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An experimental study of concrete with expanded clay replacement.

Un estudio experimental del hormigón con sustitución de arcilla expandida.

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ABSTRACT

This paper describes the mechanical characteristics of concrete that has expanded clay in partial replacement of coarse aggregates. Its properties are comparedto conventional concrete in terms of compressive strength. Thecompressive strength of various mixes with replacement ratiosof 20%, 30%, and 40% of coarse aggregate by expanded clay was investigated. These aggregates have a lower specific gravity and a higher water absorption rate. The prepared specimens were tested after 3, 7, and 28 days. When compared to regular concrete, there was a slight reduction in the mechanical properties. There is a decline in the strength as the percentage increases. The optimum ratio was found to be 20%, providing 72% of the strength of conventional concrete. Expansive Clay aggregate concretes have characteristics that suggest they could be one of the materials used to create structural concrete in the future. This leads to the conclusion that expanded clay aggregates can be substituted to create concrete more cost effectively.

RESUMEN

This paper describes the mechanical characteristics of concrete that has expanded clay in partial replacement of coarse aggregates. Its properties are comparedto conventional concrete in terms of compressive strength. Thecompressive strength of various mixes with replacement ratiosof 20%, 30%, and 40% of coarse aggregate by expanded clay was investigated. These aggregates have a lower specific gravity and a higher water absorption rate. The prepared specimens were tested after 3, 7, and 28 days. When compared to regular concrete, there was a slight reduction in the mechanical properties. There is a decline in the strength as the percentage increases. The optimum ratio was found to be 20%, providing 72% of the strength of conventional concrete. Expansive Clay aggregate concretes have characteristics that suggest they could be one of the materials used to create structural concrete in the future. This leads to the conclusion that expanded clay aggregates can be substituted to create concrete more cost effectively.

INTRODUCTION

Concrete as a building material can not currently be replaced by any current technology. Concrete is the best building material because of its accessibility, versatility, andcost. Moreover, the highest proportion of the mix is made upof coarse aggregate, one of the crucial elements of concrete.The use o flight weight

aggregates which has remark able advantages such excellent heat and sound insulation properties, has seen a grow thin research in efforts to conserve energy and reduce greenhouse gas emissions, which are thought to be the main contributor to global warming. However, it is thought that the mechanical qualities and durability of such concrete are affected whenthe unit weight of concrete is reduced by adding light weight aggregates. In order to function well when exposed to adverse weather conditions, it must be constructed for both outstanding mechanical performance and long-term durability. The construction sector is anticipated to under goa revolution as a result of the employment of expanded clay. Due to its technical qualities and several benefits over manyother industrial raw materials, expanded clay aggregates areemployed inawiderangeofindustries.

Expanded clay aggregates have the highest compressive strength when compared to other lightweight aggregates. Itnow has a significant presence in the construction sector. In order to improve the properties of concrete, expanded clay was included in the mix due to its advantageous insulating qualities. It offers good fire resistance, great crushing resistance, and superior thermal and sound insulation qualities. Compared too there aggregates, expanded clay aggregate is generally favored due to its superior resistance to acidic and alkaline substances as cited by M.R Ahmad et.al in his research. However complete replacement of coarse aggregate by expanded clay aggregates reduces the mechanical properties of the resulting concrete.
R. Vijayalakshmi et.al in her research stated that expanded clay concretes had significantly lower slump values than that of the normal weight granite concrete. Test results showed that at the same water and superplasticizer contents, the expanded clay concrete has a higher slump value compared to the other light weight aggregate concrete. This may be attributed to the round shape of expanded clay aggregates and their limited surface porosity compared to other light weight aggregate.

Partially replacement using expanded clay helps in improving the properties. Expanded clay aggregate is an artificial and man-made light weight aggregate. Expanded clay aggregate production does not result in the release of any air pollution-causing gases, such as carbon dioxide, methane, or propane. The expanded clay balls can be used repeatedly, which can result in costs a vings. Its characteristics make it lightweight, which makes it simple tocarry more ofitat once. The clay is swelled to around fourto five times its initial size and is developed to the shape ofpellets after being heated at 1150 °C in a rotary kiln. Theexpanded clay aggregates have a spherical shape, a browncolor, and a black core inside. A honeycomb structure iscreated during construction, allowing water to be retained in the stones and strength eningit to with stand pressure. Expanded clay aggregate balls' structure makes them one of the modern construction industry's greatest pressure engrossing agents. The construction is strengthened by thematerial's ability to absorb water. Because of its flexibility, the building is resistant to earthquakes. In this paper, the mechanical properties of concrete with expanded clay in replacement of some of the coarse aggregates are discussed. In terms of compressive strength, its characteristics are contrasted with those of regular concrete.

MATERIALS AND METHODS

The materials used here are tested for their properties as per IS Specifications. Portland Pozzolan Cement of grade 53 was used. The PPC was tested as per IS 4031-1996. Shown in Fig 1 and 2. Its properties are listed in Table 1.

Fig.1 Standard Consistency of Cement

Fig.2 Initial Setting Time of Cement

Table.1 Properties of cement

Sl.no	Test property	Result
1	Fineness by sieve test	6%
2	Standard consistency	40%
3	Specific Gravity	3.04
4	Initial Setting Time	85min
5	Final Setting Time	287min
6	Soundness	3mm

Crushed coarse aggregate of 20mm size are used. Fine Aggregate used here is Msand belonging to Zone II. Expanded clay aggregates of 2mm-8mm size are used in this work. Expanded clay aggregates are light weight aggregates manufactured by burning clay at high temperature in rotary kiln. The properties are listed in Table2.

Table.2 Properties of Aggregates

Sl. no	Item	Water Absorption (%)	Specific Gravity
1	Coarse Aggregate	0.5	2.8
2	Fine Aggregate	0.9	2.4
3	Expanded Clay	35	0.6

The expanded clay aggregates had specific gravity value much lesser than that of coarse aggregate sand higher water absorption. Based on guidelines and specifications as perIS10262-2009, concrete mix proportion of M25 grade weremade. Control mixes were prepared with pozzolan Portland cement, sand, coarse aggregate and water. Nine cube specimens were casted. The size of cube istakenas150*150*150mm. The cubes are demolded after 24 hours and subsequently cured. They were then tested for compressive strength at 3,7 and 28 days. Three cubes weretested at each tested day and average compressive strengthwasfoundout.

The experimental investigation is done by partially replacing coarse aggregate with expanded clay atratios20%,30% and 40%. Design mix for M25 grade was made with pozzolan Portland cement, msand, coarse aggregate, water and expanded clay of 2mm-8mm size. For each rationine cubes were casted for testing at 3, 7 and 28 days. After curing they were tested for compressive strength using universal testing machine and the average strength is found out.

RESULTS AND DISCUSSIONS

The data obtained for the compressive strength of conventional concrete mix on third, seven thant wenty eighth day are shown in Table3. The compressive strengthvalues of expanded clay replacing coarse aggregate at the ratios 20%, 30% and 40% are shown in Table 3 well as the average between three specimens of each composition. The compressives trength decreased as the ratios increased.

Fig.3 Cubes of control mix

Expanded clay concrete showed much reduced slump values. According to test results, the slump value was 75mm (True slump), for a 20% replacement, 40mm for a 30% replacement (shear slump) and the slump value for replacement at 40% was 17mm (shear slump).

Fig.4. Cubes of 20% replacement by expanded clay

Fig.5.Cubes of 30% replacement by expanded clay

The optimum ratio was found out to be 20% which gavethe maximum strength. The average compressive strength at28 days when 20% of expanded clay was replaced by coarse aggregate was obtained as 21.53MPa. The average compressive strength at seventh and third days were 14.09MPa and 6.53MPa. This was72% of strength when compared to conventional concrete. At 30% and 40% replacements the strengths obtained were low than those ofthe references expected. At 30% replacement the average compressive strength obtained at 28^{th} day were 16.1MPa.

At seventh and third day the average compressive strength was 10.4MPa and4.9MPa. At40% replacement the average compressive strength was 4.15 MPa ,9,2 MPa and 14.03MPa at third, seventh and twenty eighth days respectively. This may be due to the surface irregularity of the specimen which doesn't allow uniform load to be applied. Small irregularities are enough to reduce the final strength. The replacement of expanded clay resulted in honey comb structure at higher ratios. So, it is advisable not to use higher ratios of expanded clay replacements as to maintain sufficient strength

CONCLUSION

The feasibility of expanded clay LWA to the development of structural concrete was studied.

Table.3 Compressive Strength of Conventional Cubes and Expanded Clay Replaced cubes

	Day	Specimen 1	Specimen 2	Specimen 3	Average Compressive Strength
Conventional	3	8.9	9.1	9.02	9.0
Cube	7	18.9	19.2	19.36	19.15
	28	29.6	30.1	29.99	29.9
20 %	3	6.58	6.7	6.3	6.53
	7	14.22	14.5	13.54	14.09
	28	21.5	22	21.1	21.53
30%	3	4.75	5.1	4.9	4.9
	7	10.1	11	10.4	10.4
	28	15.5	16.9	16.1	16.1
40%	3	4.1	4.06	4.29	4.15
	7	9.3	8.9	9.4	9.2
	28	14.16	13.54	14.39	14.03

The use of expanded clay in concrete can provide several benefits, including improved thermal insulation, reduced weight etc.

Additionally, because expanded clay is a natural and sustainable material, it is a neco-friendly choice for construction projects. ECA in concrete is that it can improvethe insulation properties of the concrete. ECA has a low thermal conductivity, which means that it can help to reduce heat transfer through the concrete.

This can be useful inbuildings where energy efficiency is important. From the study it is noted that using too much expanded clay in concrete can have a number of negative effects on its performance. While expanded clay can provide several benefits, it is important to ensure that it is used in the appropriate proportion to maintain the necessary structural strength and durability of the concrete.

If too much expanded clay is used in the mix, it can leadto a reduction in thecompressive strength of the concrete. Expanded clay offers less structural support than denser aggregates like sand and gravel because it is porous. Because of this, expanded clay concrete has a lower compressive strength. This can occur because expanded clay has a lower densityand a higher porosity than traditional aggregates, which can result in a weaker bond between the aggregate and the cement paste. Expanded clay has a limited surface area and is generally smooth, making it challenging for the cement paste to adhere to the clay particles' surface.

The water-to-cement ratio of the concrete can also be impacted by the usage of expanded clay. Expanded clay absorbs more water than conventional aggregates because it is porous and lightweight. A larger water-to-cement ratio could arise from this, which might result in lessening of compressive strength.
Additionally, using too much expanded clay in concretecan also result in a reduction in its workability and increase the risk of segregation during placement. This can result in a poorly consolidated concrete with voids, which can further reduce its strength and durability.

From the experimental study, the optimum ratio was found to be 20% providing 72%strength of conventional concrete. If used in appropriate proportion concrete with expanded in partial replacement of coarse aggregate can becosteffective andsustainable.

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