on the land and it helps for the growth of green environment

The present research mainly predicts that the demolition aggregates can be safely used in high strength concrete by adding synthetic fibers.

The addition of polypropylene fibres reduces the flow characteristics and workability of the concrete mixture; however it also reduces bleeding and Segregation in the concrete mixture.

The mixing, placing, finishing and consolidation of the Polypropylene fibre reinforced concrete (PPFRC) needs careful attention and control as the performance of PPFRC is greatly affected by these.

The polypropylene fibers (PPF) reduce early age shrinkage and moisture loss

of the concrete mix even when low volume fractions of PPF are used.

Addition of the polypropylene fibers (PPF) has little or insignificant effect on the compressive strength of plain concrete.

Addition of the polypropylene fibers (PPF) increases the deformation capacity of concrete (in compression) and thus improves the material ductility of concrete.

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