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EXPERIMENTAL STUDY ON RECYCLED COARSE AGGREGATE CONCRETE

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Abstract: Disposal and treatment of construction and demolition (C&D) wastes are often costly and hazardous to the environment. Their recycling could lead to a greener solution to the environmental conservation and pave the way towards sustainability. Large scale recycling can substantially reduce the consumption of natural aggregate and help preserve the environment. However, in near future, it can raise new challenges. The use of "repeated recycled coarse aggregate" in concrete production can be a viable solution to the growing problem regarding the C&D waste disposal. During the development of new generation product like recycled and repeated recycled coarse aggregate concrete. The present study utilizes demolished concrete as coarse aggregate often termed as recycled coarse aggregate (RCA) for producing industry quality concrete. It is essential to investigate the fresh, hardened, and durability properties of concrete to promote and escalate its application in the construction industry. This present research investigates the fresh, mechanical, and durability properties of 30MPa and 60MPa recycled aggregate concrete (RAC) made with 100% RCA replacement level. Durability performance of 30 MPa and 60MPa RAC was evaluated in terms of Acid attack, sulphate attack and permeability for the addition of different percentages of Fly ash and GGBS like 0%, 10%, 20%, 30%, 40% in the place of the cement

Keywords: Coarse Aggregate, concrete, recycles,waste.

I. Introduction

General

Concrete has been proved to be a leading construction material for more than a century. It is estimated that the global production of concrete is at an annual rate of 1 m3 per capita. The global consumption of natural aggregate will be in the range of 48.3 billion metric tons after 2015. Over 1 billion tonnes of construction and demolition waste (C&DW) is generated every year worldwide. At the same time, large quantities of natural aggregates are extracted for construction every year leading to the large scale depletion of natural aggregate and the increased amounts of C&DW. The construction and demolition waste are primarily used for landfill sites which are causing significant damage to the environment and developing serious problems. The use of the recycled aggregates created from processing of construction and demolition waste in new construction has become more important over the last two decades as it conserve the non-renewable natural resource of virgin aggregates.

Need of the Present Work

It is now widely accepted that there is a significant potential for reclaiming and recycling demolished debris for use in value added applications to maximize economic and environmental benefits. At present converts low value waste into secondary construction materials such as a variety of aggregate grades, road materials and aggregate fines (dust). Often these materials are used in as road construction, backfill for retaining walls, low-grade concrete production, drainage and brickwork and block work for low-cost housing. Due to issues relating to sustainability and limited natural resources, it is clear that the use of recycled and secondary aggregates (RSA), for example crushed concrete and asphalt and industrial by products such as fly ash and blast furnace slag, will grow.

II. Literature Review

General

This Chapter presents the background to the needs for the development of alternative coarse aggregate to manufacture concrete and the use of RCA in concrete. The available published literature on RCA is also briefly reviewed.In Hong Kong, a huge quantity of construction and demolition (C&D) wastes is produced every year. The disposal of the wastes has become a severe social and environmental problem in the territory. The possibility of recycling of these wastes in the construction industry is thus of increasing importance. In addition to the environmental benefits in reducing the demand on land for disposing the waste, the recycling of C&D wastes can also help to conserve natural materials and to reduce the cost of waste treatment prior to disposal

GordanaPetkovic, Jacob Mehus & Synnøve A. Myren Since the mid-90s the recycling, reuse and reduction of construction and demolition waste (C&D-waste) have received increasing attention in Norway. The main focus of the Norwegian recycling effort has been on the concrete and masonry rubble and recycled aggregate

This paper presents a summary of the most important results related to RCA durability characteristics from two major R&D programs carried out in Norway: RESIBA (1999 - 2002), and Norwegian Roads Recycled Materials R&D Program (2002 – 2005). The main focus has been documentation of freeze-thaw durability and degradation from water drainage. The results of extensive testing of

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RCA with different exposure conditions confirm that freeze-thaw resistance is sufficient for the most common exposure conditions. However, for extreme exposure conditions such as when aggregate is submerged in in combination with dicing salts the freeze-thaw resistance is not acceptable. The results have been implemented in a revised test method based on EN 1367-1. Degradation from water drainage is an important aspect of durability for RCA in unbound applications such as trenches and road base. The paper presents a laboratory set-up aimed at investigating the impact of steady water drainage at two different pH-levels on the basic material properties such as mechanical strength, density and waterabsorption.

III. Experimental Study: General

The experimental program was designed to compare the mechanical properties i.e., Compressive strength, Flexural strength, Splitting Tensile strength and Acid Attack, Sulphate attack and Permeability characteristics of RCA concrete with different percentages replacement of Fly Ash and GGBS with 100% recycled aggregate.

Material Used

1. Cement
2. Recycled coarse aggregate
3. Fine aggregate
4. Water
5. GGBS
6. Fly ash
7. Super Plasticizer

Tests of Workability

1. Slump Cone Test
2. Compaction Factor Test

IV. Results and Discussions

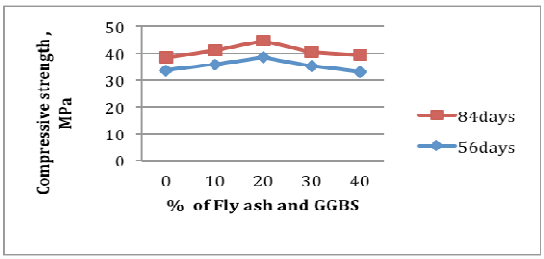

Figure 1 Variation of compressive strength with the effect of 1% of H_2SO_4 solution for the M30 grade RCA concrete

Figure 1 shows, M30 grade concrete shows higher compressive strength for 84 days than 56 days whereaas M60 grade concrete gives approximately 60% more strength than when compared to M30 grade.

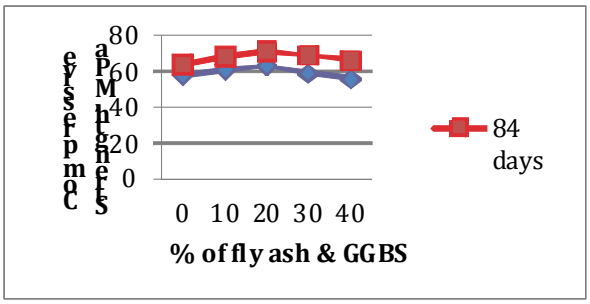

Figure 2. Variation of compressive strength with the effect of 1% of H_2SO_4solution for the M60 grade RCA concrete

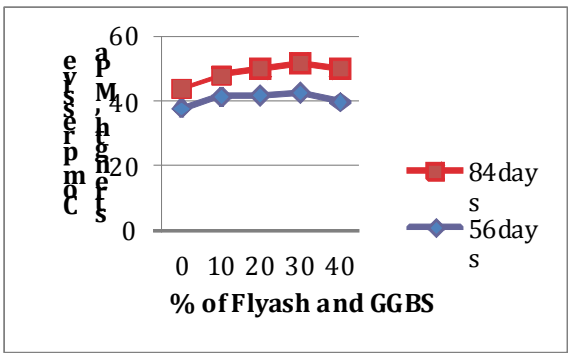

Figure 3. Variation of compressive strength with the effect of 1% of Na_2SO_4 solution for the M30 grade RCA concrete

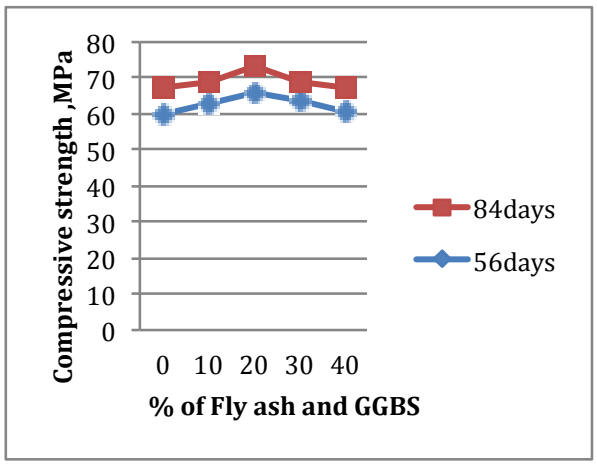

Figure 4 Variation of compressive strength with the effect of 1% of Na_2SO_4 solution for the M60 grade RCA concrete

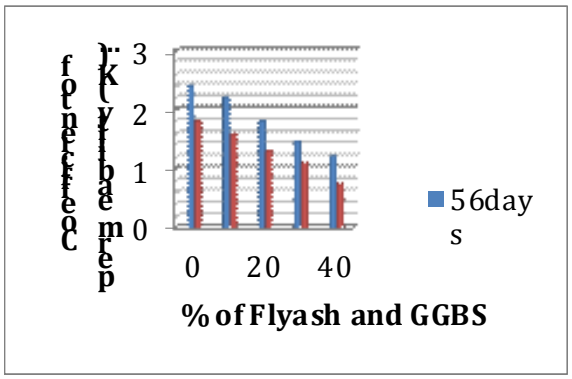

Figure 5 Variation of coefficient of permeability with the effect of % of Fly Ash and GGBS for the M30 grade RCA concrete

100% replacement of recycled Coarse aggregate for M30 grade of concrete at 0% and 40% of Fly ash and GGBS for 56 days and 84 days the Coefficient of permeability has 2.2x10-5, 1.8x10-5 cm/sec and 1.1x10-5, 0.8x10-5 cm/sec respectively

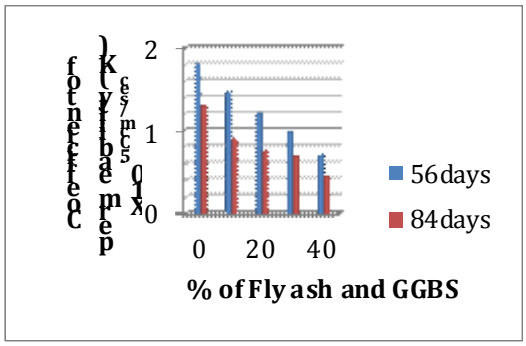

Figure 6 Variation of coefficient of permeability with the effect of % of Fly Ash and GGBS for the M60 grade RCA concrete

Its seen that100% replacement of recycled Coarse aggregate for M60 grade of concrete at 0% and 40% of Fly ash and GGBS For 56 days and 84 days the Coefficient of permeability has1.8x10-5,1.218x10-5 cm/sec and 0.6x10-5, 0.4x10-5 cm/sec respectively.

V. Conclusion

Based on the investigation and observations the following conclusions were arrived. From graphs above

1. 100% replacement of recycled Coarse aggregate for M30 and M60 grade of concrete For 28 days and 56 days, the Compressive strength is 38Mpa and 46MPa respectively and 61MPa, 69.8MPa almost equal to the permissible limit.
2. 100% replacement of recycled Coarse aggregate for M30 and M60 grade of concrete For 28 days the Compressive strength has increased 10% up to 20% of Fly ash and GGBS then It is decrease by 12% and for 56 days the Compressive strength has increased 20% up to 20% of Fly ash and GGBS den It is Decreases by 10%.
3. 100% replacement level of recycled Coarse aggregate and 20% of Fly ash and GGBS for M30 and M60 grade of concrete the Loss of Mass due to the effect of acid curing (H2SO4) decreased by 17% and 11% for 28 days and 56 days respectively.
4. 100% replacement level of recycled Coarse aggregate and 20% of Fly ash GGBS for M30 and M60 grade of concrete the Loss of Mass due to the effect of sulphate curing (Na2SO4) decreased by 11% and 8% for 28 days and 56 days respectively.
5. 100% replacement level of recycled Coarse aggregate and 0% and 20% of Fly ash and GGBS for M30 and M60 grade of concrete due to the effect of acid curing (H2SO4) the Compressive strength decreased by 7.3% , 9.6% % and 4.5%, 3.1% for 28 days and 56 days respectively.
6. 100% replacement level of recycled Coarse aggregate and 0% and 20% of Fly ash GGBS for M30 and M60 grade of concrete the due to the effect of sulphate curing (Na2SO4) the Compressive strength decreased by 5.5%, 7.4% and 3.6%, 2.0% for 28 days and 56 days respectively.
7. 100% replacement of recycled Coarse aggregate for M30 and M60 grade of concrete at 0% of Fly ash and GGBS For 56 days and 84 days the Coefficient of permeability has more than the conventional concrete.
8. 100% replacement of recycled Coarse aggregate for M30 and M60 grade of concrete at 40 of Fly ash and GGBS For 56 days and 84 days the Coefficient of permeability has decreased by 50% and 70% and which is less than the conventional concrete
9. The workability reduced with the property of high water absorption capacity of recycled coarse aggregates.

VI. Future Scope of Work

Recycled concrete aggregate seems to have satisfying durability properties for the most common exposure conditions. The composition of the material requires, however, tailored test methods. Tests of freeze-thaw durability need to include deicing salts for Nordic climate conditions. Drying the specimens for the calculation of dry mass is suggested performed after the freeze-thaw test, since pre-drying damages the material.In addition, submerged conditions are suggested replaced by water saturated conditions. Applications where the

material can be exposed to frost in submerged conditions are suggested avoided. Acid containing water seems to affect recycled concrete aggregate substantially, probably due to the deterioration of the concrete phase. A laboratory test rig for accelerated testing of water deterioration is expected to give basis for the documentation of changes in material properties such as mechanical strength, density and water absorption

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