



Article Title: Experimental Study on Concrete Structural Elements Using Calcined Clay and Basalt Aggregate

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ABSTRACT

The term 'Sustainable' environmentally means "green". The deteriorating environment is driving the worldwide focus on sustainable development. It is to be noted that the largest impact on nature and environment is by the construction industry. Previously, the concern on environment formed a small part of construction development. We know that cement is the main constituent of concrete. Production of large quantity of cement results in increasing CO₂ emissions and the consequence being Greenhouse Effect. The purpose of this paper is to investigate the feasibility of using basalt aggregates in concrete mixes. Concrete is the most important engineering material and the addition or replacement of some of the materials may change the properties of the concrete. In recent years a lot of research been carried out in order to obtain more durable and long term performance of concrete structures in the dynamic environment. An experimental program is set up to test the effect of basalt aggregate content and its combinations with calcined clay with variation of percentages in concrete mixes. Different aggregate percentage combinations were used in this study for basalt and calcined clay respectively. The laboratory investigation included measurement of compressive strength, tensile strength and flexural strength. In addition the source aggregate properties were considered in this study: specific gravity and absorption for coarse aggregates and fine aggregate. The result of this investigation indicates a general improvement in mix properties with the introduction of basalt aggregates in the mix.

Keywords: Calcined Clay, Basalt Aggregate, Concrete Grade, Concrete, Workability, Setting Times, Compressive Strength, Split Tensile Strength, etc

1 Introduction

Now a days concrete is widely used in various type of construction industries, because of high strength, durability, workability so that presently many structures are constructed by concrete. The materials used for normal conventional concrete cement, coarse aggregate, fine aggregate. Portland cement is an important building material which supports the concrete industry for infrastructural and residential development. Concrete is the second most widely consumed material after water. Research has shown that not only Port land cement is used to prepare durable concrete but also mixture between Portland cement and supplementary cementitious materials (SCMs) is possible. SCMs that have been used in concrete include pozzolanic materials



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such as fly ash, slag, silica fume, and metakaolin, calcined clay etc. Also, environmental concerns the damage caused by extraction of raw materials and CO₂ emission during cement manufacture have brought about pressures to reduce cement consumption by the use of supplementary materials. Calcined clay consists basically of pozzolanic properties. Coarse aggregates normally possesses more than 33% of the volume of cement. Concrete durability is one of the most important parameter while designing new structure or assessing the condition of any existing structure. Basalt is that type of volcanic rocks, grey to black in color, contains less than 20% quartz, 10% feldspathoid and at least 65% of the feldspar of its volume. Basalt is considered an igneous rock with fine grains due to the rapid cooling of lava. The durability of concrete is increased by using Basalt as Coarse aggregate. The other materials are available from the market. The strength of concrete can be increased by Calcined clay and basalt as coarse aggregate

2 Proposed System

The study is limited to concrete mix modified by replacing fine aggregate with different of basalt aggregate and keeping the constant replacing amount of cement with calcined clay, which is designed for a characteristic compressive strength of 35 N/mm². The work is carried out to find axial compressive strength and reduce full dependence of natural aggregate.

3 Objective

- To reduce the dependence of natural aggregate as the main source of aggregate.
- Introduction of new construction materials.
- To find mix ratio which gives good strength while replace with calcined clay and basalt aggregate.
- To compare the mechanical properties of normal concrete and basalt replaced concrete

4 Material Testing

4.1 Sieve Analysis of cement

- Weight the empty pycnometer with to cover in the weighing balance.
- Remove the top cover and place 300– 500 grams of thoroughly dried cement sample passing through 90μ sieve into the pycnometer and note the weight.
- Add sufficient quantity of kerosene to the cement with pycnometer.
- Shake the pycnometer so as to remove entrapped air and fill with kerosene completely and note the weight.
- Now clean the pycnometer by weighing thoroughly with kerosene and find the weight.



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Empty weight of pycnometer

$W_1 = 0.655\text{g}$ Weight of

Pycnometer + cement, $W_2 = 1.300\text{g}$

Weight of pycnometer + cement + kerosene, $W_3 = 1.805\text{g}$ Weight of pycnometer + water,

$$W_4 = 1.365\text{g} \quad \frac{W_2 - W_1}{(W_2 - W_1) - (W_3 - W_4)}$$

Specific gravity, $G =$

$$= \frac{1.3 - 0.655}{(1.3 - 0.655) - (1.805 - 1.365)}$$

$$= 3.15$$

4.2 Initial Setting Time of Cement

- A 400gm of cement was taken and paste was made with 0.85 times of water that was prepared to give a standard consistency.
- The time at which the water initially added was noted. The Vicat mould was filled with the cement paste in 3 to 5 minutes.
- The surface of the paste is smoothened, making it level with the top of the mould. The needle was gently lowered to the surface of the paste and was quickly released allowing it to sink into the paste by its own weight.
- Note the penetration value every two minutes.
- The procedure was repeated until the needle fails to pierce the block for about 5mm measured from the bottom and the time was noted during stop watch.
- The difference between the timing will give the initial setting time.

4.3 Observation

Initial setting time = 30 minutes

4.4 Fineness of Cement

Weigh correctly 100 grams of cement and take it on a standard IS sieve no. 9. Break down the air set lumps and sieve the material continuously for 15 minutes using sieve shaker. Weigh the residue left and the weight shall not exceed the specified limit as given in the table below.

Weight of cement sample taken = 100g

Weight of cement retained on 90 μ sieve = 8.4g

$$\% \text{ of residue left on the sieve} = \frac{\text{weight retained}}{\text{original weight}} \times 100$$



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$$\frac{8.4}{100} * 100$$

Fineness of cement = 8.4%

5 Mix Design of Concrete

5.1 Grade of Concreted

Esignstipulations

1.Characteristic compressive strength at 28days	=	35MPa
2.Maximumsize of aggregate	=	20mm
3.Degree of workability	=	0.9
4.Degree of quality control	=	Good
5.Type of exposure	=	Mild

Test on materials

1.Specific gravity of cement	=	3.15
2.Specific gravity of coarse aggregate	=	2.71
3.Specific gravity of fine aggregate	=	2.68
4.Water absorption		
i)Coarse aggregate	=	0.5%
ii)Fine aggregate	=	1%(assume)
5.Free moisture		
i)Coarse aggregate	=	Wet
ii)Fine aggregate	=	2%(assume)

Target Mean Strength

$$\begin{aligned}
 F_{ck} &= f_{ck} + t_s \\
 &= 35 + (1.65 \times 5) \\
 &= 43.25 \text{ N/mm}^2
 \end{aligned}$$



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6 Casting and Curing Of Cubes

6.1 Casting

Casting is a manufacturing process by which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting materials are usually metals or various cold setting materials that cure after mixing two or more components together; examples are, concrete, plaster and clay.



Figure 1: *Casting of beam*

6.2 Flexural strength Comparison bar chart

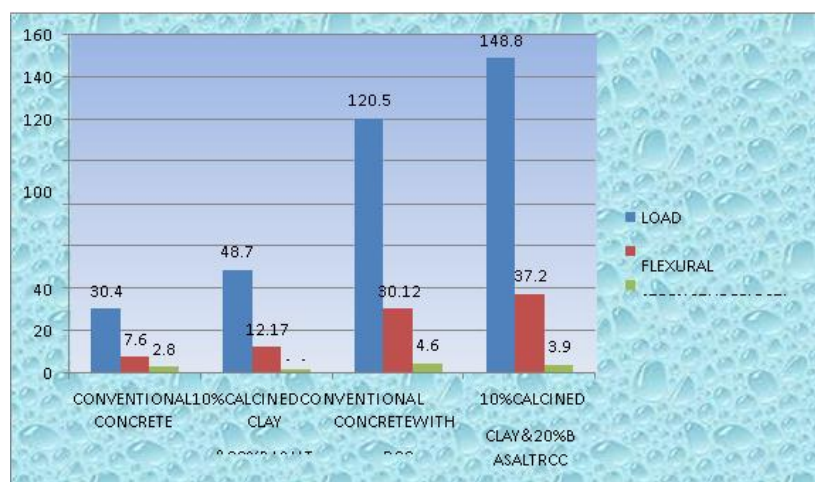


Figure 2: *Flexural Strength*



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6.3 Flexural strength Comparison bar chart

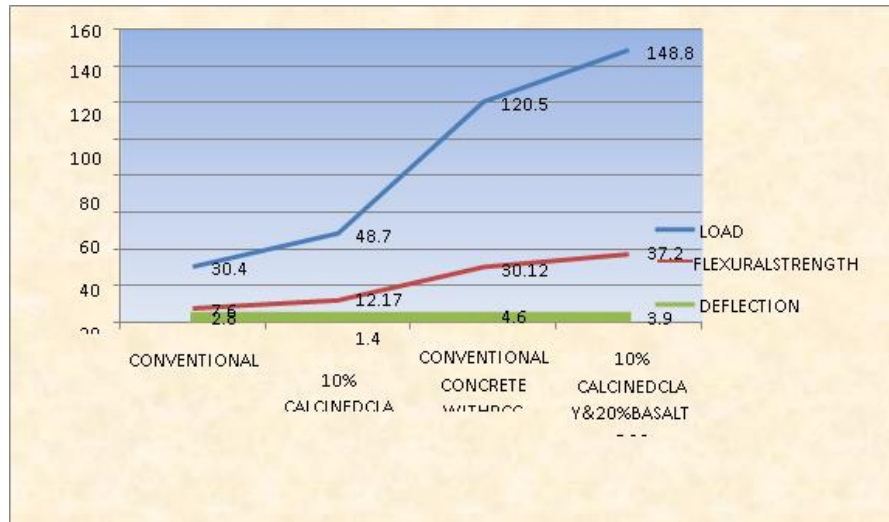


Figure 3: Flexural Strength

7 Conclusion

From the experimental study the partial replacement of calcined clay for cement and Basalt for coarse aggregate is mixed with the concrete to compare the strength. Thus the experimental investigation the strength is determined by various test like compressive strength, split tensile strength, flexural strength test. The specimens are casted and the result is obtained. Here 20% replacement of basalt for coarse aggregate and 10% of Calcined clay for cement gives higher strength, when compared with other percentage. Since, they are naturally occurring material their will be no hazardous to the environment.