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A Review on Effective Utilization of Construction and Demolition (C & D) Waste as Recycled Aggregates (RA) in Concrete

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***Abstract*: Over the years there has been a change in the use of building materials. Cheap and locally available materials such as moulded earth bricks, stones, thatch, timber, steel, aluminium, plastics and fibers of various types and forms have replaced the traditional and costly materials. However, all these materials have been developed to meet specific requirements of climate, availability of skilled labour and specific raw materials to effect the desired economy. Demolition of old structures to make way for new and modern ones is common features in metropolitan areas due to rapid urbanization. However, very little demolished concrete is recycled or reused. The strict environmental laws and lack of dumping sites in urban areas on one hand are making the disposal of demolition wastes problematic while on the other hand the quarrying of raw materials is becoming difficult. The present paper effective utilization of construction and demolition (c & d) waste as recycled aggregates based on strength and workability of concrete are reviewed. Various conclusions drawn from the literature papers, throws light on effective utilization of construction and demolition waste in concrete and create awareness among contractors, site Engineers and practicing Civil Engineers.**

***Keywords*: Demolition waste aggregate, Demolition waste fine aggregate, Demolition waste powder, Concrete**

1. Introduction

Over the years there has been a change in the use of building materials. Cheap and locally available materials such as moulded earth bricks, stones, thatch, timber, steel, aluminum, plastics and fibers of various types and forms have replaced the traditional and costly materials. However, all these materials have been developed to meet specific requirements of climate, availability of skilled labour and specific raw materials to effect the desired economy. Construction and demolition waste (CDW) is authentic as waste which are produced from construction, acclimation and annihilation activities including damaged articles and abstracts arising from construction works. Construction area is one of the biggest waste ambassadors worldwide. Landfill is the best cheapest and acceptable auctioning adjustment for C& D wastes, but in accordance with the absolute amazing pressures on landfill area, recycling should be the capital focus for the waste management. Waste appliance and administration involves Eco affable and socially favorable way. Usage of C&D waste in production industry is a brand new innovative practice. Use of C&D waste concrete will sell and inspire green construction for sustainable traits. Use of C&D waste fabric will lower the power inside the buildings so as to lead them to greater energy efficient. Initially, recycling of annihilation waste was aboriginal agitated out afterwards the Second World War in Germany. Since then, analysis plan agitated out in several countries has demonstrated acceptable affiance for developing use of construction waste as a basic in new concrete. Construction and annihilation (C&D) waste could be torn concrete, bricks from buildings, or torn pavement. Thus, Recycled Aggregate (RA) could appear from the demolition of buildings, arch supports, airport runways, and accurate roadbeds. Concrete made application such aggregates is referred to as recycled accumulated accurate (RAC).

2. Management of construction and demolition wastes

- Proper planning to construction new one and to annihilate old ones.
- Location and association akin storage.
- Proper guidelines for agreement on accessible roads.
- Transportation and processing of C&D waste.
- Appliance of processing residues.
- Applied use of C&D waste.
- Cost accretion and acknowledgment from pilot projects for administration of C&D waste.

3. Characteristics

This category of waste is complex due to the different types of building materials being used but in general may comprise the following materials:

Major components

- Cement concrete
- Bricks
- Cement plaster
- Steel
- Rubble
- Stone

Minor components

- Conduits (iron, plastic)

- Pipes (GI, iron, plastic)
- Electrical fixtures (copper/aluminium wiring, wooden baton, bakelite/plastic switches, wire insulation).
- Panels (wooden, laminated) · Others (glazed tiles, glass panels)

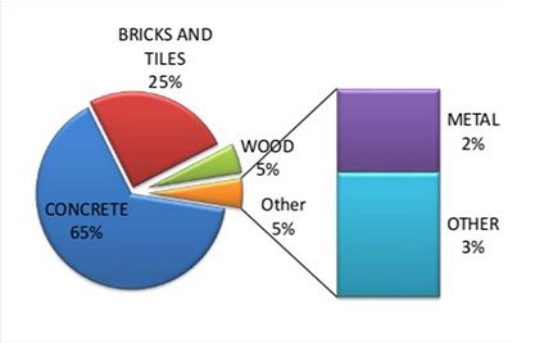

Fig 1. Components-Bar graph

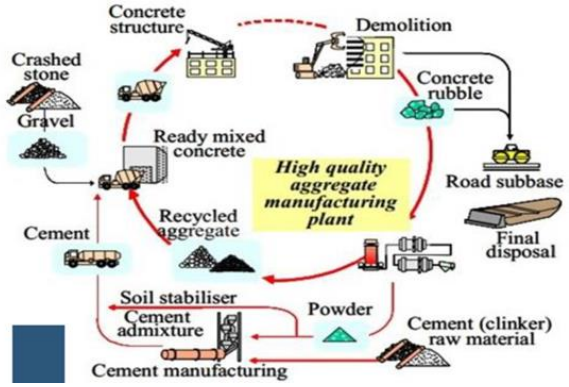

Fig. 2. Manufacturing process

4. Recycled aggregates

Fig. 3. Recycle Aggregates

Recycled Aggregates Rapid industrial development causes serious problems all over the world such as the depletion of natural aggregates and creates an enormous amount of waste material from construction and demolition activities. One way to reduce this problem is to utilize recycled concrete aggregates in the production of concrete. Recycled aggregates are the main component of old concrete and recycling operations have the added benefit of reducing landfill disposal. The use of RCA for the production of concrete involves breaking, removing, and crushing existing concrete into a material with specified size and quality. Recycling concrete is important because it helps to promote sustainable development by protecting natural resources and reducing the disposal of demolition waste from old concrete. Recycled aggregates normally have higher water absorption and lower specific gravity. The density of recycled aggregates used is lower than the density of normal aggregates. The porosity of recycled aggregates is also much higher than those of natural aggregates. After some mechanical processes, it can be used as aggregates in concrete mixing. The demolished concrete structures are crushed and sieved according to its required size.

5. Resin as binding material

Resin was the main binding material for the polymer concrete and was required to be mixed with a catalyst. It was important that the catalyst and resin were fully mixed together to ensure that the molecular structure of the mixture was uniform. Recycle aggregates basically have a high level of water absorption. Resins were used to coat the aggregates surface and minimize the water absorptions. At the same time, the impact of pollution will be less to environment.

6. Material preparation

Recycled aggregates are obtained from construction wastes. Recycled aggregates may be sourced from buildings demolition, broken concrete, pavements, airport runways, and concrete roadbeds. The concrete wastes were crushed in the machine then the materials were sieving to classify the size of aggregate.

Fig. 4. Process of Crushing and Sieving Recycled Aggregates; (a) Concrete Waste, (b) Crusher Machine, (c) Sieve Method

7. Treatment of recycled aggregates

Crushed aggregates usually cannot be used directly to produce a new concrete structure since it has a porous structure. This is due to the high water absorptions rate compare to normal aggregates. Therefore, recycled aggregates have to be treated using epoxy resin to reduce the water absorption inside the aggregate. Firstly, the epoxy resins have to mix together before placing the aggregate inside the container. Then the aggregates were immersing into the epoxy resin and dry it.

8. Sample testing

Sample preparation was done for both fresh and hardened concrete. The samples are used for different type of testing which are the slump cone test, compression test, split tensile test. Design of normal concrete method was used for concrete mixing in this research. The formworks used to prepare the

samples were cylindrical size of 150mm x 200mm and cubical size 100mm x 100mm x 100mm. The size of aggregates were used during the experimental works are 5mm, 10mm, 14mm, 20mm and 37.5mm. All the specimens were conducted for 7 and 28 days curing time.

9. Result and discussion

The analysis results were reviewed in the form of tables and graphs in this part. The recycled aggregates were treated with 25% epoxy resin and the remaining 75% constitutes recycled aggregates.

A. Fresh concrete

Slump test were used to determine the flow of concrete mixing as presented in Fig. 4. The values of the slump test falls within the range of 30mm – 60mm. The highest value recorded approximately 50mm for aggregate size of 5 mm and 10 mm and the lowest slump value was 40mm for size of 20mm and 37.5mm. The small scale sizes of aggregates were absorbed less water compared to the larger size of aggregates. This happened because of the less surface area for small scale size aggregates will be less water absorption in the aggregates. Thus the large scale size of aggregates has harsher surfaces that able to withstand the better grip compared to other aggregates during the slump test.

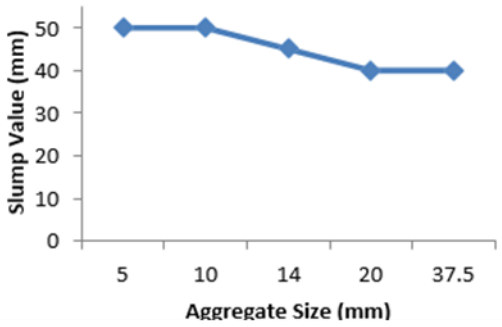

Fig. 5. Slump cone test

B. Split tensile strength

Based on the results in fig. 6, it can be observed that the strength for size of 10mm aggregates is the highest at 2.3 MPa and the second highest tensile strength was achieved by sizing of 20mm aggregates approximately value of 2.15 MPa. Size for 14mm and 37.5mm aggregates recorded tensile strength of 1.85 and 1.78 MPa respectively. The lowest strength was recorded by 5mm a size aggregate which is 1.24 MPa. In nutshell, the size of 10mm, 14mm and 20mm aggregates were recorded the highest strength while it can be seen that there is a drop in tensile strength for the 37.5mm size aggregates. The size of 5mm aggregates recorded the lowest strength. The larger size of aggregate, the greater is tendency of blocking the bleed water and thus the weaker the transition zone. Thus we came to know that the void fraction increases as the size of aggregates increases, the chances of failure are extremely high.

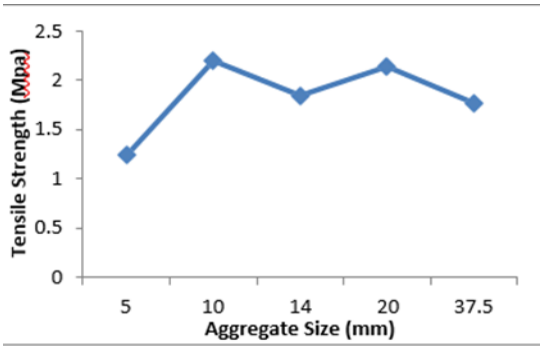

Fig. 6. Tensile test

C. Compressive strength

The results for compressive strength in 7 days increased dramatically from 14 MPa (5mm) up to 29.5 Mpa (10 mm). The size of 20mm aggregate was recorded the highest strength at 33 MPa, followed by the second highest strength achieved approximately 32.5 MPa for size of 37.5 mm. The aggregate size of 14mm was also among the highest ranks in the category at 31.3 MPa. For the specimens cured for 28 days, the compressive strength sharply changed from size of 5 mm (13.8 MPa) up to aggregates size 10 mm (41.1 MPa). Then, the graph shown fluctuate between the 14mm aggregates at 37.8 MPa, 20mm aggregates at 38.8 Mpa and 37.5 mm aggregates at 37.7 MPa.

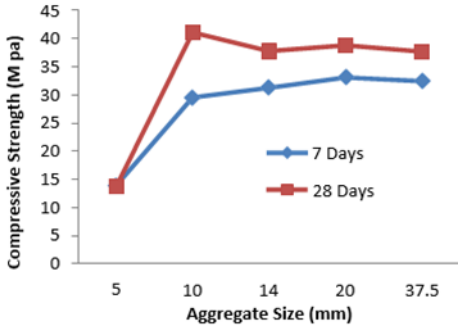

Fig. 7. Compressive strength test

The bigger the mean size of aggregates, the greater the compressive strength of concrete. The bigger aggregates result in a larger ITZ (Inter-facial Transition Zone) which refers to the weak binder zone around the aggregates which is more susceptible to cracks. This increases the chances of cracks occurring. Internal bleeding can take place when water gets trapped on the underside of large size aggregates. It will then result in a zone which has poor bonds. As the trapped water evaporates, a void is formed.

10. Conclusion

Production of construction and annihilation waste is not approved like borough solid waste. Authorities should construct a plan by which nominal accuse can be imposed on the agencies bearing construction and annihilation waste. The optimum strength of various sizes of aggregates in concrete was

recorded. This review of study was found that the optimum results for the split tensile test, compressive strength test and slump cone test were obtained for the aggregates measuring 10mm. The aggregate size of 10mm was taken as the optimum result because the highest figures were recorded for the split tensile test and the compressive strength test after a curing period of 28 days. Replacement of natural coarse aggregate by recycled aggregate gives the maximum compressive strength. The concrete mix is more workable when of coarse aggregate is replaced by C&D recycled coarse aggregate as the slump values and compacting factor values are high when compared to conventional mix. Finally, the concrete mix with aggregate replaced by C&D coarse aggregate gives the best mix with high compressive strength with high workability. Hence from this review we can clearly understand that by using 10mm recycled aggregate from C&D waste we can obtain better results such as in strength and workability. Thus we can utilize these type of C & D waste recycled aggregate in concrete for construction.

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