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To Analysis the Feasibility of Utilization of Modified Recycled Aggregate for Recycled Cement Bound Mixtures (A Review)

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Abstract - Construction and Demolition (C&D) wastes are generated through the demolition of concrete structures, and they are often discarded into the open area causing environmental problems. Various components such as bricks, concrete, steel, wood, etc., are generated through the demolition of structures. Perhaps the necessity of construction materials, especially aggregates, increases rapidly due to urbanization and industrialization. Construction activities mainly depend on natural resources as a source of raw materials, leading to ecological imbalance. So, the construction industries tend to depend on alternative materials as the source of aggregates in concrete production. Recycling C&D wastes and using them as aggregates will be a viable option to counteract the problems mentioned above. The recycled aggregates are broken fractions of C&D wastes with smeared cement particles adhered to on the surface of natural aggregates. In this study, recycled aggregates were collected from a 20-year- old demolished building at the university and recycled into fractions of 1.18 mm~2.36 mm and 10 mm~20 mm and replaced for both fine aggregates and coarse aggregates. However, the poor quality of recycled aggregates resulting from the presence of adhered mortar affects the properties of the concrete. Thus, this paper aims to improve the property of recycled aggregates through surface treatments. Though various treatments were developed either to remove or coat the adhered mortar surface on the recycled aggregates, this study uses microbes in conjunction with advanced mixing approach techniques to improve the quality of recycled aggregates and properties of the recycled aggregate concrete (RAC). This paper finds Feasibility of Utilization of Modified Recycled Aggregate in various construction work by study the different Literature review and articles

Keywords: Construction Demolish waste, Recycle aggregate ,concrete

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INTRODUCTION

The recycled aggregates differ from the natural aggregates concerning their physical properties and chemical characteristics. Recycled aggregates are concrete fractions of C&D wastes comprising of natural aggregates with cement particles smeared on their surface. The cement particles smeared on the surface of the aggregates have a significant influence on the physical, mechanical, and chemical characteristics of the recycled aggregates. The various physical properties of recycled aggregates include adhered cement mortar, shape, surface texture, bulk density, specific gravity, and water absorption. The aggregates recycled from the C&D wastes possess the following characteristics as follows:

Nearly 20% of cement mortar will get adhered to the surface of aggregate while recycling. The recycled aggregates prepared from low strength concrete will have fewer adherences than those prepared from high strength concrete, and hence the adherence parameter is inversely proportional to the size of the aggregates.

1. The adherence of mortar on the surface of recycled aggregates lacks bonding characteristics, so rough textured aggregates (angular) should be preferred compared to smooth textured aggregates (rounded).

2. The bulk density of recycled aggregate is directly proportional to its strength, size and inversely proportional to the adhered mortar on its surface. A decrease in the bulk density decreases the specific gravity of recycled aggregates.

3. The water absorption rate of recycled aggregate is more compared to natural aggregate. The recycled aggregates absorb

75% of the 24hour absorption capacity during the first 30minutes of soaking. The increase in the water absorption of recycled aggregates is due to the micro-cracks on the surface of the adhered mortar.

4. Los- Angeles abrasion value for the recycled aggregates produced from high strength concrete is more for smaller sized aggregates compared to larger sized aggregates.

Regulations On Utilization Of C&D Wastes As Recycled Aggregates

The generation of construction wastes increases with the increase in the demolition of concrete structures. An increase in the manufacture of concrete may also increase the concrete waste due to poor workmanship, improper raw materials, poor quality control, etc. Conversely, with the statistics mentioned inTable 1.1, it could be observed that the re-utilization of C&D wastes is very limited. Only 40% of C&D wastes are recycled, whereas the remaining 60% are discarded in the landfill leading to several environmental problems. The re- utilization of C&D wastes as aggregates in the manufacture of concrete may reduce the impact on concrete production by nearly 7% . The international standards outline several recommendations on the effective utilization of C&D wastes as aggregates, applications, etc.

The Need of Innovative Solution:

Production of concrete rose to 10 billion tones every year around the world. For concrete production, nearly 70% of the volume of concrete

LITERATURE REVIEW

This reviews various literatures on the behaviour of RAC with recycled coarse aggregates in terms of strength, durability, fracture and thermal properties**.**

Mechanical Properties

Mukharjee and Sudhirkumar observed that the properties of RCA such as bulk density and specific gravity of RCA were 14.26% and 9.55% less compared to NCA, whereas the impact value, abrasion value, and crushing value of RCA was 55.95%, 46.06% and 52.06% more compared to NCA. In terms of mechanical properties, the strength of RAC was observed to be 14% lesser compared to NAC at 28 days. The authors infer that a decrease in RAC strength is due to the inferior properties of RCA.

Gomes et al. replaced NCA by 12.5%, 25%, 50%, and 100% of RCA and observed that replacement of NCA by 50% of RCA improved the strength of RAC by 13.48% at 28 days. Similarly,

Ho et al. replaced NCA with 0%, 20%, 40%, 60%, 80%, and 100% of RCA and observed a decrease in the properties of the RAC with an increase in the RCA beyond 40%. The study infers that an increase in the replacement of RCA weakens the ITZ of the RAC and thus exhibits a decrease in the strength compared to NAC.

Abdullah used different types of recycled aggregates such as concrete, tiles, concrete block, 10 – perforated-hole bricks, Kura bricks, limestone, stone, and marble and observed that among the various recycled aggregates, Kura bricks (23.9%) exhibit the highest water absorption and marble (0.77%) exhibit the lowest water absorption. The study also infers that the density of the recycled aggregates was greatly influenced by the crushing strength and less by the shape and surface texture. The results also indicate that slump loss in the concrete is attributed to the adherence of mortar, type, and geometry of the aggregates.

Thermal properties

Sarhat and Sherwood : investigated the mechanical properties of RAC at 20 °C, 250 °C, 500 °C, and 750 °C. At room temperature, the strength decreases with the replacement of RCA, this is attributed to the presence of adhered mortar on its surface. However, with an increase in the temperature, the strength of RAC decreases, but no visible cracks are observed in the temperature range between 250 °C and 500 °C. The study infers that the coefficient of thermal expansion of adhered mortar on RCA was equivalent to new cement mortar, and thus improvement in the strength of RAC was observed when exposed to elevated temperature.

However, Khaliq and Taimur performed similar studies with varying elevated temperatures from 23 °C to 800 °C. This study observed residual temperature in the range of 200 °C and 600 °C, but a sudden decrease in the strength of 9% at 800 °C. The study concludes that the strength loss in RAC is less compared to NAC due to the equivalent coefficient of thermal expansion of adhered mortar in RCA with cement matrix. Also, the mass loss was also maximum ranging from 16% to 20% for RAC and NAC at 800 °C.

A similar study by Laneyrie et al. investigated the behaviour of RAC with elevated temperature but with different sources such as laboratory waste and field waste. It is observed that no spalling was reported in the RAC when exposed to a temperature of 150 °C and below for both sourced RAC mixtures. However, the laboratory prepared RAC was better compared to field prepared RAC. The study infers that a higher percentage of impurities on the surface of RCA collected from demolished buildings reduce resistance to elevated temperature. In the case of RAC with laboratory crushed RCA, the ITZ was strengthened due to the reaction of un-hydrated cement particles on RCA with the new cement mortar.

Fracture properties

Lee and Lopez studied the fracture energy using two different loading conditions: Constant stroke control and constant crack mouth opening displacement (CMOD) control. The study infers that the fair tail constant “A” could change the actual fracture up to 11% if tested using CMOD instead of linear varying different transformer (LVDT). It is also observed that actual fracture energy from the tested fracture energy using far tail constant “A”. However, this study does not provide the exact details on the fracture parameters of the RAC.

Thus, Li et al. determines the fracture energy and fracture parameters such as fracture toughness and crack mouth opening displacement (CMOD) of RAC beams. The study infers that fracture energy of the RAC decreases with an increase in the replacement of RCA. The fracture energy of RAC was reduced by 24% with 100% of RCA. This is due to the weak ITZ between RCA and cement matrix that reduces the fracture energy of RAC. No significant change in the fracture toughness was observed till 70%, beyond which it causes a 10% decrease.

However, Pradhan et al. determined the fracture parameters of RAC beams similar to , but the RAC mixes are prepared by particle packing optimization (PPO) method rather than the conventional method. The study infers that the fracture parameters such as initial cracking and unstable fracture toughness of RAC mixes prepared by the PPO method were 9% and 10% more than the RAC mixes prepared by the conventional method. Such an attribute is due to the reduced void content resulting from the better particle packing of RCA by the PPO method.

All these above studies do not discuss the influencing parameters such as the size of RCA, types of RCA, mixing approaches, etc.

Appa Rao and Raghu Prasad used RCA of sizes 4.75, 6.3, 12.5, and 20mm to study the fracture parameters of RAC and observed an increase in the fracture energy of RAC with an increase in the size of RCA. The study infers that an increase in the size of RCA increases the compressive strength, and thus the fracture energy of RAC increases. As the size of the RCA increases, cement paste- aggregate interface experiences higher bond stress leading to bond failure.

In another study, Butler et al. used RCA collected from different locations such as Ontario, Toronto, and RMC plant and observed that the fracture energy of locally located RCA mixes was better than others. The study infers that stronger aggregate-cement paste interface bond and higher strength of RCA improved the compressive strength and thus increasing the fracture energy of RAC. This study could signify that the source factor directly influences the fracture parameters of RAC as fracture energy and compressive strength are interdependent with each other.

All the above studies discuss the fracture parameters of RAC beams without any notches at the bottom. However, ,

Bhowmik and Ray examined the size effect of specimen on the fracture parameters of RAC with three different beams of size 300 mm x 50 mm x 50 mm, 550 mm x 100 mm x 50 mm, and 1000 mm x 200 mm x 50 mm having notches of 10 mm, 20 mm and 40 mm. The study infers that the thickness of the fracture zone increases with the increase in the size of the beam. Also, the fracture length in both medium and large beams under fatigue loading is equivalent to the static loading.

SUMMARY OF LITERATURE REVIEW

Reviews On Recycled Aggregate Concrete With Recycled Fine Aggregate

Leite and Leite utilised recycled fine aggregate (RFA) as a viable alternative for natural fine aggregate (NFA) and found that increasing the FRA enhances the RAC's workability. This is because to the presence of dust particles in the FRA, which functioned as a lubricant. Further, the inclusion of RFA in the RAC improves the RAC's strength to a specific replacement level, despite its inferior physical characteristics. This was presumed from the fact that the greater the roughness of the RFA, the better the bond, the porosity of the RFA, which allows the precipitation of the cement hydration crystals in its pores, increasing the stiffness of the paste, and the greater the fines content of the RFA, which decreases segregation and increases the matrix's compacity.

Findings on Review of RCA and RFA

A detailed review on the utilization of RCA and RFA as a replacement to natural aggregates in RAC manufacture was conducted. Based on the review, the following validations are performed as follows:

1. The source of RCA may decide the strength of RAC as the RA collected from high strength exhibits better concrete properties to the RA collected from low strength/ normal strength concrete.

2. RA's physical properties were inferior to natural aggregates (NA) due to its higher porosity resulting from the adherence of mortar.

3. An increase in the replacement of RA affects the fresh, hardened, and durability properties. Such attribute is influenced by various factors such as adhered mortar, quality, source, crushing process, pre-saturation, particle packing, shape, size, the surface texture of RA, etc.

4. A decrease in the w/c ratio will tend to increase the properties of RAC.

5. Pre-soaking the recycled aggregates (RA) before their use in the concrete will improve the workability of the RAC.

6. The addition of high range SP has a positive effect on the fresh, hardened, and durability properties of the RAC even at higher replacement levels of RA.

7. The RAC possesses two ITZ, one between the RCA and the old mortar and the other between the new and old mortar (weakest link).

8. An increase in the curing period will tend to enhance the properties of the RAC, sometimes even equivalent to NAC.

9. The RAC shows better resistance to thermal properties with higher percentages of RA as the coefficient of thermal expansion of adhered mortar is equivalent to cement matrix.

10. An increase in the RA decreases the fracture energy of RAC, and the fracture energy has a direct relationship with the compressive strength of the RAC.

CONCLUSION

Concrete is the most widely used man made construction material in the world and its second only to water as the most utilized substance in the planet. Seeking aggregates for concrete and to dispose of the plastic waste is the present concern. Today sustainability has got top priority in construction industry. In the present study the recycled plastics were used to prepare the coarse aggregates thereby providing a sustainable option to deal with the plastic waste. There are many recycling plants across the world, but as plastics are recycled they lose their strength with the number of recycling. So these plastics will end up as earth fill. In this circumstance instead of recycling it repeatedly, if it is utilized to prepare aggregates for concrete, it will be a boon to the construction industry.

Most of the failures in concrete structures occur due to the failure of concrete by crushing of aggregates. Plastic Coarse Aggregates which have low crushing values will not be crushed as easily as the stone aggregates. These aggregates are also lighter in weight compared to stone aggregates. Since a complete substitution for Normal Coarse Aggregate is not found feasible, a partial substitution with various percentage of Plastic Coarse Aggregate is done. Volumetric substitution was employed in this investigation

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