RECYCLED CONCRETE AGGREGATE (RCA) BY USING M-25 GRADE

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Abstarct:Recycled aggregate are comprised of crushed, graded inorganic particles processed from the materials that have been used in the construction and demolition debris. One of the major challenges of our present society is the protection of environment. The use of aggregates from construction and demolition debris (wastes) is showing prospective application in construction as alternative to primary (natural) aggregates. It conserves natural resources and reduces the space required for the landfill disposal. Although there is a critical shortage of natural aggregate, the availability of demolished concrete for use as RECYCLED CONCRETE AGGREGATE (RCA) is increasing. Using the waste concrete as RCA can provide cost savings. Recycled aggregates are the materials for the future.
The aim of this project is to determine the strength characteristic of recycled aggregates for application in high strength structural concrete, which will give a better understanding on the properties of concrete with recycled aggregates, as an alternative material to coarse aggregate in structural concrete. Further, this work is to determine and compare the workability, compression strength, indirect tensile strength, flexural strength and modulus of elasticity properties of recycled aggregate concrete with that of natural aggregate concrete.
To attain the planned objectives of the present investigation, M25 grade concrete is taken and the replacement values viz, 0%, 25%, 50%, 75%, 100% were considered. These five replacement ratios mix design are done by using IS 10262-2009 method. A total of 60 cubes, 40 cylinders, 10 beams were casted to determine the properties mentioned as aboveThe development of compressive and tensile strengths of recycled aggregate concrete at the age of 7and 28 days; the development of flexural strength and static modulus of elasticity at the age of 28 days areinvestigated. The parameters which were investigated for recycled aggregate concrete and compared with natural aggregate concrete as per BIS specifications found to be decreasing gradually as the percentage of recycled aggregate are increased.

1.INTRODUCTION

Concrete is a composite construction material composed primarily of aggregate, cement and water. It 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 $1m^3$ (approximately 2.5 tones) per capita (**Neville 2003**). The global consumption of natural aggregate (NA) will be in the range of 8-12 billion tones after 2020. Over 1 billion tones of construction and demolition wastes(C&DW) is generated every year worldwide (Anon 2004). The large scale depletion of NA and the increased amounts of C&DW going to landfill sites are causing significant damage to the environment and developing serious problems denting the public and the environmentalist's aspirations for a waste-free society. factors contributing to this, from the availability of new material and the damage caused by the quarrying of NA and the increased disposal of costs of waste materials. C&DW are generated mainly from demolished concrete and masonry structures. Due to advances in manufacturing of crushing industry, machinery and recycling process, it became possible to scale or crush down large masses of C&DW into smaller particles to produce recycled aggregate (RA) at acceptable cost.

Fig . recycled aggregates.

In the past, almost all materials which are used in the construction industry were entirely natural and all waste from demolished buildings was disposed of in landfills and partially in unauthorized places. The utilization of the recycled aggregates created from processing C&DW in new construction has become more important over the last two decades. There are many

A.Concrete Kerb and Gutter Mix

Recycled aggregate have been used as concrete kerb and gutter mix in Australia.
According to Building Innovation & Construction Technology (1999), Stone says that the10mm recycled aggregate and blended recycled sand are used for concrete kerb and gutter mix in the Lenthall Street project in Sydney.

B.Granular Base Course Materials

According to Market Development Study for Recycled Aggregate Products (2001), recycled aggregate are used as granular base course in the road construction.
It also stated that recycled aggregate had proved that better than natural aggregate when used as granular base course in roads construction.
They also found that when the road is built on the wet sub grade areas, recycled aggregate will stabilize the base and provide an improved working surface for pavement structure construction.

Figure . Application of Recycled Aggregate as Road Ker (Source: Building Innovation & Construction Technology, 1999)

2.LITERATURE REVIEW

Sustainable development is defined by Bruntland's report to the world commission on the environment (our common future 1987) as ; "development which meets the needs as present without compromising the needs of future generation to meet their own needs". This statement is the central theme, which the UK government have incorporated into the white paper on the environment: "this common inheritance (CM1200; HMSO September 1990)" and "sustainable development: the UK strategy (CM 2426; HMSO 1994)".great Importance as therefore, been placed upon the issue of sustainable developmen.

Review of Recycled Aggregate:

There are many testing based on the recycled aggregate have been carried out all around the world. Hanson and Torben (1986) stated that since 1945, the research on recycled aggregate had been carried out in many countries. Some of the literature reviews on recycled aggregate are shown as below.

According to Ramamurthy and Gumaster (1998), the compressive strength of recycled aggregate concrete was relatively lower and variation was depended on the strength of parent concrete from the obtained aggregate.

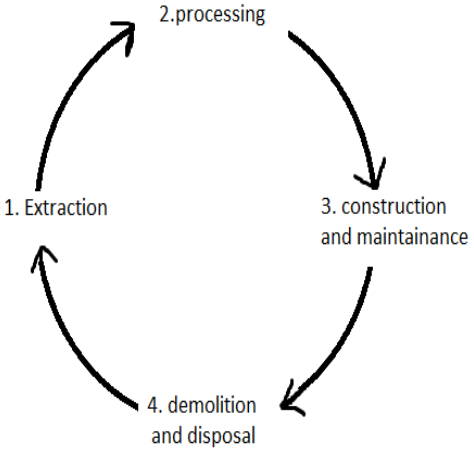
Sawamoto and Takehino (2000) found that the strength of the recycled aggregate concrete can be increased by using Pozzolanic material that can absorb the water.

Limbachiya and Leelawat (2000) found that recycled concrete aggregate had 7 to 9% lower relative density and 2 times higher water absorption than natural aggregate.

According to their test results, it shown that there was no effect with the replacement of 30% coarse recycled concrete aggregate used on the ceiling strength of concrete. It also mentioned that recycled concrete aggregate could be used in high strength concrete mixes with the recycled concrete aggregate content in the concrete.

Scale of waste materials and the need of recycling:

Waste materials and by-products are created from several sources. This study will focus on waste arising from construction materials. When structures are demolished, the resulting material is either dumped in landfill sites or recycled in new applications.



life cycle of construction materials

Fig shows that mineral and C&DW together accounted for 71% of all India waste, therefore they are the major sources of waste materials. However even though the data presented here date back to 2005, it is predicted to be of the same pattern for the years till nowise. Wastes generated from quarrying of minerals and C&DW remain the major portions.

If the C&DW are been used in the proper manner then the amount of waste and pollution can be reduced to a maximum extent of 35% of total.

Processing of C&DW materials

C&DW crushing and processing equipment and their correspondent accessories used to make RA are similar to those commonly used for production of crushed aggregate from Natural rock. It is not the aim of this study to discuss in detail the processing techniques, machinery and controlling devices, or processing methods. However, in general processing plants in corporate various types of crushers, screens, transfer equipments(conveying belts),magnets for separation of ferrous materials, then sorting devices for dry and wet removal of other substances from crushed concrete. For more details, reference can be made to relevant resources such as the U.S Environmental Protection Agency (www.epa.gov).

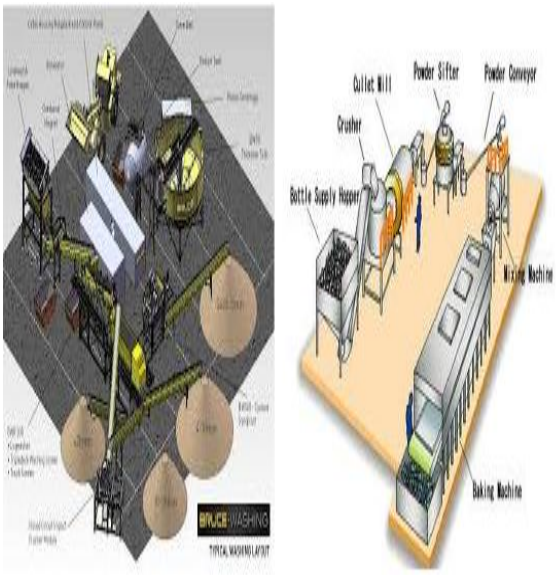


Fig . recycling plant

III.TEST ON MATERIALS

Materials

Cement: cement is a binding material invented by Joseph Aspdin in 1824. It is manufactured from calcareous materials, such as limestone or chalk, and argillaceous material such as shale and clay.

Coarse Aggregate: If the size of aggregate is bigger than 4.75 mm, then the aggregate is considered as coarse aggregate.
Eg: Stone, ballast, gravel, brick ballast.

Fine Aggregate: According to IS 383, most of the aggregate which will pass through 4.75 mm IS sieve and entirely retained on 75 µ sieve is considered as fine aggregate.
Eg: Sand crushed stone, ash or cinder and surkhi.

Water: water is the main ingredient used to mix all the contents. Potable water is used as usage of any other water may contain salts and cause decrease in strength of concrete.

Fig standard consistency

Apparatus

The apparatus used in this test are Vicat's apparatus, Plunger (10mm dia, 50mm long), Mould (980mm dia, 40 mm high), Glass plate, Non-porous tray and weighing balance.

Result: Normal consistency of the cement sample used in this study is 32%

Fig vibrator and compression strength mould

Soundness of cement

Soundness of cement is determined by Le-Chatelier method as per IS: 4031 (Part3)–1988.

Apparatus – The apparatus for conducting the Le-Chatelier test should conform to IS: 5514 – 1969

Balance, whose permissible variation at a load of 1000g should be +1.0g and Water bath.

Fig cube and cylinder moulds

During the placing of fresh concrete into the moulds, compaction is done using the tamping rod; each layer is tamped 25 times. The compaction of concrete releases any entrained air voids contained in the fresh concrete. If the concrete specimens were not compact in a proper manner, the maximum strength of the concrete cannot be achieved. The vibration/compaction was done every sufficient one third layer of the fresh concrete was poured into the moulds. It is found that the placing and compacting of concrete is getting difficult when the percentage of recycled aggregate increased. This shows that the workability of recycled aggregate used in the concrete is very poor. The leveling of concrete was done on the surface of the concrete. Leveling is the initial operation carried out after the concrete has been placed and compacted. . After the leveling of fresh concrete specimen was done, the concrete in the mould was left overnight to allow the fresh concrete to set

Fig casting of cubes, cylinders and beams

Stripping and Curing of Concrete Specimens After leaving the fresh concrete in the moulds to set overnight, the concrete specimens in the moulds were stripping. The identification of concrete specimens was done and the moulds were cleaned and oiled for the next batch of concrete mix. All concrete specimens were placed into the curing room with a controlled temperature of 25c in further for 28 days for the hardened properties of recycled aggregate concrete.

Fig curing of cubes, cylinders and beams

Summary: It shows the mix design depends on the variables of aggregate/cement ratio, water absorption, particles density and proportioning of the aggregates. It seems that volume of

Aggregate for each mix batches were different Once the fresh concrete was mixed, the workability test of the fresh concrete will be conduct. Moreover, after required days of the concrete specimens were cured, the compression test was conducted on day 7, 14 and 28. On day 28, the indirect tensile test and modules of elasticity test will be conducted. All the test procedures and methods on workability and hardened were discussed in chapter 4.

IV.EXPERIMENTAL METHODOLOGY

Tests on Fresh Concrete

Workability tests :

Slump test: Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete.

The apparatus for conducting the slump test essentially consists of a metallic mould in the form of a frustum of a cone having the internal dimensions bottom diameter 20 cm, top diameter 10 cm, height 30cm. The thickness of metal sheet for the mould should not be thinner than 1.6 mm. the internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete before commencing the test.

Fig.Apparatus to determine the workability of concrete (slump test)

Compaction factor test

The compaction factor test is designed primarily for use in the laboratory. It is more precise and sensitive than the slump test and is mostly useful for very low workability concrete mixes.

Compaction Factor = weight of partially compacted concrete/weight of fully compacted concrete.

Fig.Apparatus for compaction factor test

Fig .slump results at R0, R25, R50, R75, R100

V.TEST RESULT AND ANALYSIS

Series of test was carried out on the concrete cylinder to obtain the strength characteristics of recycled aggregate for potential application in high strength structural Concrete. This chapter discuss on the result that obtained from the testing. The results are such as slump test, compacting factor test, compression test, indirect tensile test and modulus of elasticity.

VI.CONCLUSION

Research on the usage of waste construction materials is very important due to the materials waste is gradually increasing with the increased of population and increasing of urban development. The reasons that many investigations and analysis had been made on recycled aggregate are because recycled aggregate is easy to obtain and the cost is cheaper than virgin aggregate.

Virgin aggregate need to mine but recycled aggregate can ignore this process. This on-going research project is to determine the strength characteristics of recycled aggregate for potential application in the high concrete structural concrete. This type of concrete can only be The slump test indicates a decreasing trend of workability when the percentage of Recycled aggregate increased. Table shows the average slump recorded during the test. Figure 5.1 below shows a graphical representation of slump height. According to the result, the highest slump obtained was 110mm and the lowest slump was 82mm. the average slum for each batch of mix was 96mm. therefore, target slump had been achieved, where the range is from 50mm to 120mm.The workability was good and can be satisfactorily handle for 0% recycled aggregate to 100% recycled aggregate. The slump from 0% recycled aggregate to 100% recycled aggregate were considered moderate due to the drop in the range of 5mm to 9mm.The average slump that obtained for 100% recycled aggregate (with 0.47 water cement ratio) was 82mm.

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