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Use of Construction and Demolition Waste as Partial Replacement of Fine Aggregate for Development of Paving Block

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Abstract – India is beetle of both reclamation sites and landfill space for the disposal of construction and demolition (C&D) waste. It is important for India to adopt a strategy to reduce, reuse and recycle C&D waste. One of the ways to achieve this is by The use of C&D waste in paving blocks as partial replacement of fine aggregate, reducing the quantity of C&D waste as well as the cost of fine aggregate in concrete. Different mix proportions were prepared for 0%, 20%, 40%, 60%, 80% replacement of C&D wastes fine aggregate. The compressive strength of paving block was measured. The results showed that maximum strength is achieved between the ranges of 40% to 60% replacement of fine aggregate with C&D waste fine aggregate, saving 3.28% cost of concrete. The study indicated that the C&D waste can effectively replace fine aggregate with little increase in strength.

Keywords:- C&D waste, Compressive Strength, Paving Blocks, and Percentage Replacement of Fine aggregate.

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I. INTRODUCTION

C&D waste generates during the construction, renovation, and demolition of building, roads, and other structures. C&D materials often contain materials that include: concrete, asphalt, wood, metals, gypsum, plastics and salvaged building components. It is a challenging task to handle C&D waste because it is bulky, heavy and inert and alsomixture of various materials of different characteristics. It is also difficult to choose any suitable disposalmethod, for example, it cannot be incinerated due to its high density and inertness. With the advent ofsustainable practices in the construction industry, C&D waste generation and handling issues have beenin focus to achieve the sustainable goals for our common future. Reduce, Reuse, Recycle philosophy is highly useful in handling of C&D waste. The better practice to handle C&D waste is tominimize generation of C&D waste, but sometimes it is unavoidable due to various issues such aschange-orders or demolition requirements for redevelopment. C&D waste issues are more importantfor the developing countries, which are entering or already entered in construction boom era. It is foundthat many countries in Asia do not have specific regulations designed for C&D wastes, although somecountries include some sections in their solid waste management regulations and/or related policies. It wasalso mentioned that very small percentage of waste from construction industry is reused or recycled,the majority being deposited or used as landfill. Like other developing countries, India is also enjoyingconstruction boom. With the rapid growth in construction activities of India it is appropriate to link thegeneration of C&D waste with the growth of construction industry and related issues. It is also essential to study C&D waste generation and handling to develop accurate data and establish.

II. METHODOLOGY

The blocks were 25×13.5×6 mm in dimension and were produced to get fair idea. Recycled aggregates were used in proportions of 0, 0.20, 0.40, 0.60, and 0.80 to replace fine aggregate. The Best proportion for percentage replacement of C&D waste fine aggregate was decided based on compressive strength of paving block that was tested experimentally.

A. Mix Design

The paving blocks usually of pre-cast cement concrete units require dry, low slump mixes. Mix design is

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carried out to form M30 grade of concrete by using IS10262: 2009. Five different mixes were prepared using fine aggregate replaced C&D waste fine aggregate at varying percentage of 0, 20, 40, 60 and 80.

Table 1: Mix Design

% REPLACEMENT OF C&D WASTE FA	0%	20 %	40 %	60 %	80 %
Cement(Kg)	416	416	416	416	416
Water(Kg)	262	262	262	262	262
Fine Aggregate(Kg)	1019	815	611	407	203
Fine C&D Aggregate(Kg)	0	176	354	531	708
Coarse Aggregate(Kg)	928	928	928	928	928

B. Casting of Interlocking Concrete Paving Blocks

The interlocking concrete block specimens of plan area 40126 mm2 and thickness of 59.3 mm were cast according to mix proportion in a rubber mould of red shape.

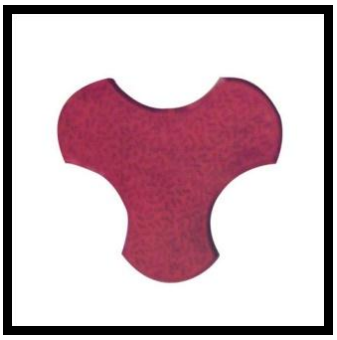

Figure 1: Shape of Paving Block

III. TESTING

A. Compression Test

Compressive strength of paving blocks wasdetermined in accordance to IS: 2185 (Part1): 2005 as well as IS 15658: 2006. As per IRC: SP: 63: 2004 minimum compressive strength of a single block should be above 30 MPa for non-traffic road. Recommended minimum grades of paver blocks for different traffic categorieswere specified by IS 15658: 2006.

B. Flexural Test

Flexural strength of paving blocks were measured and expressed in terms of flexural stress or in the form of breaking load specified by IS 15658: 2006. It is suggested that minimum flexural strength of a single paving block should be above 4.50 MPa.

C. Split Tensile Test

Split Tensile Strength of paving block were determined by testing according to IS 15658: 2006. The characteristic split tensile strength shall not be less than 3.6MPa. None of the individual results shall be less than 2.9 MPa.

D. Abrasion Test

Abrasion Resistance test of paver block was done in accordance to IS: 15658: 2006. The abrasion resistance of specimen is tested by Tile abrasion testing machine or Bohme disc abrader. The specimen for abrasion testing was cut from the whole concrete paving block. The test specimens shall be square in shape and of size 7.06 x 7.06 cm(i.e., 50 sq.cm in area). As per IS: 15658: 2006 the wearing depth should not exceed 3.5 mm of concrete block used for general purpose and should not exceed 2.0 mm for heavy traffic. The abrasion resistance of the concrete paving blocks, when tested as per IS:15658: 2006 shall not have volume loss greater than 15 cum. per 50 sq.cm.

E. Water Absorption Test

Water absorption of concrete paver block was determined as per IS: 15658: 2006. As per IS:15658: 2006 water absorption of individual concrete paver block should not be greater than 7% or maximum 6% by mass (i.e., Average of 3 units).

IV. TEST RESULTS

Test results were presented graphically and in tabular forms and have been discussed under different categories.

A. Compressive Strength

Figure 2: Compression Test

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Compressive strength of paver block were determined in accordance to IS: 2185 (Part1):2005 as well as IS 15658: 2006. The apparent compressive strength of individual specimen shall be calculated by dividing the maximum load (in Newton) by the plan area (in sq.mm). The corrected compressive strength shall be calculated by multiplying the apparent compressive strength by the appropriate correction factor.

Table 2: Compressive Strength

Percentage replacement of C&D waste fine aggregate	No.of specimens tested	Average load obtained (KN)	Compressive strength of paver block (N/mm^2)
0	8	1935.63	48.23
20	8	1944.83	48.86
40	8	1967.33	49.02
60	8	1958.70	48.81
80	8	1916.93	47.77

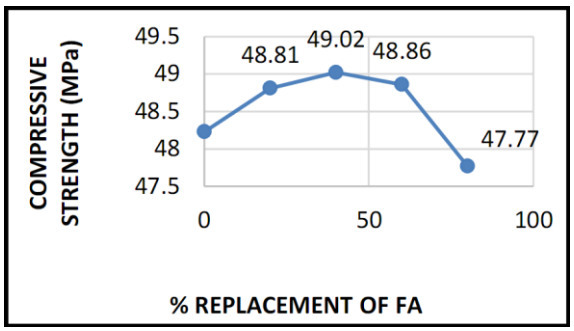

Figure 3: Graph Showing Variation of Compressive strength

B. Flexural Strength

Result of flexural strength for concrete paving block was 4.8Mpa greater than 4.5Mpa, hence satisfied minimum requirement.

Figure 4: Flexural Test

C. Split Tensile Strength

Result of split tensile strength for concrete paving block was 3.8 Mpa greater than 3.6 Mpa, hence satisfied minimum requirement.

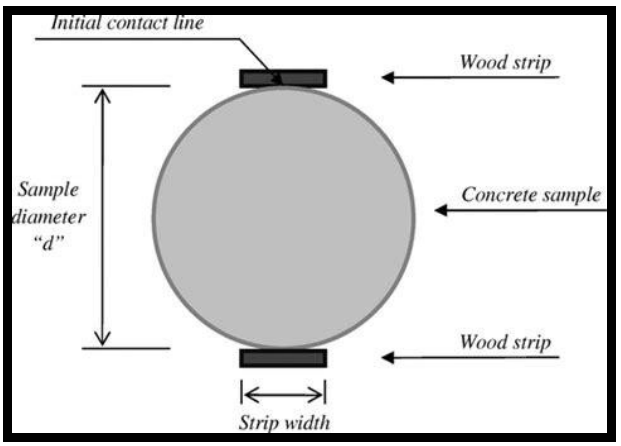

Figure 5: Split Tensile Test

D. ABRASSION RESISTANCE

Result of abrasion test for concrete paving block with was 2.3mm less than 3.5 mm, hence satisfied maximum wearing depth criteria.

Figure 6: Abrasion Test

Table 3: Abrasion Value (mm)

Age Days	Variation of % replacement of FA				
	0	20	40	60	80
28	2.31	2.31	2.32	2.31	2.32
56	2.32	2.30	2.31	2.30	2.30

V. CONCLUSIONS

- Higher compressive strength was achieved when 40% to 60% fine aggregate was replaced by C&D waste fine aggregate.
- The characteristics split tensile strength were satisfied.
- Water absorption by the paving block was within permissible limit.
- The characteristics flexural strength was satisfied.
- The abrasion was within permissible limit.

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