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An Experimental Investigation of Strength of Concrete with Cuddapah stone as Partial Replacement of Coarse Aggregate

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ABSTRACT

Ultrasonic pulse velocity testing method, which involves measurement of the time of travel of electronically generated mechanical pulse through the concrete. UPV consists of measuring the time of an ultrasonic pulse, passing through the specimen to be tested. The pulse generator circuit consists of electronic circuit for generating pulses and a transducer for transforming this electronic pulse into mechanical energy having vibration frequencies in the range of 15 to 50 KHZ. The time of travel between initial onset and reception of the pulse is measured electronically. The path length between transducer divided by the time travel gives the average velocity of wave propagation. Comparatively higher velocity is obtained when concrete quality is good in terms of density, uniformity, homogeneity etc.Partial replacement for the aggregate or cement in regular concrete has become a common for day to day increase in demand of concrete. In these effects Natural aggregate had been replaced with the waste cuddapah stone in four different percentages namely 0%, 15%, 30% & 45 %. A comparison was made between the specimens of partially replaced coarse aggregate and the same set of specimens with 0% replacement. The effects on Ultrasonic pulse velocity compressive strength, flexural strength were reported. Test results indicate so as to the alternative of coarse aggregate by 30% had attained a good strength in the two suitcases mention above.

KEYWORDS:Ultrasonic Pulse Velocity, Structuralbehaviour, Failure mode, Crack pattern monitoring and Compressive strength

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INTRODUCTION

The statement concrete come from the Latin word "concretus" (significance compact), the perfect passive participle of "concrescere", from "con-" (together) and "crescere" (to grow). Concrete is a composite material composed mainly of water, aggregate, and cement. Often, additives and reinforcements (such as rebar) are included in the mixture to reach the desired physical properties of the finished material. When these ingredients are mixed together, they form a fluid mass that is easily moulded into shape. Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses. Concrete is widely used for making architectural structures, foundations, pipes, footings for gates, fences and poles and even boats. Concrete is used in large quantities almost everywhere mankind has a need for infrastructure. The manufacture and use of concrete produce a wide range of environmental and social consequences. Some are harmful,some welcome, and some both, depending on circumstances. The amount of concrete used worldwide, ton for ton, is twice that of steel, wood, plastics, and aluminium combined. Concrete's use in the modern world is exceeded only by that of naturally occurring water. Concrete recycling is an increasingly common method of disposing of concrete structures. Concrete debris was once routinely shipped to landfills for disposal, but recycling is increasing due to improved environmental awareness, governmental laws and economic benefits. Waste Cuddapah stones (WCS) were partly replaced as coarse aggregates in 20%, 40% and 60% respectively and fly ash (FA) was partly replaced with cement by 20% in that order are casted and tested for 7 and 28 days. Clean and hardened concrete properties are evaluated by workability test, compressive strength and split tensile test with a fixed water cement ratio 0.4. The test results were compared with the conventional concrete property and show that there is an increase in strength of the concrete[1]. In testing, concrete specimens were cast with ceramic waste aggregate as coarse aggregate by replacing natural coarse aggregate at 0, 20, 40, 60, 80 and 100%. Due to the quality and behaviour of ceramic waste aggregate, strength properties of the ceramic waste aggregate concrete is declining. A numerical model is developed for compressive strength and split tensile strength using failure analysis of experimental results[2]. A comparison was prepared between the sample of partially replace coarse aggregate and the same set of specimens admixed with supaflo. The property on compressive strength, split tensile strength and modulus of rupture were reported. Test results indicate that the replacements of coarse aggregate by 30% have attained high-quality strength in the two cases mentioned above[3]. Tests are conduct on concrete cubes, cylinders and flexural beams to study compressive strength, split tensile strength and flexural strength. Tests are conduct for finding the strength of the concrete in 7 days and 28 days strength. At last the results are comparing with the normal predictable concrete. The weight decrease is also calculated. The appropriateness of the fly ash and egg shell powder concrete is evaluated[4]. In this process a small investigate work had done on the concrete by using Bethamcherla Marble Stone in place of normal aggregate in different proportions like 0%, 25%, 50%, 75% and 100%. Bethamcherla Marble Stone is mostly flaggy lime stone. In that similar way it is also add some amount of GalvanizedSteel Fibres to the concrete mix similar to 0%, 1%, and 2%, by the volume of whole concrete to develop the performance of concrete mix. The aim of the manuscript is to study the workability of fibre reinforced concrete by replacing natural aggregate with Bethamcherla marble stone. In this manuscript we know the workability of the Bethamcherla Marble Stone by experiment the slump, compaction factor and Vee – Bee tests for each mix batch[5].

II. EXPERIMENTAL SET UP

In this stage collection of materials essential and the data required for mix design are obtained by sieve analysis and specific gravity test. Sieve analysis is carried out from various fine aggregates (FA) and coarse aggregates (CA) samples and the samples which suit the requirement are selected. Specific gravity tests are carried out for fine and coarse aggregate. The various materials used were tested as per Indian standard specifications.

II.1 Materials

Raw materials required for the concreting operations of the present work are cement, fine aggregate, coarse aggregate (CS) and water. Cement: Ultra tech cement of 53 Grade ordinary Portland cement was used whose specific gravity is 3.15. The properties of materials are shown below the table.

Table 1, Properties of Materials

Sl. No	Property	Test results
1	Normal consistency	30%
2	Specific gravity	3.15
3	Initial setting time	45 min
4	Fineness of cement	97.5 %
5	Compressive strength of cement At 7days At 28 days	 28.89 N/mm^2 32.22 N/mm^2
6	Specific gravity	2.65
7	Fineness modulus	2.42

II.2 Coarse Aggregate

The material whose particles are of size as are retained on I.S. sieve no. 4.75 mm is termed as coarse aggregate. The size of coarse aggregate depends upon the nature of the work the coarse aggregate that is the CS used in this experimental investigation is 20mm size, crushed and angular in shape. The aggregates are free from dust before used in the concrete. The Cuddapah Stone (CS) is obtained for the experiment is from the quarried. Specific gravity = 2.74.

II.3 Water

Water to be used in the concrete work should have following property: It should be free from harmful quantity of oil, acids, alkalis or other organic or inorganic impurities. It should be free from iron, vegetable matter or other any type of substances, which are likely to have adverse effect on concrete or reinforcement. It should be quite satisfactory for drinking purpose which is used in mixing of concrete.

Material	**kg/cum**	**ratio**
Water	197.00	0.40
Cement	492.50	1
Fine aggregate	673.65	1.36
Coarse aggregate	1099	2.23

II. 4 Ultrasonic Pulse Velocity Test

Ultrasonic pulse velocity testing method involves measurement of travel time, T of ultrasonic pulse of 50 to 54 kHz, produced by an electro-acoustical transducer, held in contact with one surface of the concrete member under test and receiving the same by a similar transducer in contact with the surface at the other end. With the path length L and time of travel T, the pulse velocity (V=L/T) is calculated. From Table 5.3 it will be observed that for all the concrete time of travel of an ultrasonic pulse is very good on 15% and 30%. Because as per Central Water and Power Research Station Khadakwasla (India) if velocity value is more than 4.5 km/sec quality of concrete is excellent. The velocity value is determined is shown in below table 2.

Fig 1, Ultrasonic Pulse Velocity

Table 2, Result of Ultrasonic Pulse Velocity

Sl. No	Type of concrete	Mix Design	Time travelling(µ)	Velocity value (km/sec)
1	Conventional Concrete	M_{60}	21.4µ	4.67
2	Cuddapah stone Concrete (15% Replacement)	M_{60}	20.5µ	4.88
3	Cuddapah stone Concrete (30% Replacement	M_{60}	21.6µ	4.63
4	Cuddapah stone Concrete (45% Replacement	M_{60}	22.2µ	4.51

II.5 Compressive strength

Compression test: It is the most common test conducted on hardened concrete as it is an easy test to perform and also most of the desirable characteristic properties of concrete arequalitatively related to its compressive strength. The compression test is carried out on specimens cubical in shape as shown in figure 1 of the size 150 × 150 × 150 mm. The test is carried out in the following steps: First of all the mould preferably of cast iron, is used to prepare the specimen of size 150 × 150 × 150 mm. During the placing of concrete in the moulds it is compacted with the tamping bar with not less than 35 strokes per layer. Then these moulds are placed on the vibrating table and are compacted until the specified condition is attained. After 24 hours the specimens are removed from the moulds and immediately submerged in clean fresh water. After 28 days the specimens are tested under the load in a compression testing machine.

Fig 2, Specimen for Compressive Strength

Table 3, 7 days Compressive Strength Results

Sl. No	Total replacement by CS in percentage	Mix Design	Compressive StrengthN/mm^2
1	**0**	M_{60}	43.90
2	15	M_{60}	44.70
3	30	M_{60}	41.45
4	45	M_{60}	34.70

Table 4, 14 days Compressive Strength Results

Sl. No	Total replacement by CS in percentage	Mix Design	Compressive Strength N/mm2
1	**0**	M_{60}	42.00
2	15	M_{60}	47.30
3	30	M_{60}	47.45
4	45	M_{60}	41.30

Table 5, 28 days Compressive Strength Results

Sl. No	Total replacement by CS in percentage	Mix Design	Compressive Strength N/mm2
1	**0**	M_{60}	61.00
2	15	M_{60}	62.30
3	30	M_{60}	63.75
4	45	M_{60}	58.50

II.6 Flexural strength for beam

Flexural strength is also known as modulus of rupture, bend strength or fracture strength, mechanical parameters of brittle material is defined as a material ability to resist deformation under load. The transfers bending test is most frequently employed, in which specimen having either circular or rectangular cross-section in bent until fracture or yielding using a one point flexural test technique. The flexural strength represents the highest strength experienced within the material as its moment of rupture. It is measured in terms of stress, here given symbol σ. Size of beam 500mmx100mmx100mm.

$$\text{Flexural strength} = 3Wl/2bd^2 \ \text{N/mm}^2$$

Where

W = weight of the load applied (N)

L = Length of the flexural beam (mm)

B = Breadth of the flexural beam (mm)

D = Height of the flexural beam (mm)

Table 6, 28 days flexural Strength of beam Results

Sl. No	Total replacement by CS in percentage	Mix Design	Load (N)	Flexural Strength N/mm^2
1	**0**	M_{60}	1700	1.28
2	15	M_{60}	1740	1.30
3	30	M_{60}	2050	1.55
4	45	M_{60}	2000	1.52

III STRESS VERSUS STRAIN CURVE

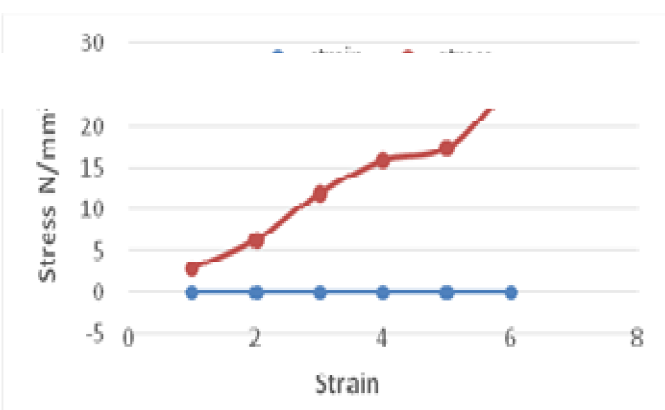

Fig 3, 0% replacement

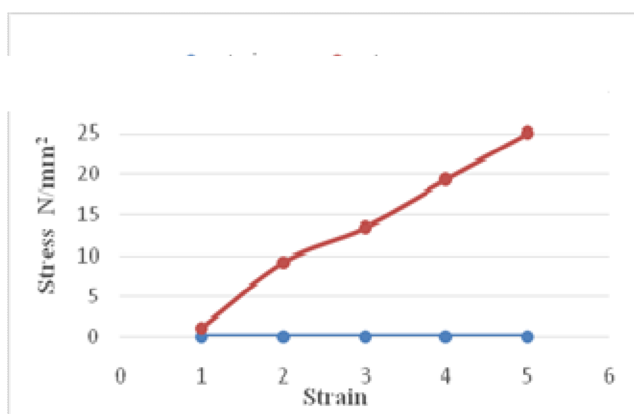

Fig 4, 15% replacement

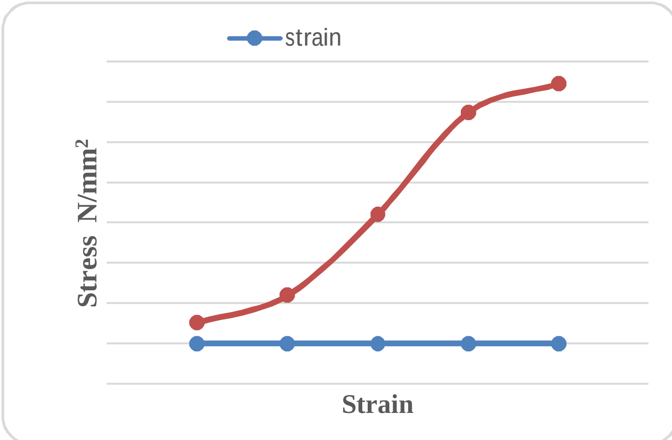

Fig 5, 30% replacement

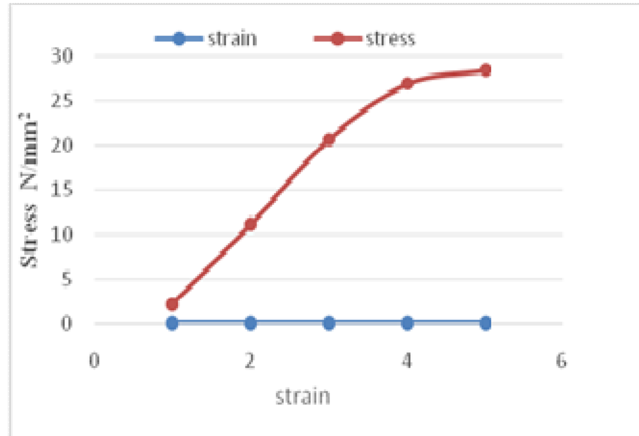

Fig6, 45% replacement

IV COMPARATIVE GRAPH FOR CUBES

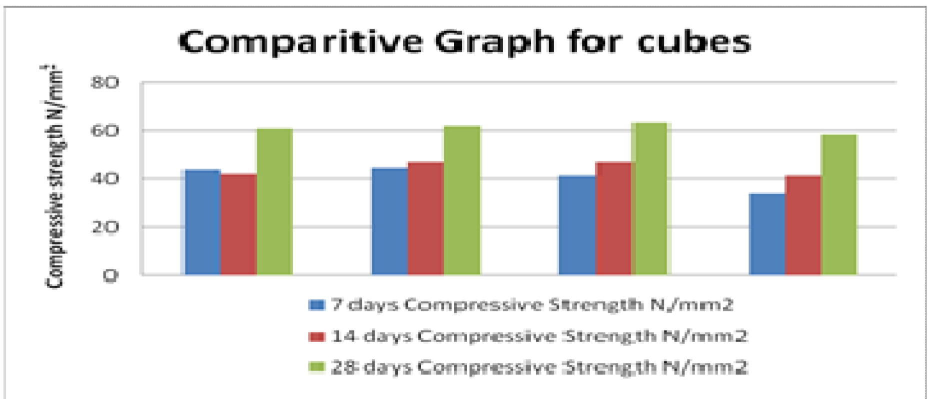

Fig 7, Comparative Graph for cubes

V. CONCLUSION

Based on the results obtained from the experiment the following conclusions are drawn. It will be observed that for all the concrete time of travel of an ultrasonic pulse is very good on 15% and 30%. Because as per Central Water and Power Research Station if velocity value is more than 4.5 km/sec quality of concrete is excellent. The maximum Compressive strength of concrete without chemical admixture can be achieved by 30% replacement of cuddapah stone was found to be 53.5% higher than the conventional concrete. Compare to the conventional concrete the tensile strength of 30% replacement of coarse aggregate concrete was gradually increased up to 21.70% and 28.30% without chemical admixture respectively. Similarly the flexural strength of concrete was gradually increased up to 11.76% and 15.29% with partial replacement of 30% coarse aggregate without chemical admixture respectively. From the above 3 cases the strength had decreased when the 45% of coarse aggregate was replaced.Hence replacement of coarse aggregate with 30% cuddapah stone was achieved good strength.

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