INFLUENCE OF PARENT CONCRETE (M25) ON RECYCLED AGGREGATE CONCRETE USING POZZOLANIC MATERIALS

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ABSTRACT

The availability of demolished concrete is increasing day by day and natural resources are depleting due to rapid development of construction industry. To meet the requirements of the construction industry there is a need to use recycled materials from C&D wastage as an aggregate in concrete. The current specifications in many parts of the world are not able to support and encourage the recycling of C and D waste. In recent past the usage of recycled concrete aggregate has gained its peak to use as an aggregate in concrete. As the recycled the aggregate has more water absorption, and adhered mortar can be controlled by using pozzolanic materials such as met kaolin, silica fume, fly ash, slag, VCAS.

In the present work, the physical and mechanical properties of natural aggregate and recycled aggregate were studied and found that the properties of recycled aggregate fall within the limits. Trail mixes were carried out to achieve M20, M25, M30, M35 and M40 grades of concrete. The casted cubes after achieving the strength were crushed at 28 days of curing for recycling aggregate. These recycled aggregate obtained from different grades is replaced to natural aggregate in percentages of 50%, 75% and 100% to get M25 grade of concrete. The cement also replaced with FA of 20% and SF of 10% to improve the mechanical properties.

It is concluded the compressive strength of M25 concrete is achieved by replacing the natural aggregate with recycled aggregate by 50% of its weight and with 20% FA and 10% SF.

KEY WORDS: Recycled aggregate, fly ash, silica fume, compressive strength, density, water absorption.

INTRODUCTION

Construction Scenario

Construction Industry of India is an important indicator of the development as it create investment offers across various related sectors. The period 1952 to mid-60’s witnessed the government playing an active role in development of those services. The professional consultancy company, national Industry development of corporation (NIDC) was set up in the public sector in 1954. Some important elements in this respect are the reduction of the consumption of energy and natural raw materials and consumption of waste materials. Sustainable construction is reduce the impact of environmental a constructed facility over its lifetime. Concrete is the main material used in construction projects in the world. Recycled concrete aggregates mainly different from natural aggregates that they are composed of two different materials: natural aggregate and cement mortar attached. Cement mortar is the origin of the properties of recycled aggregates: lower density, higher absorption, and Los
Angeles abrasion. Recycled aggregates are also highly heterogeneous and porous, as well as contain a high content of impurities.

There will however be increased costs in other areas.

Issues Related To Sustainability In Case Of Aggregates

Crushed stone, gravel, sand and clay, known in the industry as aggregate, are essential in most of our lives. Used in concrete for buildings, asphalt for roads and even in toothpaste, aggregate is essential, but is also low in value per tonne. To keep costs in check, it must be sourced close to its end use, and therefore extraction often happens close to cities and towns.

Use of Recycled Aggregates

Materials studied in the given project include three types of aggregates. They are:

1. The storage of aggregates was not included in the study due to the lack of available data regarding this issue.

2. The stage of aggregates use in construction was excluded due to its insignificance with regards to the objectives. This stage is mostly investigated when considering and comparing of selected aggregates during their life cycle (e.g. in Olsson, 2005; Mroueh, 2000 etc.). Thus when considering the whole system of aggregate provision on the regional level it was assumed that considering this stage would be too complex and at the same time not important for the achievement of the aim of the study.

3. Secondary aggregates were excluded during the Life Cycle Assessment (due to the lack of statistical data regarding this type of aggregates in the chosen regions).

Performance of Recycled Aggregates in Field

The recycled aggregate was used in making Recycled Aggregate Concrete (RAC). The concrete was molded into cubes of the size 150mm x 150mm x 150mm. The mixing of the concrete was done according to the IS method for the targeted compressive strength of 34 MPa at 28 days. The detailed of mix proportions. We were cast using the RA and NA with different sizes of 10 mm and 20 mm. The 50%, 75% and 100% of recycled aggregate was used in the mix as a coarse aggregate for the recycled aggregate concrete. Based on mix design by IS method, the target workability in this studied is between 39-65 mm.

Types and Use of Pozzolanic materials

The benefits of pozzolana utilization in cement and concrete are threefold. First is the economic gain obtained by replacing a substantial part of the Portland cement by cheaper, pollution free, natural pozzolans or industrial by-products. Second is the lowering of the blended cement environmental cost associated with the greenhouse gases emitted during Portland cement production.

- The concrete of the strength is increased
- Its density is increased
- The propensity for alkali-silica reaction (reaction with glass) is decreased, or even virtually eliminated

Depending upon the particle size, chemical composition and dosage, different pozzolans will affect the concrete strength differently and at different times during curing.
Typical pozzolans include:

- Metakaolinite
- Silica fume
- Fly ash
- Slag
- VCAS (vitrified calcium alumino-silicate)

Influence of adhered mortar in RCA concrete

Improve RA quality by pre-soaking RA with water, to remove the adhering old cement mortar to strengthen it. Characterized by a reduction of water absorption and crushing value, these measures help to produce RA with better quality. New problems, however, might accompany with these pretreatment methods: In TSMA, recycled aggregate is first coated with a thin cement mortar and then mixed with the remaining water. Before mixing remaining water add pozzolanic materials (silica fume, fly ash). The increase of compressive strength is obvious compared to that in NMA.

Advantages of recycling of construction materials

- Used for construction of precast & cast in situ gutters & kerb’s.
- Cost saving: - There are no detrimental effects on concrete & it is expected that the increase in the cost of cement could be offset by the lower cost of Recycled Concrete Aggregate (RCA).
- 20% and 10% cement replaced by fly ash and silica fume is found to control alkali silica reaction (ASR).
- Save environment: - There is no excavation of natural resources & less transportation. Also less land is required.

Limitations or disadvantages of recycling of construction Material

- Less quality (e.g. compressive strength reduces by 10-30%).
- Very high water absorption (up to 6%).
- It has higher drying shrinkage & creep.

Objective and scope

- To achieve M25 grade of concrete with optimum replacement level of recycled aggregate.
- To introduction pozzolanic materials into recycled aggregate concrete to enhance the strength.

EXPERIMENTAL PROCEDURE

Introduction:

We are observed that experimental procedures the aggregate of cement properties of natural and recycled aggregates. When the properties of cement, fine and coarse aggregate of specific gravity and water absorption fineness it’s all compare to natural aggregate, recycled aggregates lower at all stages. The properties and methodology included in this chapter for awareness. In methodology contain all work we were done in project area in recycled aggregates.

Determination of Fineness of cement As Per IS 4031 (Part I)-1996

1. Agitate the sample of cement to remove any lumps.

2. Stir the resulting powder gently using a clean brush in order to distribute the fines throughout the cement. Attach a pan under the sieve to collect the cement passing the sieve.

3. Weigh approximately 10g of cement to the nearest 0.01g and place it on the sieve. Fit the lid over the sieve.
4. Aggregate the sieve by swirling, planetary and linear movement until no more fine material passes through it.

5. Remove and weigh the residue. Express its mass as a percentage (R1) of the quantity first placed in the sieve to the nearest 0.1 percent.

6. Repeat the whole procedure using a fresh 10 g sample as above to obtain R2.

**Determination of Soundness of Cement As Per IS 4031 (Part 3)-1988**

1. Take 300 grams of cement i.e., 100 g for each sample and add water of quantity 0.78*P*C, where P is standard consistency of cement paste and C is quantity of cement.

2. Apply oil for all sides of the mould to prevent loss of cement paste to the mould. Place the mould on a glass plate.

3. Now, fill the mould with cement paste, which is prepared in step 1.

4. Cover the with another piece of lightly oiled glass sheet, place a small weight on this covering glass sheet and immediately submerge the whole assembly in water at a temperature of 27±2°C and keep there for 24 hours.

5. After 24 hrs, measure the distance separating the indicator points to the nearest 0.5 mm.

6. After measuring, place the mould in water. Bring the water to boiling, with the mould kept submerged, in 25 to 30 minutes, and keep it boiling for three hours.

7. Remove the mould from the water, allow it to cool and measure the distance between the indicator points.

8. The difference between these two measurements indicates the expansion of the cement.

**Determination of Consistency of standard cement paste As Per IS 4031( Part 4)-1988**

1. The standard consistency of a cement paste is defined as that consistency which will permit the Vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the Vicatmould.

2. Prepare a paste of weighed quantity 400g of Cement with a weighed quantity of potable or distilled water, care should be taken that the time of gauging is not less than 3 minutes, nor more than 5 minutes from the time of adding water to the cement.

3. Fill the Vicatmould with this paste, the mould resting upon a nonporous plate.

4. After completely filling the mould, smooth the surface of the paste, making it level with the top of the mould. The mould may be slightly shaken to expel the air.

**Determination of initial setting time As Per IS 4031(Part 5)- 1988**

1. Prepare a neat cement paste of 300 grams by adding a water of 0.85*P*C, where P is standard consistency of cement paste and C is quantity of cement.

2. Start a stop-watch at the instant when water is added to the cement.

3. Fill the Vicatmould with a cement paste gauged as above completely and smooth off the surface of the paste making it level with the top of the mould.

4. The period elapsing between the time when water is added to the cement and the time at which the needle fails to pierce the test block to
a point 5.0 ± 0.5 mm measured from the bottom of the mould shall be the initial setting time.

The test results are given below,

Quantity of water to be added = 0.85*P*C

\[
= 0.85 \times 33 \times 300
\]

\[
= 84.15\text{ml}
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Time at which water is first added (T1) = 10.50AM

**Determination of Final Setting Time [ IS 4031 – 1988 Part 5 ]**

1. The same procedure of initial setting time was adopted to determine the final setting time of cement.

2. Replaced the needle of the Vicat’s apparatus by the needle with an annular attachment.

3. The period elapsed between the time when water is added to the cement and the time at which the needle makes an impression on the surface of test block while the attachment fails to do so is the final setting time.

We got final setting time is 215 minutes.

**Determination of Specific Gravity of cement**

1. Take clean and dry weight specific gravity bottle (w1).

2. Take certain quantity of cement (about one third of the bottle) in the bottle and weight (w2).

3. Pour kerosene over the cement to fill the bottle and find the total weight (w3).

4. Clean the bottle thoroughly and fill the bottle with kerosene and weigh (w4).

5. Finally clean the bottle fill with water and weight (w5).

6. Repeat the above steps for each cement sample.

**Determination of Compressive Strength of cement As Per IS 4031 (Part 6) - 1988**

1. Take sample of cement and sand such that the quantity of cement and sand should be 1:3.

2. Attach a hopper of suitable size and shape securely at the top of the mould to facilitate filling and this hopper shall not be removed until the completion of the vibration period.

3. The period of vibration shall be 2 minutes at the specified speed of 12000±400 vibration per minute.

4. Keep the filled moulds in moist closet or moist room for 24 hours after completion of vibration. At the end of that period, remove them from the moulds and immediately submerge in clean fresh water and keep there until taken out just prior to breaking.

5. The cubes shall be tested on their sides without any packing between the cube and the steel plates of the testing machine.

6. One of the plates shall be carried on a base and shall be self-adjusting, and the load shall be steadily and uniformly applied, starting from zero at a rate of 35N/mm2/min

**Three stage mixing approach**

a) Add fly ash with hydroxide into the mixture and mix it for 3 minutes.

b) After that, add silicates and continue mixing for another 2 minutes.

c) Add aggregates into the mixture and continue mixing for 3 minutes.
d) Last, add water and plasticizer and mix all the mixture for 2 minutes

Fig 2: compressive strength for RAC

Fig 3: cubes are curing in water

Fly ash

Fly Ash is a by-product of coal-fired furnaces at power generation and it is a reactive spherical particle, typically finer than cement, which provides workability to concrete because of its shape, and typically allows for strength and durability enhancing lower water contents. Strength and durability results may vary based on the fly ash chemistry. Low oxide/high calcium Class C fly ash may provide higher early concrete strengths than a high oxide/low calcium Class F fly ash. Class F fly ash is typically superior to a Class C fly ash in mitigating damage from both sulfate and alkali-silica damage to concrete.

1. Reduces bleeding
2. Increases time setting
3. Improves workability
4. Reduces segregation

Silica fume

Silica Fume is a highly reactive pozzolanic material and is by-product from the manufacture of silicon or Ferro-silicon metal. It is collected from the flue gases from electric arc furnaces. Silica fume is an extremely fine powder, with particles about 100 times smaller than an average cement grain. Silica fume is available as a densified powder or in a water-slurry form.

1. Reduced permeability
2. Improves bonding within the concrete
3. Improves resistance to corrosion
4. Increased durability
5. Increased compressive and flexural strength

Silica Fume used in experimental work was obtained from local industries near Auto Nagar, and Visakhapatnam. The specific gravity of fly ash is found to be 2.1. The particles are in the form of solid spheres with sizes ranging from less than 1 μ to 100 μ and an average diameter of 20 μ.

RESULTS AND DISCUSSION

Introduction

We observed all properties of aggregate and cement at increases the grade decreases the values at gradually. We conducted all tests observed increases the replacement except the
water absorption values decreases at all stages. In that GA 20 grade obtained the strength at M25 grade concrete. Which was the maximum level of values are obtained at the GA 20 grade remaining all grades are gradually decreases.

Physical properties of Aggregates

Specific Gravity of Granite Aggregate

When observed the above specific gravity of granite aggregate graph compared to the natural aggregate recycled aggregate was decreases with increases the grade of concrete. In which the replacement of recycled aggregate with increases the grade also strength was decreases. So that replacement of natural aggregate specific gravity of GA also decreases.

Water Absorption (%) of Granite Aggregate

Water absorption of GA was increases with increases the grade of concrete. When compared to the natural aggregate, recycled aggregates were highly increases. At grades (GA20, GA25, GA30, GA35 and GA40) was equal water absorption. For water absorption reducing We adding mineral admixes(fly ash, silica fume). There are comparing to the RAC without pozzolanic project water absorption was high. The aggregate sizes decreases the water absorption also decreases.

Bulk Density (Kg/m3) of GA

In this above graph was bulk density of GA compare to the natural aggregate. When the compare to the NA, RAC was lower strengths. Which sizes of aggregate was decreases when density also decreases. At grade of concrete increases density decreases. Which was the all values of density compare to the natural aggregate decreases the all values. Its was bulk density was combination of NA and RAC.

Flakiness Index (%) of Granite Aggregate

When flakiness of aggregate was to taken the samples of two aggregate (20mm, 10mm). Then conducted test sample into the flakiness index. The sample of 20mm aggregate compared to the natural aggregate increases with increases of grade of concrete. In 10mm aggregate also grade of concrete increases GA aggregate index also increases. Both comparing that size of aggregate 10mm was higher than 20mm aggregate. That
percentage of aggregate compared to the natural aggregate high

Properties of hardened concrete

Workability of Recycled aggregate concrete

Workability of RAC was gradually decreases with increases the grade of concrete. Which have workability we are using PM of FA&SF was water absorption materials. The workability test result is a workability of the behaviour of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete.

Workability of RACWP compared to the RAC lower. Which the workability of GA grade values decreases with increases GA concrete.

Compressive strength for RAC with pozzolanic materials for 7 days

When compared the compressive strength values for 7 days was lower when compared to target strength. In the compression values of were decreases when increases of grade concrete. And compared to the NA it strength was lower. Replacement of RAC with PM also decreases when increases of

The percentage of RAC replacement water absorption also increased. When grade of concrete increases water absorption decreased. In this way observed the water absorption decreases when increased the grade of concrete due to the pozzolanic reactions

CONCLUSIONS
Based on the results and discussion, the following conclusions can be drawn:

1. From physical and mechanical properties of natural aggregate and recycled aggregate, it is concluded that, the specific gravity of recycled aggregate is less and water absorption, impact values, crushing values and flakiness index are more than that of natural aggregate. This may be attributed to the adhered mortar and porous structure of recycled aggregate.

2. As percentage of replacement increases, compression strength decreases. Also it is concluded that as the parent concrete grade increases the strength gets reduced. The adhered mortar increases with the increases in grade of concrete which leads to loss the strength.

3. To enhance the compressive strength FA and SF were added by 20% and 10% respectively.

4. At GA20 replacement from 50 to 100%, the strength reduces in the range of 0.35% to 3.04%, for GA25 replacement of 50 to 100% the strength reduces in the range of 7.3% to 21.58%, for GA30 replacement of 50 to 100% the strength reduces in the range of 18.97% to 25.5%, for GA35 replacement of 50 to 100% the strength reduces in the range of 21.58% to 29.44%, for GA40 replacement of 50 to 100% the strength reduces in the range of 25.5% to 35.97%.

5. The water absorption of concrete increased with increases in replacement and decreased with increasing grade.

6. The density of concrete decreased with increased in replacement and decrease in grade of concrete.

7. It is concluded that M25 grade of recycled concrete can be achieved by replacing 50% of GA20 with an addition of 20% FA & 10% SF.

References

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