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# BEHAVIORAL STUDY OF CONSTRUCTION AND DEMOLITION WASTE LOW COST CONCRETE

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## ABSTRACT

Degradation of ground water quality take place by leachate generated from Construction and Demolition (C&D) waste material's landfill site. An illegal disposal site may also attract the illegal disposal of other types of waste, including conventional municipal waste, industrial waste and hazardous waste. This would further impact the site and increase the future cost for cleaning up an impacted or contaminated site. In view of protecting the environment, this study was carried out with an objective of utilizing demolished waste effectively. So, lean mix concrete of 1:3:6 was prepared and experiment was carried out by using concrete demolition waste with fly ash and M-sand as replacing materials instead of cement and fine aggregate. The compressive strength of concrete using the waste materials and replacing materials show that adding fly ash up to 50% is benefiting the users cost wise and strength wise. Hence, concrete demolition waste can be used to prepare lean mix. Moreover the experimental investigation reveals that the use of fly ash up to 50%, saving the cement and cement cost. In view of scarcity of river sand, it was replaced by M-sand and the strength of prepared concrete is coinciding with the value of compressive strength of normal concrete. Hence it is suggested that the demolition waste concrete, fly ash and M-sand can be used and utilized for the practical applications as lean mix.

**Key words-** Demolition waste, flyash, lean mix, M sand, reuse.

## 1. INTRODUCTION

Construction and Demolition waste is generated whenever any construction/demolition activity takes place, such as buildings, roads, bridges, flyover, subway, remodeling etc. These wastes are heavy, having high density, often bulky and occupy considerable storage space either on the road or

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communal waste bin[1]. It is commonly understood that this waste can be considered as a resource, either for reuse in its original form or for recycling or energy recovery [2]. Construction and Demolition waste waste recycling is among the most visible commitments, a developer can make to sustainable building, visible to every worker on the site and to every passerby [3,4]. There is critical shortage of natural aggregate for production of new concrete, on the another, the enormous amounts of demolished concrete produced from deteriorated and obsolete structures creates severe ecological and environmental problem [5,6]. To promote recycling and reuse of waste, more number of recycling plants should be installed and allowing the use of recycled aggregate instead of natural aggregate for some purpose [7]. High cost of building landfills with adequate environmental protection, public resistance to the construction of local landfills and an increased interest in reducing demand for natural resources have prompted many governments and municipalities to find ways to encourage the reuse and recycling of C&D waste [8]. Recycling of aggregate materials from construction and demolition waste may reduce the demand supply gap in both these sector. Recycling of C&D waste has many benefits such as reduction in transportation cost, keeps environment clean and reduces natural resource exploitation [9].

## 2. MATERIALS & METHODS

With the increasing human population the needs for the people also increases. But the point of concern is that there is no sufficient natural resources to service all our needs. So, we need to start recycling the waste to conserve our natural resources. It is important to recycle the waste so that we can at least conserve some of our natural resources for our generations to come.

### 3.1 Materials

#### 3.1.1 Location

An abandoned culvert was demolished near Perambur, Chennai, Tamilnadu, India. The demolished waste consists of concrete, mortar, bricks, coarse aggregate and the same was taken for the purpose of reusing through investigation.

#### 3.1.2 Size of demolished waste materials

The materials which were collected from the demolished bridge consist of various size. Following table lists the demolished materials and its size.

**Table1. Demolished materials and its size**

| Sl. No. | Demolished Materials | Size |
|---|---|---|
| 1. | Concrete | 50-80 mm |
| 2. | Coarse aggregate | 20 mm |
| 3. | Brick waste | 40-60 mm |
| 4. | Mortar | 50-60 mm |

### 3.2 Replacing fine aggregate and binding material by M- Sand and Fly Ash

#### 3.2.1 Fly Ash:

To prevent air pollution by the cement manufacturing process and to reduce carbon-dioxide emission in to the atmosphere it is the way of replacing the binding material in the construction activities with the another waste material like fly ash and also to reduce the burden of disposal of fly ash. So the ecology and the environment is conserved by the use of fly ash in the construction technology. In this investigation three fly ashes were used and are Thermal Fly Ash (TFA), Wet Fly Ash (WFA) and Complex Fly Ash (CFA). These are shown in Fig. 1,2 & 3.

**Fig. 1 Thermal fly ash**

**Fig. 2 Complex fly ash**

**Fig. 3 Wet fly ash**

### 3.2.2 M- Sand

Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost. Since this sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed. The M sand which was used in this research is shown in Fig. 4.

**Fig. 4 M-sand**

Thus, the cost of construction can be controlled by the use of manufactured sand as an alternative material for construction.

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### 3.3 Methods

The demolished materials such as bricks, concrete, mortar, coarse aggregates were segregated and they were crushed to its minimum size i.e., 20mm.

(a) Mortar (b) Concrete (c) Bricks

**Fig. 5 Segregation of waste materials**

### 3.3.1 Segregation

Different types of demolished wastes are segregated. The demolished materials such as mortar, concrete and bricks are shown in Fig.5.

### 3.3.2 Crushing:

The segregated waste is crushed to a minimum size of 20 mm with a help of steel hammer.

### 3.3.3 Batching:

It is the process of measuring concrete mix ingredients either by volume or by mass and introducing them into the mixture. Traditionally batching is done by volume but most specifications require that batching be done by mass rather than volume. Hence weigh batching is adopted in this study.

### 3.3.4 Casting

The C&D waste concrete was casted with standard cube for various replacement percentages. In the mix of 1:3:6, fine aggregate wass replaced by M-sand and cement was replaced by three different types of fly ashes. A compacting bar was used for compacting the concrete. It is a 380 mm long steel bar, weighs 1.8 kg and 25 mm diameter.

### 3.3.5 Testing

These specimens were tested by compression testing machine after 28 days of curing. Load was applied gradually at the rate of 140 kg/cm$^2$ per minute till the specimens fails.

## 3. RESULTS AND DISCUSSIONS

### 3.1 Characterics study of M sand and coarse aggregate from demolished material

The materials M sand and coarse aggregate from demolished material have been taken for specific gravity test by pycnometer method. The test results of specific gravity are shown in Table 2.

**Table 2 Specific gravity of M sand and coarse aggregate**

| Sl. No. | M Sand | Coarse aggregate |
|---|---|---|
| 1 | 2.65 | 2.72 |
| 2 | 2.67 | 2.73 |
| 3 | 2.63 | 2.69 |
| Average | **2.65** | **2.71** |

### 3.2 Proportions for the specimens with fly ash

The proportions for the specimens casted with Cement Concrete Waste, M sand and varying the percentage of fly ash as 10%, 20%, 30%, 40% &

50% for Thermal Fly Ash (TFA), Wet Fly Ash (WFA) and Complex Fly Ash (CFA) are shown in Table 3, 4 & 5.

**Table 3 Proportion of concrete mix using Thermal Fly ash**

| Specimen No. | Proportion |
|---|---|
| 1 | CCW+ cement(10% TFA) + M sand |
| 2 | CCW+ cement(20% TFA) + M sand |
| 3 | CCW+ cement(30% TFA) + M sand |
| 4 | CCW+ cement(40% TFA) + M sand |
| 5 | CCW+ cement(50% TFA) + M sand |

**Table 4 Proportion of concrete mix using wet flyash**

| Specimen No. | Proportion |
|---|---|
| 1 | CCW+ cement(10% WFA) + M sand |
| 2 | CCW+ cement(20% WFA) + M sand |
| 3 | CCW+ cement(30% WFA) + M sand |
| 4 | CCW+ cement(40% WFA) + M sand |
| 5 | CCW+ cement(50% WFA) + M sand |

**Table 5 Proportion of concrete mix using complex Fly ash**

| Specimen No. | Proportion |
|---|---|
| 1 | CCW+ cement(10% CFA) + M sand |
| 2 | CCW+ cement(20% CFA) + M sand |
| 3 | CCW+ cement(30% CFA) + M sand |
| 4 | CCW+ cement(40% CFA) + M sand |
| 5 | CCW+ cement(50% CFA) + M sand |

### 3.3 Proportions for the specimens with fly ash

The proportions for the specimens casted with cement concrete waste, M sand and varying the percentage of Brick Waste (BW) as 10%, 20%, 30%, 40% & 50% as a substitute of cement concrete waste is shown in Table 6.

**Table 6 Proportion of concrete mix using concrete with Brick waste**

| Specimen No. | Mixture |
|---|---|
| 1 | CCW (10% BW) + cement + M sand |
| 2 | CCW (20% BW) + cement + M sand |
| 3 | CCW (30% BW) + cement + M sand |
| 4 | CCW (40% BW) + cement + M sand |
| 5 | CCW (50% BW) + cement + M sand |

### 3.4 Compressive strength of concrete with fly ash

The results of compressive strength of specimens at 28 days curing with cement concrete waste, M sand and varying the percentage of fly ash (FA) as 10%, 20%, 30%, 40% & 50% for thermal fly ash, wet fly ash and complex fly ash are shown in Table 7,8 & 9.

**Table 7 Compressive strength of concrete cube using Thermal Fly ash**

| Specimen No. | Divisions | Compressive Strength |
|---|---|---|
| 1 | 259 | 11.50 $N/mm^2$ |
| 2 | 251 | 11.17 $N/mm^2$ |
| 3 | 249 | 11.05 $N/mm^2$ |
| 4 | 232 | 10.30 $N/mm^2$ |
| 5 | 226 | 10.06 $N/mm^2$ |

**Table 8 Compressive strength of concrete cube using Wet Fly ash**

| Specimen No. | Divisions | Compressive Strength |
|---|---|---|
| 1 | 231 | 10.26 $N/mm^2$ |
| 2 | 227 | 10.10 $N/mm^2$ |
| 3 | 222 | 9.86 $N/mm^2$ |
| 4 | 209 | 9.30 $N/mm^2$ |

| | | |
|---|---|---|
| 5 | 203 | 9.00 N/mm$^2$ |

**Table 9 Compressive strength of concrete cube using Complex Fly ash**

| Specimen No. | Divisions | Compressive Strength |
|---|---|---|
| 1 | 266 | 11.30 N/mm$^2$ |
| 2 | 249 | 11.05 N/mm$^2$ |
| 3 | 244 | 10.85N/mm$^2$ |
| 4 | 224 | 9.95N/mm$^2$ |
| 5 | 216 | 9.60 N/mm$^2$ |

### 3.5 Compressive strength of concrete cube using concrete with Brick waste

The results of compressive strength of the specimens at 28 days curing casted with cement concrete waste, M sand and varying the percentage of brick waste as 10%, 20%, 30%, 40% & 50% as a substitute of cement concrete waste is shown in Table 10.

**Table 10 Compressive strength of concrete cube using concrete with Brick waste**

| Specimen No. | Divisions | Compressive strength |
|---|---|---|
| 1 | 30 | 5.25 N/ mm$^2$ |
| 2 | 34 | 4.95 N/ mm$^2$ |
| 3 | 36 | 4.50 N/ mm$^2$ |
| 4 | 38 | 3.88 N/ mm$^2$ |
| 5 | 40 | 3.55 N/ mm$^2$ |

Specimens 1 to 5 (Table 7) of concrete waste with varying percentage of thermal fly ash such as 10, 20, 30, 40, 50 has the compressive strength of 11.50, 11.17, 11.05, 10.30, 10.06 N/mm$^2$. Specimens 1 to 5 (Table 8) of concrete waste with varying percentage of wet fly ash such as 10, 20, 30, 40, 50 has the compressive strength of 10.26, 10.10, 9.86, 9.30, 9.00 N/mm$^2$. Specimens 1 to 5 (Table 9) of concrete waste with varying percentage of complex fly ash such as 10, 20, 30, 40, 50 has the compressive strength of 11.30, 11.05, 10.85, 9.95, 9.60 N/mm$^2$.

So, the compressive strength of concrete with fly ash is high when compared to normal strength of concrete so it can be suggested.

Specimens 1 to 5 (Table 10) of concrete waste with brick waste has the compressive strength of 5.25, 4.95, 4.50, 3.88 & 3.55 N/mm$^2$. The compressive strength of concrete with brick waste is very less when compared to normal strength of concrete so it cannot be suggested.

In support of this research, it was found by the researcher [11] that replacement of natural fine aggregates up to 31.97 % by recycled construction and demolition waste is effective. The investigation [12] reveals that recycled aggregate concrete containing 40% fly ash increases compressive strength.

## 4. Conclusions

The study was carried out with an objective of utilizing demolished waste effectively. So, lean mix concrete of 1:3:6 was prepared and experiment was carried out by using concrete demolition waste with fly ash and M-sand as replacing materials instead of cement and fine aggregate. The compressive strength of concrete using the waste materials and replacing materials shows that adding fly ash up to 50% is benefiting the users cost wise and strength wise. At the same time the compressive strength of concrete using M-sand is almost same as that of using river sand. Hence, concrete demolition waste can be used to prepare lean mix and the same can be used for practical applications such as base concrete to retaining walls, concrete to the lining of canals and for improving the bearing capacity of sub-grade of road structure.

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