A REVIEW PAPER ON PARTIAL REPLACEMENT OF FINE AGGREGATE WITH WASTE GLASS AND COARSE AGGREGATE WITH DEMOLISHED AGGREGATE

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Abstract - *In today's scenario concrete is the most widely used material for infrastructure development around the world. Concrete is made up of components that are found naturally in the environment, resulting in a gradual decrease in the availability of these resources. To address this scarcity, numerous studies have been conducted and various waste materials have been introduced as partial replacements for cement, fine aggregate and coarse aggregate. These waste materials if utilized in production of concrete, will lead to save the environment by reducing the junk deposition in landfills. This paper aims to give a brief review on the replacement of fine aggregate with waste glass and coarse aggregate with demolished aggregate to analyze the properties of fresh and hardened concrete.*

Key Words: Waste glass, Demolished aggregate (Recycled Concrete Aggregate), Fresh and Hardened concrete properties, Environmental problems, Fine aggregate replacement, Coarse aggregate replacement.

1. INTRODUCTION

Concrete is now the most frequently utilized composite material on the planet. Concrete is made up of cement, fine aggregate, coarse aggregate, and water. Since fine aggregate and coarse aggregate are inert minerals that will degrade over time, we must develop alternative materials rather than relying on natural resources. Glass, e-waste, rubber, demolition scrap, ceramic, plastic, and other materials can be used as replacements. In this study, glass and demolition waste are used to replace fine and coarse aggregate, respectively.

1.1 About Glass

Considering glass is an inert substance that contains silica, it can be used to substitute fine aggregate. Glass makes up about 0.7 percent of India's urban garbage. Liquor stores, damaged utensils, electrical and electronic gadgets, mirror businesses, laboratories, and other sources generate glass garbage. This glass waste can be recycled, but because the recycling rate is so low, the majority of it ends up in landfills. However, because glass is a non-biodegradable substance that takes millions of years to disintegrate, it is dangerous to the environment to deposit glass garbage.

1.2 About Demolition Waste

Coarse aggregates, like fine aggregates, are formed from rocks, which are natural resources and hence finite. As a result, aggregates obtained from building and demolition debris can easily substitute coarse materials. Every year, 150 million tons of C&D garbage are generated in India, with just approximately 1% of it being recycled. Old decaying structures, replacement by new investments, renovation of structures, excavation of roadways, and structures that fail to meet requirements are some of the sources of C&D trash. The quality and grade of concrete used in the structure determines the properties of demolished aggregate.

2. LITERATURE REVIEW

This literature is based on the replacement of fine aggregate and coarse aggregate with waste crushed glass and demolished aggregate.

2.1 Replacement with waste glass

(Aman Roy Patil, 2019), for the study M25 grade of concrete is prepared using fine aggregate replacement percentages of 0%, 5%, 10%, 12% and 20% with waste glass. The mix was prepared using two water cement ratios, 0.45 and 0.5. Water cement ratio of 0.5 shows better results for M25 grade concrete. The workability of concrete decreased with increase in glass percentage. The compressive strength was found to increase upto 10% replacement at 7 and 28 days. The increase in compressive strength for 0.45 W/C was 7.18% and 13.19% for 0.5 W/C. Hence, the optimum replacement percentage was considered as 10%.

(Prajakta N. Haramkar, 2018), in their paper they partially replaced fine aggregate with waste glass by 0%, 10%, 20% and 30%. The concrete specimens with water cement ratio 0.55 were prepared and the compressive strength was observed at 7, 14 and 28 days. The maximum increase in strength was found to be 11.29% at 10% replacement of fine aggregate and hence was considered to be the optimum percentage replacement. Slump was found to increase with the increase in glass percentage.

(Jostin.P.jose, 2014), they prepared M50 grade of concrete using fine aggregate replacement percentage to be 0%, 10%, 20% and 30% with waste glass. The specimens were tested for compressive strength, split tensile strength and flexural strength. The optimum replacement percentage was 10% as the increase in compressive strength, split tensile strength and flexural strength after 28days curing was 9%, 23% and 74% respectively.

(Jagriti Gupta, 2018), they used waste glass bottles as the partial replacement of sand. The percentage replacements were 0%, 2%, 5%, 7% and 10%. An M30 grade concrete mix was formed with above replacement percentages and was tested for compressive strength at 7days and 28days. The water absorption and density of concrete decreases with increase in percentage of glass. The workability of concrete increases upto 20% replacement and compressive strength increases upto 10% replacement of glass with fine aggregate. The percentage increase in compressive strength at optimum percentage was 23.75%.

(J.Premalatha, 2019), five mixes were prepared in the study namely M20, M30, M40, M50 and M60. The percentage of sand replacement with waste glass powder were 0%, 10%, 20%, 30%, 40% and 50%. The result shows that the value of slump increases with the percentage of glass upto 40%. The 28days compressive strength, split tensile strength and flexural strength were found to increase upto 30% replacement and were comparable for 40% and 50% replacement percentages as compared to the controlled mix. Upto 50% replacement percentage the chloride penetration rate and permeability showed a steep decline and hence the optimum percentage replacement was taken as 50% because it maintains the strength properties also.

2.2 Replacement with demolished aggregate

(Abdulsamee M. Halahla, 2019), prepared an M-25 mix was made with 100 percent replacement of Natural Coarse Aggregate (NCA) with Recycled Concrete Aggregate (RCA) and tested for 3, 7, 14, and 28 days. The RCA was collected from an old building in Tabuk city, Saudi Arabia having specific gravity 2.695 and fineness modulus 7.88. After testing, it was discovered that when RCA increases, compressive and split tensile strength falls, but the difference does not surpass 5%. When compared to natural aggregate concrete, the initial tangent elasticity modulus was determined to be 10% lower. The failure strain in RCA was higher than in NCA.

(Reema, 2020), created an M-25 mix with coarse aggregate replacement percentages of 0%, 10%, 15%, and 20%. The aggregate utilized had a nominal size of 20mm. RCA had a specific gravity of 2.45 and a water absorption rate of 5.62%. At 7 and 28 days, various tests were carried out with a water cement ratio of 0.5 and Auramix 200 as the additive. The results showed that when the percentage of RCA increases, the slump increases, but the strength decreases nominally. The highest compressive and split tensile strength decreases were 8.825% and 13.22%, respectively. Since it did not influence the structure's functional requirements, the optimum percentage replacement was 20%.

(Mohd Monish, 2013), retrieved the RCA from IIT building, Allahabad. They made a 1:1.67:3.33 mixture with the replacement percentages of 0%, 10%, 20%, and 30%. Workability and compressive strength were assessed on these specimens after 7, 14, and 28 days. it was concluded that the slump decreases as compared to the control mix, and the amount of water required to produce the same workability is significant. With RCA, the compressive strength was found to be comparable up to 30% replacement.

(Rao, 2018), in his study he extracted recycled concrete aggregates from previously existing concrete of grade M20, M25, M30 and M40. He termed it as RCA20, RCA25, RCA30 and RCA40. Using RCA20 and RCA25 he prepared an M20 mix and using RCA30 and RCA40, he prepared M30 grade of concrete. The prepared specimens were cured and tested at 3days, 7days and 28days for compressive strength test. The split tensile strength, flexural strength, and ultrasonic pulse velocity test were carried out at 28 days. The results shows that for high grade RCA bulk density decreases whereas, water absorption increases. It was also observed that the concrete made with same grade of RCA gives lower strength as compared to the sample made with higher grade of RCA which gives equivalent result as that of conventional mix. Similar trend was observed for split tensile and flexural strength. For the concrete with higher grade of RCA, 6% decrease in strength was observed when tested with ultrasonic pulse velocity meter as compared to original mix.

(M. Chakradhara Rao, 2010), the study was done considering the coarse aggregate replacement percentages of 0%, 25%, 50% and 100% with recycled concrete aggregate. The mix were prepared considering water cement ratio to be 0.43 with 50mm to 60mm slump. The super-plasticizer used was Sika Viscocrete R-550. The results shows that upto 50% replacement percentage the compressive strength was comparable to the conventional mix, while the modulus of elasticity and split tensile strength shows significant difference. The observation shows that the concrete with partial wet and air curing shows better result than constant wet curing. The chloride penetration depth increases with increase in percentage replacement. It can also be used as light weight concrete since, the density of concrete decreases.

3. CONCLUSIONS

From the above papers, following conclusions can be made:

- Waste glass can be used as the replacement of fine aggregate in a concrete mix.
- The initial and final setting time of concrete decreases as the percentage of glass increases. This shows that crushed glass can also work as a retarder in a mix.
- The water absorption of a concrete mix decreases as the glass percentage increases.
- No exact trend in workability is observed, it depends on the grade of concrete and the percentage of glass replacement.
- The compressive, tensile and flexural strength were found to increase with glass because of the angular particles.
- The use of demolished aggregates as the partial replacement of coarse aggregate can be beneficial.
- The coarse aggregates can 100% be replaced by the demolished aggregates but the good strength is achieved when the replacement percentage is between 25% to 50%.
- The water absorption of concrete mix having demolished aggregate as the coarse aggregate is higher as compared to the mix having virgin aggregates. This is due to the old mortar attached on the surface of demolished aggregates.
- The concrete mix made with the demolished aggregate as the partial replacement of coarse aggregate requires more water to maintain the workability same as the original mix.
- The compressive, tensile and flexural strength of concrete decreases as the replacement percentage of demolished aggregate increases. The strength mainly depends on the grade of concrete of the demolished aggregate.
- The use of waste glass and demolished aggregate at the place of fine aggregate and coarse aggregate makes the concrete economical and eco-friendly.

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