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Use of Construction and Demolition Waste in Rigid Pavement

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***Abstract* — Road construction in India has gone through big differences in the past two decades attributable to modern technology. The usage of recycled material has many welfares consisting of cost saving in their disposal, dumping and recyclability. Examples included materials of recycled crushed bricks and recycled concrete. This is leading road construction on the right track closer to sustainable one. The recycled construction and demolition waste material is sized to 20mm aggregate and the feasibility of such substances in rigid pavement. We evaluated the strength characteristics of C&D waste material concrete for M40 grade of concrete. The work has been done structural specimen like beams and cubes and evaluated compressive, split tensile strength, flexural strength for different binding material proportions and solution concentration. This helps to ease landfill pressure, extraction load and natural resources.**

Keywords: Sustainable, Recycled Materials, Rigid Pavement.

I. INTRODUCTION

Due to rapid growth of construction in India, huge amount of Construction & Demolition (C&D) waste is generated. C&D waste is recognized as one of the major issues in the construction industries. It could cause great effects on human health and the environment. There is big quantity of aggregates is required in the housing and transportation these days. The C&D waste aggregate is generally produced by the crushing of concrete rubble, then screening and removal of contaminants such as plaster, paper, reinforcements, wood, plastic and with the use of jaw crusher for obtaining coarse recycled aggregate in 20mm size are used in construction activities. This eco-friendly action lead to reuse and recycling of these types of wastes. Concrete made up of C & D aggregate is called Demolished aggregate concrete. The recycled aggregate is suggested as a replacement to the natural aggregates in road and building construction activities.

C&D waste has huge demand for recycling and economic value, 80 percentage of which may be re-used. Due to high dumping cost for demolition waste, suggested that today, recycling the construction and demolition waste is an inexpensive opportunity to the existing unsustainable disposal techniques such as land filling and fly tipping. Recycling of C&D waste is reducing emission rates and also reduces the costs associated with new material purchases.

This study aims to discover the possibility of C&D in various base layer of rigid pavements. Construction and demolished waste are used as coarse aggregate in rigid pavement. The usage of C&D waste in rigid pavement is carried out using the usual concrete technology methods. As the C&D waste aggregate is the lighter than the natural aggregate. A processed C&D material, used for road construction, is to assessed for its environment, health and safety hazards, physical, chemical and engineering properties, cost effectiveness, field performance etc.

Junhui Zhang, Fan gu (2019 geared towards assessing the feasibility of the use of the recycled construction and demolition waste in motorway embankment. First, the recycling of C&D wastes was elaborated, concerned both the manual and mechanical sorting tactics. The physical and chemical composition of recycled construction and demolition waste were additionally investigated, which all met the requirements. [1].

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A.Busari,E.Adeyanju(2019) tested the technology of construction and demolition waste generated in many countries, waste characterized, and usage in pavement production additionally, concluded that there could be discount in the electricity cost associated with mining, extraction and transportation of natural aggregates in track with the conservation of natural resources and the construction of price-effective pavement [2]. Mansi Jain et al (2012) studied on the aspects of waste minimization of construction waste material in terms of cost savings of construction project in India. He found that the various causes for the waste generation like lack of awareness among owners and contractors, lack knowledge of labour, lack of proper training and education towards waste minimization system [3].

Abhijith Harikumar, Sreejith M H (2014), suggested the reusing of the material waste is very good and helpful especially when it will be useful in minimizing demolition of earth's stone crust and green forest cover by aim of reduced mining. By proper reduce, reuse and recycling, these waste materials will not addition of wastes at dumping and disposal sites. It is proved that construction industry can help by encouraging use of recycled concrete stones and bricks and its commitment to protection of environment [4].

II. MATERIAL COLLECTION

A. Selecting and Obtaining of Required Material

The project is about the Construction and demolished waste are used as coarse aggregate in rigid pavement. The demolished concrete waste is collected from demolition On-Site building used as course aggregate in the design of rigid concrete. The process involved in obtaining the concrete waste is demolition, segregation, transportation and management.

B. Collecting of Waste

Construction and demolished waste is being collected from the sites of demolition and transported to the segregation plant using trucks and tractors. In the segregation plant we can separate the sand waste, brick bat, and the heavier concrete waste which is then graded by normal grading techniques.

C. Construction and Demolished Waste Processing

In many countries C and D waste is processed and used. The processing is done in processing plants. The processing plant is classified into mobile processing unit and stationary processing unit as shown in the fig 1. The process involved is crushing, sieving and washing machinery interconnected by conveyer belts for material moment. The difference between stationary and mobile crushing is that equipment will be mounted on a mobile truck whereas in stationary unit it is fixed at one place. Mobile crushing has a advantage that crushing of material happen without transporting material from one place to another. Mini mobile crusher has an advantage that it can handle ULBs generating less than 1 or 2 trucks loads of C&D waste per day as shown in fig 2.

Fig. 1. (a) Stationary Processing Unit; (b) Mobile Crushing Unit

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Fig. 2. Mini Mobile Crushes

D. Secondary Construction Raw Materials

The secondary raw materials are 10mm ,20mm ,40mm coarse aggregate, Brick bats of size 20mm & 40mm, manufactured sand, clay and dust as shown in the fig. 3 and the process as shown in the fig.4.

Fig. 3. Secondary Construction Raw Materials

E.Segregation

The C& D waste are segregated as Reused waste, recyclable waste and non-Recyclable waste. The Process of segregation is done as shown in Fig. 4.

a

b

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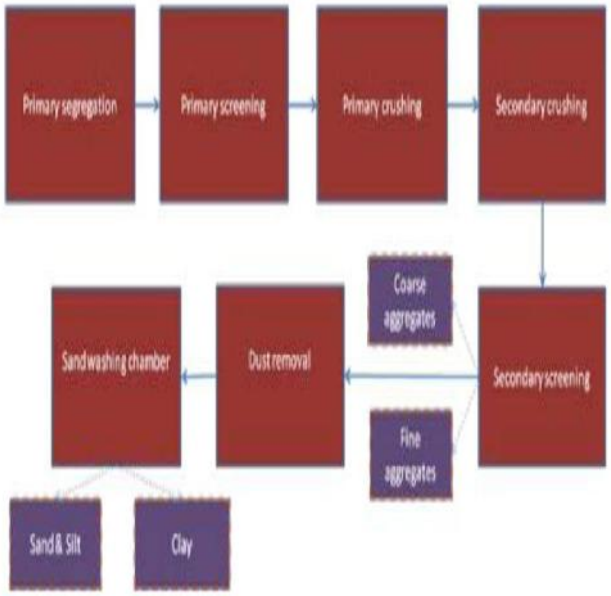

Fig. 4. Process of Segregation
Source: Training Manual on C&D Waste Management in India for Cities and Towns

III. Material Testing

A. Aggregate testing

Basic material testing like specific gravity, sieve analysis, water absorption test was conducted on both coarse aggregate of recycled aggregate and fine aggregate as shown in the table 1. The available river sand is used as fine aggregate. The proportion of passing is under the limits according to IS: 383-1970. Crushed recycled C and D aggregate was used as coarse aggregate. The coarse aggregate according to IS 383-1970 was used.

TABLE 1. MATERIAL TESTING

Properties	Obtained value
Specific Gravity of Fine Aggregate	2.55
Specific Gravity of recycled C & D Aggregate	2.72
Fineness Modulus of Fine Aggregate	3.104
Fineness Modulus of recycled C & D Aggregate	6.73
Water absorption of Fine Aggregate	1%
Water absorption of recycled C & D Aggregate	0.9 %

B. Mix Proportion

The process of selecting suitable substance of concrete and figuring out their relative amounts with the objective of producing a concrete of the required, strength, durability and workability as

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economically as possible, is called the concrete mix design. The mix proportion for M40 is given in the table 2.

TABLE 2. MIX PROPORTION FOR M40

Materials used	Mix proportion
Cement content	492.5 kg/m^3
Water	197 liters
Fine aggregate	751.74 kg
Proportion of Recycled aggregate: Normal aggregate	40:60
Coarse aggregate	999.93 kg
w/c ratio	0.40

C. Specimen Preparation and Testing

Construction and Demolished waste concrete were prepared by mixing the dry materials such as construction and demolished waste aggregate, M-sand and cement and water primarily based on the combination proportions. The dimensions of the test specimen that was casted is 150mm x 150mm x 150mm was casted as shown in the Fig.6 and tested for compressive strength. Flexural strength test was conducted on a specimen of size 500mm x 100mm x 100mm. After 24 hours, the mould is disassembled as shown in the Fig. 6. Concrete mix proportions of M40 is used for the preparation of specimens. Recycled aggregate specimens is prepared by replacing 40% of demolished concrete and the specimens were cured by using tap water and tested for 7th and 28th days as shown in fig.5.

Fig. 5. (a) Casting of the specimen :(b) Curing of the specimen

IV. EXPERIMENTAL INVESTIGATION ON RECYCLED CONCRETE

A. Compressive Strength Test

The size of the cubes that were casted 150mm x 150mm x 150mm. 9 specimens were casted for all the proportion in M40 grade with 40 % recycled aggregate and its 7th day, 14th day and 28 th day strength values were depicted and comparison were made between conventional concrete and C & D waste recycled concrete as illustrated in table 3.

TABLE 3. COMPRESSIVE STRENGTH FOR CONVENTIONAL CONCRETE AND C & D WASTE RECYCLED CONCRETE

Journal of Current Research in Engineering and Science
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Days	Conventional Concrete	C & D Waste Concrete
7th day	26.23 N/mm^2	28.60 N/mm^2
14th day	30.32 N/mm^2	30.56 N/mm^2
28th day	40.52 N/mm^2	41.42 N/mm^2

B. Flexural Strength and Split Tensile Strength Test

The dimensions of the beam for flexural strength that was casted is 500mm x 100mm x 100m and for split tensile strength of concrete specimen dimension is 150 mm x 300 mm under three point loading. Each 9 specimens were casted for all the proportion in M40 grade with 40 % recycled aggregate and its 7th day, 14th day and 28 th day flexural strength values were depicted and comparison were made between conventional concrete and C & D waste recycled concrete as shown in table 4 and table 5

TABLE 4. FLEXURAL STRENGTH FOR CONVENTIONAL CONCRETE AND C & D WASTE RECYCLED CONCRETE

Days	Flexural Strength for Conventional Concrete (N/mm^2)	Flexural Strength for C & D Waste Concrete (N/mm^2)
7th day	2.667	2.140
14th day	3.767	3.514
28th day	4.441	4.485

Journal of Current Research in Engineering and Science
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Volume 5- Issue 1, Paper 6 January 2022

TABLE 5. SPLIT TENSILE STRENGTH FOR CONVENTIONAL CONCRETE AND C & D WASTE RECYCLED CONCRETE

Days	Conventional Concrete (N/mm^2)	C & D Waste Concrete (N/mm^2)
7th day	2.351	2.973
14th day	3.560	3.587
28th day	3.892	3.902

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IV. CONCLUSION

Based on study below conclusion are drawn:

- The performed laboratory tests that recycled aggregates had comparable overall performance with crushed gravels as used in rigid pavement construction. As the results recycled aggregates presents a continuous grading curve, an important characteristic for the performance of the cement concrete slabs.
- The compressive strength at 28 days increases with increases in the proportion of the recycled aggregate. The compressive power at 40% substitute of the aggregates by the recycled aggregates attains maximum value.
- Rigid pavement carries higher flexural strength, compression strength by C&D waste aggregate were casted as aggregate mix in cube and prism and curing is done and the strength is determined more life span with low maintenance cost and more economical.
- The physical and chemical properties of C&D waste were similar to natural aggregate. It is feasible for usage of aggregate in urban roads pavements.
- Ecological can be reduced by avoiding natural aggregate extraction from river and quarries.

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