

## STUDY OF MECHANICAL PROPERTIES IN CONCRETE WITH PLASTIC WASTE AND DEMOLISHED AGGREGATE

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### ABSTRACT

In the present scenario, no construction activity can be imagined without using concrete. Concrete is the most widely used building material in construction industry. As it is widely used for construction of various structures, the economy is depended upon the cost of material used in making concrete. On the other hand, due to rapid urbanization and industrialization all over the world, huge quantities of plastic waste and demolished waste are being generated. The disposal of these wastes is a very serious problem because, it requires huge space and also it causes environmental pollution. In this situation construction industry is in need of finding cost effective materials for increasing the strength of concrete.

So, in this project it is dealt with the possibility of using the plastic waste and demolished waste as the partial replacement

of fine aggregate and coarse aggregate in concrete mix. In this perspective, it is aimed at comparing the properties of conventional concrete mix with the concrete mix prepared using plastic waste and demolished aggregate.

In the present experimental investigation, plastic waste is used as replacement of fine aggregate partially by 10% and coarse aggregate is replaced with demolished aggregate partially by 0%, 10%, 20%, 30%, 40% and 50%. The conventional mix has been designed for M25 grade concrete and is adopted with a water-cement ratio of 0.45. In this investigation seven mixes are prepared; the specimens used are cubes of size 150mm x150mm x 150mm, cylinders of size 150mm x 300mm and impact moulds of size 150mm x 75mm.

Initially Conventional mix is prepared by using conventional materials (cement, natural sand, natural aggregate and water) and their physical and

mechanical properties were evaluated. Now, the concrete with recycled wastes are prepared and these are also tested for their properties, likewise all the seven mixes were prepared. For every mix 18 specimens (6 cubes, 6 cylinders, 6 impact specimens) were casted and. Specimens of every mix were tested for compressive strength at 7 and 28 days after curing.

### 1.INTRODUCTION

Now-a-days infrastructure development across the world created demand for construction materials. Concrete is the premier civil engineering construction material, concrete contains ingredients like cement, aggregates, water and admixtures. At present, huge quantities of construction materials are required in developing countries due to continued infrastructural growth and also huge quantities of plastic wastes and demolition wastes are generated every year in developing countries like India. The disposal of this waste is a very serious problem because on one side it requires huge space for its disposal while on the other side it pollutes the environment. It is also necessary to protect and preserve the natural resources like stone, sand etc. Continuous use of natural- resources, like river sand is another major problem and this increases the depth of river bed resulting in drafts and also changing the climatic conditions.

So, the sustainable concept was introduced in construction industry due to growing concern about the future of our planet, because it is a huge consumer of natural resources as well as waste producer. This has created what we call the biggest problem of the world, demolished waste and plastic waste accumulation. Hence there is a need to recycle these waste into something more useful and environment friendly. To achieve this, major emphasis must be laid on the use of waste from various industries. The use of aggregates from construction and demolition waste in pavement beds is the most usual way of reusing this material. Even though considered as a valid re-use technique, it is not the best economic valorization of this resource and it is considered by many researchers to be a down-cycling process that depreciates the capacities of the

material. But the production of structural concrete with recycled aggregates, however, offers great potential and recycles the materials viably and effectively. Research into new and innovative use of waste materials being undertaken world-wide and innovative ideas that are expressed are worthy of this important subject.

## II.REVIEW OF LITERATURE

In this chapter a brief literature survey conducted on utilization of plastic waste and demolished waste in making concrete has been presented.

Recycled aggregate is becoming an increasingly popular way to utilize aggregate left behind when structures or roadways are demolished and also the waste plastics which are produced from industries and households. In the past, these two wastes were disposed of in low lying areas, but with more attention being paid to environmental concerns, concrete recycling allows reuse of the plastic waste and demolished waste while also keeping construction costs down. When structures made of concrete are demolished or renovated and also when the plastics are thrown away after getting used, concrete recycling is an increasingly common method of utilizing the rubble and plastic waste individually or combined. Concrete and Plastic waste was once routinely trucked to landfills for disposal, but recycling has a number of benefits that have made it a more attractive option in this age of greater environmental awareness, more environmental laws and the desire to keep construction costs down.

Tomas U. Ganiron Jr. [1] has reported that Plastic as a substitute to fine aggregate to concrete mixture has shown unusual characteristic upon accumulation of water in the mixture for the material had floated on the surface of the water, nevertheless, upon the completion of mixing the material has suitably bonded to the mixture. In the analysis of its grain particle, in comparison to sand, which is one of the major components of concrete mixture, plastic, implies significant lightness in terms of its mass evaluation. Overall, the effect of the

plastic on the properties of the specimen was acceptable Shodolapo Oluyemi Franklin, Mmasetlthomo Tommy Gumede, [2] stated that it is obvious that structural compressive strengths may be developed in concretes incorporating up to 100% recycled aggregates based on standard mix design procedures. They also noted that the compressive, split tensile and flexural strengths, as well as the modulus of elasticity of recycled aggregate concretes, are generally lower than that

of conventional concretes made entirely from natural aggregates.

Ganesh Tapkire<sup>1</sup>, Satish parihar, et al.,[3] reported that by using the plastic in concrete mix reduces to the weight of cube upto 15% and it is possible to use the plastic in concrete and bonding admixture in concrete and also increase the percentage of plastic in concrete.

Shiva Kumar. M, Nithin K, B.M Gangadharappa, [4] reported that aggregate ratio of 1:8 with 50 % of CA and 50% of Building Demolished Waste (BDW) is recommended for low traffic volume. Similarly mix design with w/c ratio of 0.40 and 0.45 with 50% of CA and 50% of BDW is suitable for intended use. Youcef Ghernouti, Bahia Rabehi, et al.,[5] stated that the bulk density has decreased considerably for all concrete's with the content of replacement of sand by plastic waste that also becomes lighter than conventional concrete with 40% of plastic waste. Being given that the concrete must have good workability, fluidity is significantly improved by the presence of this waste. Ashraf M. Wagih, et al., [6] stated that concrete rubble could be transformed into useful recycled aggregate used in concrete production with properties suitable for most structural concrete applications.

## III.OBJECTIVE AND SCOPE OF INVESTIGATION

### GENERAL

From the brief literature survey conducted in this investigation it has been observed that even though lot of research work was conducted on utilization of plastic waste as fine aggregate in concrete mix and also demolished aggregate as coarse aggregate in concrete mix, but no work has been reported on the concrete made with replacement of sand with plastic waste and coarse aggregate with demolished aggregate combined. A M25 grade concrete with constant water cement ratio of 0.45 has been adopted to study various properties. Cubes of size 150 x 150x 150 mm, cylinders of 150mm dia x 300 mm height and impact specimens of size 150mm dia x 75 mm height were cast and tested to know the compressive strength, split tensile strength , modulus of elasticity etc.,

### OBJECTIVES

The specific objectives of the present investigation are as listed below.

- To conduct the feasibility study of producing concrete with plastic waste and demolished aggregate.
- To study the effect of various replacements of fine aggregate by

plastic waste with a constant percentage of 10% and replacement of natural aggregate by demolished aggregate in different percentages (0%, 10%, 20%, 30%, 40% and

50%) on workability properties, 28 days compressive strength, split tensile strength, modulus of elasticity etc.,

#### IV. EXPERIMENTAL INVESTIGATION

To start with mix design has been conducted for M25 concrete making use of ISI method of mix design using normal constituents of concrete. In the course of investigation, natural sand has been replaced by 10% (constant for all the mixes) of plastic waste and also coarse aggregate has been replaced by 0%, 10%, 20%, 30%, 40% and 50% of demolished aggregate. For the study of various properties different specimens has been cast and tested. Here a constant water-cement ratio of 0.45 has been adopted. The experimental part of the investigation has been planned in the following three stage.

**Stage I:** Selection of Materials and their testing

##### STAGE I:

Main constituents of concrete viz., fine aggregate, coarse aggregate, cement, water, plastic waste and demolished aggregate have been procured from various places. Fine aggregate has been procured from local river, coarse aggregate (20mm) has been procured from plant. Potable water is used for mixing and curing of concrete. Plastic waste (1-4mm sizes pieces) which is produced from households, factories, commercial places etc., has been procured from Estate (Bellary Bypass) and the demolished aggregate is obtained from demolished buildings, tested concrete specimens from laboratory are procured and made into pieces and they are sieved to 20mm size.

**Cement :**

A) Locally available Nagarjuna Ordinary Portland Cement (OPC) of 53 grade of cement brand conforming to ISI standards has been procured and various tests have been carried out according to IS8112-1989 from them it is found that Specific gravity of cement is 3.15

B) Initial and Final setting times of cement are 32 minutes and 580 minutes respectively

Fineness of cement is 4%

##### **Fine aggregate:**

Locally available river sand is procured and is found to be conformed to Zone-I of table 4

of IS:383-1970. Various tests have been carried out as per the procedure given in IS: 383-1970.

From them it is found that

- Specific Gravity of fine aggregate is 2.60
- Bulk Density

Loose:  $1400 \text{ kg/m}^3$

Compacted:  $1557 \text{ kg/m}^3$

- Fineness modulus of fine aggregate is 2.90

The sieve analysis results are presented in Table 4.1 and the set of sieves is shown in Plate 4.3

##### **Plastic Waste:**

The waste plastics are collected from dump sites and from various factories, the collected plastic is cleaned and made into pieces of varying size from 1-4 mm. Various tests have been conducted on plastic waste and following results are found out.

- Specific gravity of plastic waste is 0.46
- Density of plastic waste is  $72 \text{ kg/m}^3$
- Fineness Modulus of plastic waste is 4.7

**Coarse Aggregate:**

Machine crushed aggregate conforming to IS: 383-1970 consisting of 20mm maximum size of aggregates has been obtained from the local quarry. The test result of coarse aggregate as below.

- Specific Gravity of coarse aggregate is 2.64
- Water absorption of coarse aggregate is 1.02%

The sieve analysis results are presented in Table 4.2 and the set of sieves is shown in Plate 4.4

##### **Demolished Aggregate:**

Demolished aggregate is procured from demolished structures and the concrete specimens from laboratory. After collecting, they are broken down into pieces and also various tests are conducted on it.

- Specific Gravity of Demolished aggregate is 2.45
- Water absorption of demolished aggregate is 0.31%

The demolished aggregate is shown in Plate 4.2 and its sieve analysis results are presented in Table 4.3

##### **Water:**

Potable water which is available in the laboratory has been used in this experimental

program for mixing and curing.

#### V.DISCUSSION OF TEST RESULTS

This chapter explains about the fresh properties of concrete such as Workability, Density, and Compaction factor and also hardened properties such as compressive strength, split tensile strength, impact resistance. A comprehensive summary of the test results of the properties of all the concrete mixes are presented in tables and charts.

##### Properties of Fresh Concrete:

Visual observations during mixing and compaction of all the concretes suggested that the concretes were homogeneous; there was no segregation and bleeding, the mixes were compactable. The fresh state performance of the Plastic waste and Recycled aggregate concretes was comparable with control concrete. This observation suggests that addition of Recycled aggregate decreases workability. The workability and densities of fresh concretes were also tested and presented in Table 5.1.1 and Table 5.1.2. Fig 5.1.1 shows relationship between density of the concrete and % of Plastic waste and Recycled aggregate replacement, there was good relationship between the variables.

From the table 5.1.1 and figure 5.1.1 it may be observed that the density gets reduced with the replacement of sand by plastic waste and coarse aggregate with demolished aggregate from 0 to 50%.

The density of 100% natural aggregate concrete is  $2400 \text{ kg/m}^3$  and density of F (10% Plastic waste and 50%

Demolished waste) concrete mix is  $2100 \text{ kg/m}^3$ .

#### VI.CONCLUSIONS&RECOMMENDATIONS

From the work carried in this investigation following tentative conclusions can be drawn

1. Use of Plastic waste results in the formation of lightweight concrete.
2. The density of concrete is found to decrease with the increase in percentage replacements of sand by plastic waste and natural aggregate by demolished aggregate.
3. A small reduction in workability of resultant concrete has been observed
4. However maximum strength was shown by concrete mix having 10% plastic waste aggregates and 20% demolished aggregates. Hence this is supposed to be the best combination with respect to

compressive strength. On overall basis, it is observed that compressive strength increases with increase in demolished aggregate content and reaches an optimum value of 20% (and 10% plastic

5. waste) and afterwards it gets decreased for various contents of demolished aggregate.
6. The Split tensile strength of Plastic waste and recycled aggregate concrete is seen to decrease with increase in percentage of demolished aggregate (and also plastic waste) content and reaches an
7. optimum value at 20% (and 10% plastic waste) and afterwards gets decreased with increase in content of demolished aggregate.
8. Use of these waste materials not only cuts down the cost of construction, but also contributes in safe disposal of waste materials.
9. The production cost decreased remarkably.
10. This investigation concludes that, disposal of these (plastic and demolished) wastes is no longer a problem and this technique reduces the hazardous impact on environment.

#### RECOMMENDATIONS

The following recommendations are done from the investigation :

1. This type of concrete can be effectively used in construction of simple, unimportant and non-load bearing structures.
2. This type of concrete can be used in making of lightweight concrete.

#### VII.REFERENCES

- [1] Tomas U. Ganiron Jr. (2014) 'Effect of Thermoplastic as Fine Aggregate to Concrete Mixture' International Journal of advanced science and technology, volume 16.
- [2] Shodolapo Oluyemi Franklin1, Mmasethlomo Tommy Gumede, (2014) 'Studies on Strength and Related Properties of Concrete

Incorporating Aggregates from Demolished Wastes' Open Journal of Civil Engineering, 311-317,.

[3] Ganesh Tapkire<sup>1</sup>, Satish parihar, et al., (2014) 'Recycled plastic used in concrete paver block', IJRET Volume: 03 Special Issue: 09.

[4] Shiva Kumar. M, Nithin K, B.M Gangadharappa, (2014) 'Use of building demolished waste as coarse aggregate in concrete', IJRET, vol. (3).

[5] Youcef Ghernouti, Bahia Rabehi, Brahim Safi and Rabah Chaid, (2013) 'Use of Plastic Bag Waste in the Concrete' JIS Publications, vol.(8).

[6] Ashraf M. Wagih, Hossam Z. El-Karmoty, Magda Ebid, Samir H. Okba, (2013)'Recycled construction and demolition concrete waste as aggregate for structural concrete' HBRC Journal 9, 193-200.

[7] Mohd Monish, Vikas Srivastava<sup>1</sup>, V.C. Agarwal<sup>1</sup>, P.K. Mehta and Rakesh Kumar, (2013) 'Demolished Waste as coarse aggregate in concrete' J. Acad. Indus. Res. Vol. 1(9).

[8] Nitish Puri, Brijesh Kumar, Himanshu Tyagi, (2013) 'Utilization of Pulverized plastic in cement concrete as fine aggregate' International Journal of Innovative Technology and Exploring Engineering (IJITEE) Volume-2, Issue-2.

[9] Mohan Reddy, Bhavani and Ajitha, (2012) 'Local Construction And Demolition Waste Used As Coarse Aggregates In Concrete' IJERA Vol. 2, Issue 5, October.

[10] Ms. K.Ramadevi, Ms. R. Manju, (2012) 'Experimental Investigation on the Properties of Concrete With Plastic Bottle Fibers as Fine Aggregates', IJETAE, Vol. 2, Issue 6.

[11] R. Kumutha and K. Vijai, (2010) 'Strength of Concrete incorporating aggregates recycled from Demolition Waste' ARPN Journal, Vol. 5.