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BEHAVIOUR OF CONCRETE WHEN COARSE AGGREGATE IS PARTIALLY REPLACED WITH ALUMINIUM CAPS AND FINE AGGREGATE WITH QUARRY DUST

Dr.M.Karthikeyan, Professor, Department of Civil Engineering, Dhanalakshmi Srinivasan College of Engineering, Coimbatore, Tamil Nadu, India.

Mr.S.Kumaraguru, Assistant Professor , Department of Civil Engineering ,Dhanalakshmi Srinivasan College of engineering ,Coimbatore ,Tamil Nadu ,India.

Dr.Gopalan A, Professor, Department of Civil Engineering, Erode Sengunthar Engineering College, Erode, Tamil Nadu, India.

Mr. K.Selvam, Assistant Professor, Department of Civil Engineering, NPR College of Engineering & Technology, Dindigul, Tamil Nadu ,India.

Dr Subashchandrabose, Associate Professor, Department of Civil Engineering, ACS College of Engineering, Bangalore, India.

Abstract

Industrial waste is one of the most rapidly growing environmental issues. The site's management is made difficult by the need for space for waste segregation. In this research paper, aluminium caps from beverage bottles are chosen as a partial replacement for coarse aggregate in concrete based on waste recycling material. The investigation begins with a 5,10,15% replacement of coarse aggregate. It has also been noted that by using aluminium caps in concrete, we can reduce the corrosion effect in structural members up to a certain limit. The size of the caps is kept at 2.5cm (approximately) in the concrete mix of Grade M25 with a w/c ratio of 0.43, and the workability is comparable to Nominal concrete. These caps are first examined for moisture content and quality. They are shredded into smaller pieces after the inspection is completed. On the other hand, given the negative environmental impact of aluminium caps and the depletion of natural aggregate, using waste aluminium caps as partial aggregate replacement in concrete is expected to be a highly effective solution to the problems. Rather than investing in a landfill for waste, an alternative step is taken to implement aluminium caps in concrete. This is beneficial in low-cost construction building.

Keywords: Aluminium caps, $M_{25,}$ quarry dust, Replacement of C.A, Concrete cubes, cylindrical specimens, Mechanical properties

Introduction

The handling and disposal of waste materials is a major issue in today's environment. In today's proliferation of food carts, several stores use aluminium as a major component in the packaging of food products. The major waste products of daily life are beverage cans, aerosol cans, and aluminium foils. Aluminum producers are also focused on collecting scrap materials in order to extract secondary aluminium. This can help to reduce manufacturing time by combining the optimal combination of recycled products.

Introduction to Aluminium Caps

Aluminum caps are collected from clean beverage bottles, and the plastic liner is manually removed. Later the caps are tapered to the nominal size and mixed along with the natural coarse aggregates by 10% partial replacement. Figure 1 depicts the process of making aluminium caps.

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Fig: 1Aaluminium Caps

Applications of aluminums' Caps

Due to the aluminium beam's light weight and resistance to corrosion, composite structures made of aluminium and concrete may have a variety of uses. These elements are used in composite bridges, but they can also be found in buildings that are hard to reach or that are situated in corrosive or humid conditions.

Aluminum caps provides good compressive strength to the concrete.

♣ It is a by-product; hence, it helps in cutting down the environmental pollution

♣ Aluminum caps has good shrinkage property and increases the durability of concrete.

Introduction to Quarry Dust

Quarry dust is a byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. So it becomes as a useless material and also results in air pollution.

Fig: 2 Quarry dust

Advantages of Quarry Dust

- Easily available and low cost material.
- Reduces the pollution in environment
- It is found that 40% replacement ofsand by quarry dust gives maximum result in strengthcompared to normal concrete and then decreases 50 %.
- consumption reduces the pollution in environment and effectively used as a replacement material for river sand.

Literature Review

Sai Gopi Kamepalli, Sai Ganesh, and Misbah Bashir: In 2017, concrete was used as the coarse aggregate in an experiment using aluminium caps. They used concrete blocks with nominal dimensions of 100 x 100 x 100 mm and 10% of replacement with aluminium caps of 2.5 cm in size. After 28 days of curing, the strength of concrete containing 10% Aluminum caps gradually increases in the Compression test.

Manju S.1, Sathish K.2, Surya N.R.N.3, Raj K.4, and Sathish K. performed an experiment in 2020 using aluminium caps as coarse aggregate in concrete. They tested the concrete's compressive strength with aluminium caps acting as a partial replacement. The percentages of aluminium caps they use are 15%, 20%, and 25%. They discovered that 15% is the ideal outcome and moreover, it was discovered that as the proportion of aluminium caps rises, strength declines.

Materials used

Fig 3: OPC Cement

Fig 4: Fine& coarse aggregate

Table1: Testing on cements

Properties	**Values**
Specific Gravity	3.15
Normal Consistency	29%
Initial Setting time	65min
Final Setting time	275 min
Fineness	330 kg/m2
Soundness	2.5mm
Bulk Density	830-1650 kg/m3

Fine Aggregate

Aggregates less than 4.75 mm in size are called fine aggregates; sand falls under the fine aggregate and crushed stone or metal under the coarse aggregates. In this case study quarry dust is used as fine aggregate.

Table 2: Test on fine Aggregate

Specific gravity	2.62
Maximum dry density g/cc	2.08

Optimum moisture content %	8.03
Gravel size particles %	1.08
Sand size particles %	96.06
Fine size particles %	2.21

Table 3: Tests on Cement and Aggregates

S.NO.	Observations	weight in grams
1.	Weight of the specific gravity bottle(W1)	49
2.	Weight of bottle + 1/3rd filled with cement(W2)	111
3.	Weight of bottle + 1/3rd filled cement + kerosene(W3)	161
4.	Weight of bottle + kerosene (W4)	127
5.	Weight of bottle + Water(W5)	142

Specific gravity = (W2 - W1) / (W2 – W1) – ((W3 – W4) *0.79)
Specific gravity of cement = 3.15

Table4: Specific Gravity Of Fine Aggregate (Quarry Dust)

S.No	Observations	Wt. in grams
1.	Weight of the specific gravity bottle(W1)	633.3
2.	Weight of the bottle + 1/3rd filled dust(W2)	1606.5
3.	Weight of bottle + 1/3rd filled dust + water (W3)	2064.9
4.	Weight of bottle + water (W4)	1528

Specific gravity =
(W2 - W1) / [(W2 –W1) – (W3 – W4)]   Specific gravity of fine aggregate=2.62

Initial and Final Setting Time of Cement

The initial setting time of concrete is the time when cement paste starts hardening while the final setting time is the time when cement paste has hardened sufficiently in such a way that a 1 mm needle makes an impression on the paste in the mould but 5 mm needle does not make any impression.

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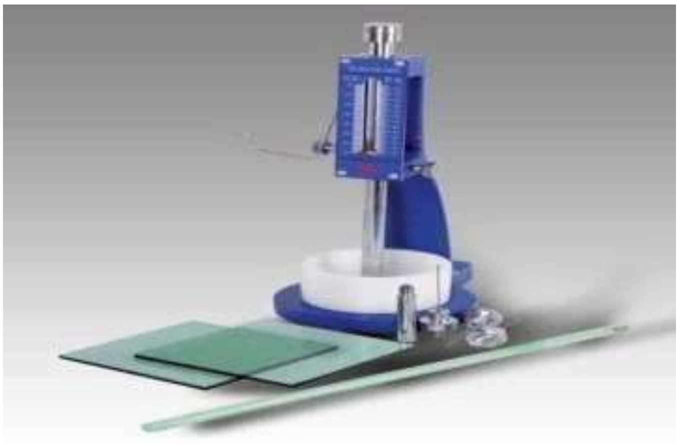

Fig5: Setting time of Cement

Initial setting time of Cement = 30 minutes
Final setting time of cement = 600 minutes

Fig 6: Specific Gravity and Water Absorption of Coarse Aggregate

IS Recommended Values

- The specific gravity of coarse aggregate as per is code is 2.5 to 3.
- The water absorption of aggregate ranges from 0.1 to 2%
- Specific gravity of Coarse Aggregates = 2.74
- Water Absorption of Coarse Aggregates = 0.44%

Tests on Fresh Concrete

Slump Test

The concrete slump test or slump cone test is the most common test for workability of freshly mixed concrete which can be performed either at the working site/field or in the laboratory. To maintain the workability and quality of fresh concrete, it is necessary to check batch by batch inspection of the concrete slump.
The slump of opc 43 grade cement = 75mm

Fig 7: Slump Test

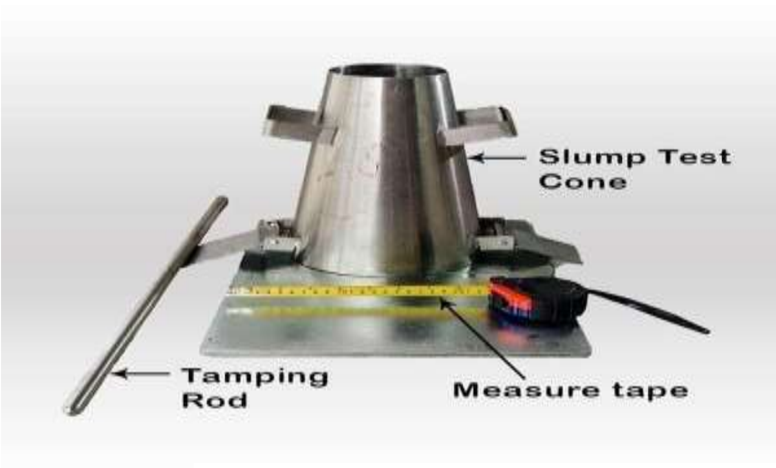

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Fig 8: Compaction factor

Table 5: Compaction factor of cement

Conditions	Degree	Values of Workability
Concreting of shallow sections with vibrations	Very low	20 – 10 seconds Vee-Bee time or 0.75 to 0.80 compacting factor
Concreting of lightly reinforced sections with vibrations	Low	10 – 5 seconds Vee-Bee time or 0.80 to 0.85 compacting factor
Concreting of lightly reinforced sections without vibrations or heavily reinforced sections with vibrations	Medium	5-2 seconds Vee-Bee time or 0.85 to 0.92 compacting factor or 25 – 75 mm slumps for 20 mm aggregates
Concreting of heavily reinforced sections without vibrations	High	Above 0.92 compacting factor or 75 – 125 mm slump for 20 mm aggregates

Compaction factor of cement=110%

Fig 9: Flow Test on concrete

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VEE-BEE Consistometer Test

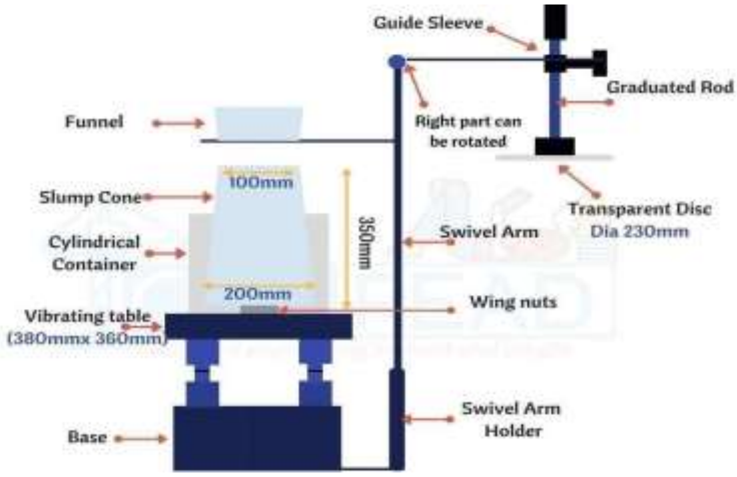

Fig10: Vee-Bee consistometer

Vee-Bee consistometer of cement= 2.6 sec

Soundness Test on Cement

Fig 11: Soundness Test

Soundness of cement Opc 43 grade = 6mm

Tests on Hardened Concrete

Compression Test

Compression test is the most common testing conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The compression test is carried out on specimens cubical or cylindrical in shape. Prism is also sometimes used, but it is not common in our country. Sometimes, the compression strength of concrete is determined using parts of a beam tested in flexure. The end parts of beam are left intact after failure in flexure and, because the beam is usually of square cross section, this part of the beam could be used to find out the Compressive Strength.

Fig12: Test on concrete cubes

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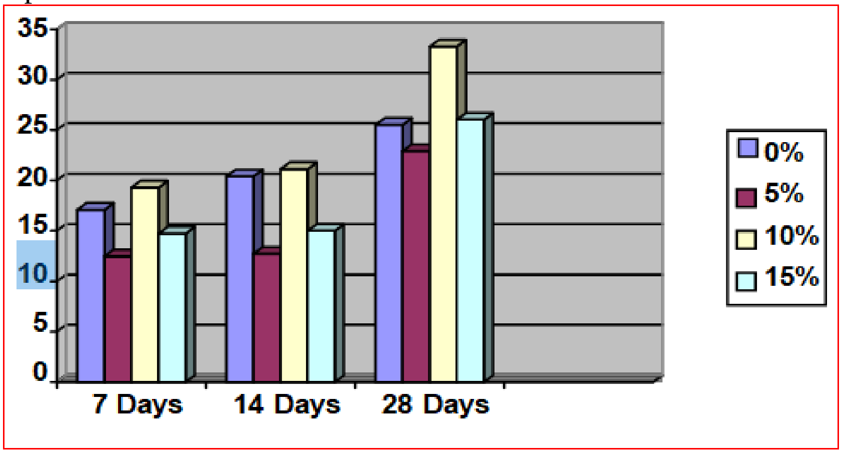
Fig13: Test on cylinder specimen

Results and Discussion

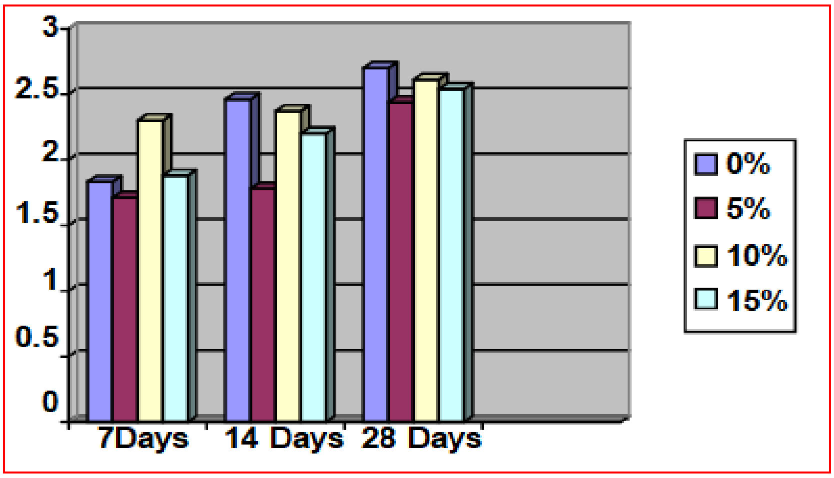
Graph shows compressive strength of cubes with different percentage of aluminum caps on ratio like 0,5,10,15% compare with conventional concrete cubes curing days for 7,14and 28 days ,In this 10% replacement aluminum caps produce optimum strength compare to conventional concrete cubes also aluminum caps bond mechanism to reduce crack in concrete structures.



Graph1: Result on concrete cubes

Test Results of Cylinders

Graph shows split tensile strength of cylinder with different percentage of aluminum caps on ratio like 0,5,10,15% compare with conventional cylindrical concrete specimens curing days for 7,14and 28 days ,In this 10% replacement aluminum caps produce optimum strength compare to conventional cylindrical concrete specimens also aluminum caps bond mechanism to reduce crack in concrete structures.



Graph 2: Result on cylinder specimens

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Conclusion

From the results of the study carried out, the following conclusion can be made. Replacing some percentages of coarse aggregate with aluminum caps and whole fine aggregate with quarry dust, compressive strength and split tensile strength decreases at 5% replacement level which was below the nominal value and increases at 10% replacement level to a great extent and decreases again at 15 %.Thus 10% was found an optimum replacement.

The maximum replacement level of aluminum caps was 10% for M25 grade concrete. On observing from the strength, it is clear that strength decreases when the percentage of aluminum caps decreases simultaneously The study helps to fix the ratio of coarse aggregate to required amount of replacement. By this project we concluded that the aluminum caps and quarry dust will be innovative supplementary building material in construction.

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