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"Utilization of Construction & Demolition Waste in High & Low Strength Concrete"

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Abstract – *Construction and Demolition waste has turned out to be a very serious issue in India as well as in entire world. Construction and Demolition waste has no proper remediation in actual practice across globe, thus finding solution for the same is a necessity for a sustainable and clean environment. This research work mainly focuses on identifying the proper or appropriate crushing technique for the construction and demolition waste. Later it deals with sieving the Construction & Demolition waste into coarse and fine aggregates with respect to its suitability for use in construction components. Research work later finds out optimum replacement for construction and demolition waste in construction of high & low strength such as M55 & M25.Various trials of replacement ratios for testing the concrete cubes for 7, 21 & 28 days are carried out.*

1. INTRODUCTION

Constructiona and Demolition waste has become one of important problem in many developed as well as developing countries.Managing construction and demolition waste in sustainable way is a major concern for all developed as well as developing countries. Construction and demolition waste is serious concern all over the world. Due to quick growth of urbanization and a notable number of impermissible dumps Construction and demolition waste has taken a eye opening stand in many researchers. Increasing population as well as rapid urbanization is the main culprits or major reasons for generation of construction and demolition waste. Demolition materials like concrete bricks, wallboards, plaster, asphalt, waste concrete, sanitary waste, scrap metal products, rubber, plastic etc. Since the construction and demolition waste is a major concern all over world, study on remediation of construction and demolition waste is carried out. Use of construction and demolition waste in high strength concrete as well as low strength is being carried out in this particular project research.

As per Rule 3 (c) of the C & D waste rules (2016) "Construction and Demolition waste" - waste comprising of building materials, debris and rubble resulting from construction, re-modeling, repair and demolition of any civil structure. The rules applies to every waste resulting from construction, re-modeling, repair and demolition of any civil structure of individual or organization or authority who generates construction and demolition waste such as building materials, debris & rubble.[16]

Fig -1: Construction & Demolition Waste

1.1 Study Area

Various samples of construction and demolition waste were collected from various places in and around Kolhapur city in Maharashtra. Initially waste samples were segregated in different sizes and total weight was checked. Testing such as water absorption and specific gravity was carried out.

Fig -2: Site of Construction & Demolition waste

2. METHODOLOGY

Proper crushing technique was identified for the construction and demolition waste. Two methods identified for crushing were manual crushing and mechanical crushing. Both showed equivalent amount of crushed sizes of construction and demolition waste. Manual crushing mainly deals with manual labor crushing the waste sample with the help of hammer. Mechanical crushing was carried out by mechanical crusher developed by some private companies. Construction and demolition

waste was segregated as coarse and fine aggregates with the help of 4.75 mm sieve. Later initial proceedings and tests such as segregation of construction and demolition waste, weighing, tests such as specific gravity and water absorption were carried out on collected samples of construction and demolition waste

Fig -3: Manual Crushing

Fig -4: Experimental setup for Sp. gravity

Replacement of natural coarse and fine aggregate in concrete by construction and demolition waste was carried out. Extremes such as high strength concrete such as M55 & low strength concrete such as M25. Different replacement percentages for high strength as well as low strength concrete were finalized as per literature review. As per the literature review done, optimum replacement ratio was found to be between 30 to 50 % for the replacement of natural coarse and fine aggregate with construction and demolition waste[12]. Replacement ratios for both natural fine and coarse aggregate in high strength concrete M55 were 5%, 8%, 12% and 20%. These 5%, 8%, 12% and 20% depict 5% of Construction and demolition waste & 95% of natural coarse and fine aggregate, 8% of Construction and demolition waste & 92% of natural coarse and fine aggregate, 12% of Construction and demolition waste & 88 % of natural coarse and fine aggregate and 15% of Construction and demolition waste & 85 % of natural coarse and fine aggregates.

Fig -5: Construction & Demolition Waste in Concrete

Replacement ratios for both natural fine and coarse aggregate in low strength concrete M25 were 15%, 30%, 45% and 60%. These 15%, 30%, 45% and 60% depict 15% of Construction and demolition waste & 85% of natural coarse and fine aggregate, 30% of Construction and demolition waste & 70% of natural coarse and fine aggregate, 45% of Construction and demolition waste & 55 % of natural coarse and fine aggregate and 60% of Construction and demolition waste & 40 % of natural coarse and fine aggregates.

Fig -6: Concrete cubes casted with construction & Demolition waste

Trials of natural concrete replaced with construction and demolition waste were prepared. Cubes of M55 & M25 were prepared with Mix Design calculations. Cubes of M55 & M25 with replaced coarse & fine aggregates with construction and demolition waste were prepared. Cubes were casted for 7 days, 21 days & 28 days respectively for checking the strength of concrete replaced with construction and demolition waste

Fig -7: Curing of Cubes

3. RESULT AND DISCUSSION

3.1 Initials tests & Crushing

3.1.1 Segregation of Concrete waste revived from Site

Total Weight of sample collected =29.89 kg

Size of CDW	Weight (Kg)	Percentage
10cm-18cm	12.790 kg	42.51%
5cm-7cm	10.950 kg	36.40%
2cm-4cm	6.150 kg	20.44%

3.1.2 Crushing of Sample

Total weight of sample = 1873.3 gm

Weight of sample retained on 4.75 mm = 1674.4 gm

Percentage of sample retained = 89.38%

Weight of sample passing from 4.75 mm = 201.1 gm

Percentage of sample passing from 4.75 mm = 10.61%

3.2 Engineering Tests on Construction & demolition waste revived from site

3.2.1 Coarse sample Construction and Demolition waste

Weight of sample = 400gm

Weight of vessel + Sample + Water = 1.1380gm
Wt of vessel + water = 1.170gm
Wt of saturated & surface dry sample = 0.395gm
Wt of oven dry sample = 0.390gm
Specific gravity of sample = 2.16
Water absorption = 0.5%

3.2.2 Fine sample Construction and Demolition waste

Mass of empty pycnometer = 0.550 gm
Pycnometer + dry sample = 0.583 gm
Pycnometer + sample + water =1.492 gm
Pycnometer with full water = 1.429 gm
Specific gravity = 2.32

3.3 Mix Design of M55 & M25 Concrete Cubes

3.3.1 M55 concrete cubes

Grade of concrete – M55

Characteristic compressive strength for 28 days = 55 N/mm^2

Type of exposure – Moderate

Fine Aggregate – Zone 2

Specific gravity of cement – 3.15

Specific gravity of water- 1

Specific gravity of coarse aggregate- 3.076

Specific gravity of fine aggregate- 2.547

Water Cement ratio- 0.5

As per **IS 456:2000 & IS 10262-2009** Mix Design procedure

Proportions for trial mix for $1m^3$:

Cement (kg/m^3): 413.3

Water (kg/m^3): 186

Fine Aggregate (kg/m^3): 624.61

Coarse aggregate (kg/m^3): 1284.42

W/C Ratio: 0.45

3.3.2 M25 concrete cubes

Grade of concrete – M 25

Characteristic compressive strength for 28 days = 25 N/mm^2

Type of exposure – Moderate

Fine Aggregate – Zone 2

Specific gravity of cement – 3.15

Specific gravity of water- 1

Specific gravity of coarse aggregate- 3.076

Specific gravity of fine aggregate- 2.547

Water Cement ratio- 0.5

As per IS 456:2000 & IS 10262-2009 Mix Design procedure

Proportions for trial mix for $1m^3$:

Cement (kg/m^3): 372

Water (kg/m^3): 186

Fine Aggregate (kg/m^3): 673.63

Coarse aggregate (kg/m^3): 1327.35

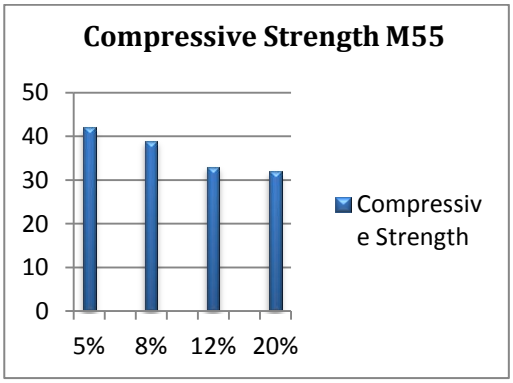
W/C Ratio: 0.45

3.4 Compressive Test Results

Fig -8: Compressive Testing Set up

3.4.1 M55 Concrete cubes replacement with Construction and Demolition Waste

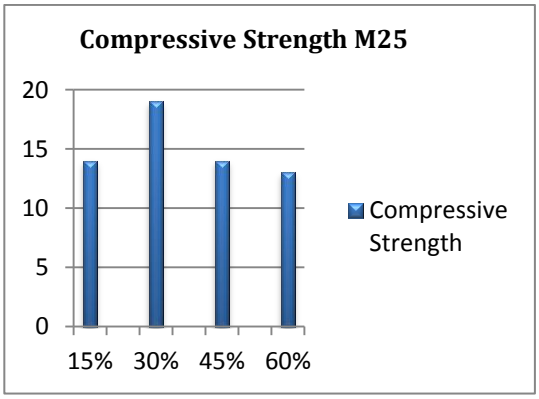
	5%	8%	12%	20%
7 Days	24 N/mm²	23 N/mm²	19 N/mm²	18 N/mm²
21 Days	39 N/mm²	37 N/mm²	28 N/mm²	28 N/mm²
28 Days	42 N/mm²	39 N/mm²	33 N/mm²	32 N/mm²



Graph -1: Compressive Test results M55

3.4.2 M25 Concrete cubes replacement with Construction and Demolition Waste

	15%	30%	45%	60%
7 Days	11 N/mm²	13 N/mm²	10 N/mm²	11 N/mm²
21 Days	13 N/mm²	18 N/mm²	14 N/mm²	13 N/mm²
28 Days	14 N/mm²	19 N/mm²	14 N/mm²	13 N/mm²



Graph -2: Compressive Test results M25

4. CONCLUSION

Construction and demolition waste can be used as replacement of natural coarse and fine aggregate. It cannot be totally replaced with 100% replacement of natural coarse and fine aggregates. In high strength concrete such as M55 optimum replacement ratio of construction & demolition waste with natural coarse and fine aggregates is 5% whereas for low strength concrete such as M25,optimum replacement ratio of construction & demolition waste with natural coarse and fine aggregates is 30%. Replacement ratios for different strength of concretes will also vary accordingly.

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