International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 05, May - 2017

Effect of Strength Properties on Concrete by Partial Replacement of Coarse Aggregate with Waste Cuddapah Stones

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***Abstract* - Cement, fine aggregate, coarse aggregate and water are important constitutes of concrete that are obtained naturally. So we can replace new materials instead of natural sources such as M Sand, fly ash, Metakaolin, etc. Aim of this project is to study the strength properties of the concrete by partially replacing coarse aggregate by waste Cuddapah stones and using PPC - Fly ash based as cement. This thesis covers the properties of materials and mix proportions, preparation of concrete with waste Cuddapah stones, hardened state characteristics, and influence of various parameters on hardened state concrete and utilization of various materials in the structural members. Waste Cuddapah stones (WCS) were partially replaced as coarse aggregates in 20%, 40% and 60% respectively are casted and tested for 7 and 28 days. Fresh 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 properties and show that there is an increase in strength of the concrete.**

Keywords: Cement, Coarse Aggregate, Cuddapah Waste, Fly Ash, Partial Replacement, Water.

1. INTRODUCTION

Concrete is a material synonymous with strength and longevity has emerged as the dominant construction material for the infrastructure needs of the present situation. Due to the vast usage of concrete in this century, concrete ingredients are in depleting stage. There is an interest mounting up to the handling of waste materials as different aggregates and significant research was performed on the use of many different materials as aggregate substitute such as waste Cuddapah and other industrial wastes. There is an interest mounting up to the handling of waste materials as different aggregates and significant research was performed on the use of many different materials as aggregate substitute such as waste Cuddapah and other industrial wastes. These waste materials can solve few problems like lack of aggregates in construction sites and environmental problems. In the last decade, construction industry has been conducted various researches on the utilization of waste products in concrete in order to reduce the utilization of natural resources. Layer stone (Cuddapah slab) is utilizing for roof and floor works. During processing of finished product, waste is generating and this waste is dumping in and around the places where they are cut as per customer's requirements. Concrete production achieves innovations in substitution of different materials in the place of natural coarse and the fine aggregates. This Paper Presents the experimental study undertaken to investigate the influence of partial substitution of coarse aggregate by waste Cuddapah stones and as a method to improve normal concrete for special applications. The tested hardened properties of M_{30} grade concrete will consist of compressive strength, and flexural strength.

2. LITERATURE REVIEW

The Shabath waste is used as the partial replacement of coarse and fine aggregate. Shabath is the slate rock which is metamorphic rock of greenish blue color and is used for the flooring of corridors. Various percentages of shabath waste stone and the shabath dust were partially replaced as coarse aggregate and the optimum percentage of replacement is determined [1]. 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 characteristics and behavior of ceramic waste aggregate, strength properties of the ceramic waste aggregate concrete is declining. A mathematical model is developed for compressive strength and split tensile strength using regression analysis of experimental results [2]. Natural aggregate had been replaced with the waste shabath stone in four different percentages namely 10, 20, 30 &40 %. A comparison was made between the specimens of partially replaced coarse aggregate and the same set of specimens admixed with supaflo. Test results indicated that the replacement of coarse aggregate by 30% had attained a

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 05, May - 2017

good strength in the two cases mentioned above [3]. This study explores the possibility of replacing part of fine aggregate with fly ash as a means of incorporating significant amounts of fly ash. Eggshell is generally thrown away as a waste. The egg shell also creates some allergies when kept for a longer time in garbage. If the waste cannot be disposed properly it will lead to social and environmental problem. [4]. Concrete is the material that can be used in any type of construction works. Hence demand of concrete and concrete materials has been increased time by time due to the limited quantity of supplying of concrete materials. Workability of concrete mix decreased with replacement of natural aggregate with bethamcherla marble stone aggregate. But up to some extent even replaced concrete mixes got optimum results [5]. Fly ash is a byproduct of burnt coal from the Thermal power plants, Marble dust is a waste product from marble industries and stone dust is a waste product from crusher plants. Waste disposal is an important issue in the present time and utilization of industrial waste like fly ash, stone dust and marble dust in concrete making studied to investigate the improvement in the properties of concrete and presenting their use as an alternative material [6]. The reduction in the sources of natural sand and the requirement for reduction in the cost of concrete production has resulted in the increased need to identify substitute material to sand as fine aggregates in the production of concretes. Slab dust, a by-product from polishing process during stone dressing activities. In recent days there were also been many attempts to use fly ash, an industrial by product as partial replacement for cement to have higher workability, long-term strength etc. This work is an attempt to use slab dust in various percentages (0%, 25%, 50%, 75%) as partial replacement for sand in concrete building material in the world. Conventionally concrete is mixture of cement, sand and aggregates [7]. In general the construction works are building with reinforced cement concrete (RCC) material. The Cement concrete is composition of cement, coarse and fine aggregate, water and some admixtures. For many works the coarse aggregate is brought from granite stone. Geographically the Tadpatri, Anantapur (District), Andhra Pradesh (State) is much potential to layered stone (Kadapa slab). The layered stone is utilizing for roof and floor works. During processing of finished product, waste is generating and this waste is dumping in and around the town (Tadpatri). The paper presents the feasibility of utilization of stone waste for construction works. The primary lab tests showed the potentiality of waste for construction.

3. EXPERIMENTAL INVESTIGATION

3.1. Materials

Cement: Portland cement and similar materials are made by heating limestone (a source of calcium) with clay and/or shale (a source of silicon, aluminum and iron) and grinding this product (called clinker) with a source of sulfate (most commonly gypsum). The extremely high temperatures and long periods of time at those temperatures allow cement kilns too efficiently and completely burn even difficult-to-use fuels. PPC (fly ash based) sample is used. Specific gravity of cement was 3.15.

Fine Aggregate: Fine aggregate is a naturally occurring granular material composed of finely divided rock and mineral particles. The fine aggregate used in the manufacturing of concrete should be free from debris, fungi and chemical attack. In this recent investigation, the river sand which was available nearby was used as fine aggregate and the tests were carried out on sand as per IS 2386 – 1963 part(I), (III) and (IV). Specific gravity of fine aggregate was 2.66 and Fineness modulus was 2.64.

Coarse Aggregate: Coarse aggregates are produced by disintegration of rocks and by crushing rocks. These are available in many different sizes. Coarse aggregates are usually those particles which are retained on an IS 4.75mm sieve. In the recent investigation, coarse aggregate of size 20mm and locally available crushed granite stone aggregate is used. Various tests were carried out as per IS 2386 – 1963 part (III) and (IV) and obtained Specific gravity as 2.66 and Fineness modules as 3.1.

Cuddapah stone: Cuddapah Black stone are quite impervious and hard. These Natural Cuddapah Black stone are used for cladding and flooring purposes as the stone is more resistant than most other sedimentary rocks which is used in place of natural coarse aggregate in the range of 20%, 40% and 60%. Specific gravity of Cuddapah stone was 2.7 and Fineness modules was 3.05.

3.2. Mix Proportion

In this investigation, M_{30} grade of concrete was adopted with water cement ratio of 0.4. The percentage replacement of coarse aggregate by Waste Cuddapah stones (WCS) was 20%, 40% and 60%. This was done to determine the proportion that would give the most favorable result. Concrete mix proportioning is mentioned in the table - I. The mix was designed as per IS 10262 – 2009 and IS 456 – 2000. The mix ratio of M_{30} is 1:2.70:3.33 and water – cement ratio is 0.4.

TABLE – I. MIX PROPORTION FOR M30 CONCRETE WITH WCS

Mix	Replacement %	Cement Kg/m^3	Fine aggregate Kg/m^3	Coarse aggregate Kg/m^3	WCS Kg/m^3
M1	0	341	933.33	1136.14	0
M2	20	341	933.33	908.91	227.23
M3	40	341	933.33	681.95	454.46
M3	60	341	933.33	455.06	681.08

4. RESULTS AND DISCUSSION

4.1. Casting

The concrete is prepared in laboratory. The concrete is poured into the mould in 3 layers by 25 strokes with tamping rod. The cast specimens are removed after 24 hours and these are immersed in a water tank. After curing 7 and 28 days the specimens are removed and these are tested for Workability, Compression, and Split tensile strength is found out for concrete which was replaced with Cuddapah stone in the proportion of 20%, 40%, and 60%. This was to be partial replacement of coarse aggregate and cement. The results compared with conventional concrete.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 05, May - 2017

4.2. *Workability*

Slump test and compacting factor tests are the most widely used workability tests for concrete. The degree of workability of concrete depends on the values of test results obtained from slump test and compacting factor tests as in the TABLE - II.

Slump Value: Slump Value $=h_1 - h_2$, where h_1 is Initial height of the cone which is 280 mm and h_2 is height of the concrete after removal of the mould.

TABLE – II. SLUMP VALUE AND COMPACTION FACTOR

Concrete Mix	W/c ratio	Slump Value	Compaction Factor
Conventional concrete	0.4	3	0.89
20% CWS	0.4	3	0.95
40% CWS	0.4	2	0.93
60% CWS	0.4	2	0.93

4.3. *Compressive Strength Test*

The compressive strength of different mixes for 7 and 28 days are shown in TABLE – III. Conventional concrete and different mixes of partial replacement of CWS compressive strength results are compared by plotting graphs shown in Figure 1.

TABLE - III. COMPRESSIVE STRENGTH FOR 7 & 28 DAYS

Concrete Mix	7 days (N/mm^2)	28 days (N/mm^2)
Conventional concrete	19.28	29.64
20% CWS	20.14	30.96
40% CWS	21.03	32.31
60% CWS	19.49	30.01

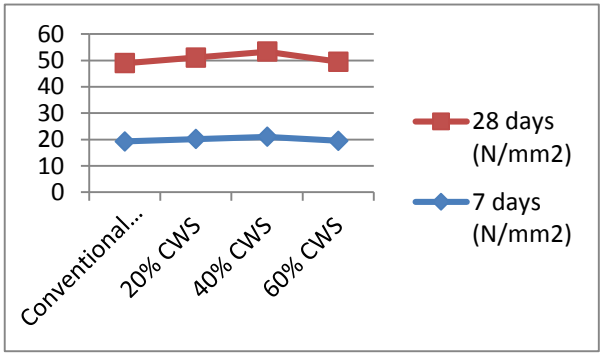

Figure 1. Compressive strength for 7 & 28 days

4.4. *Split tensile Strength Test*

The split tensile strength of different mixes for 7 and 28 days are shown in TABLE – IV. Conventional concrete and different mixes of partial replacement of CWS concrete compressive strength results are compared by plotting graphs shown in Figure 2.

TABLE – IV. SPLIT TENSILE STRENGTH FOR 7 & 28 DAYS

Concrete Mix	7 days (N/mm^2)	28 days (N/mm^2)
Conventional concrete	1.70	2.42
20% CWS	1.96	2.89
40% CWS	2.12	3.01
60% CWS	1.88	2.63

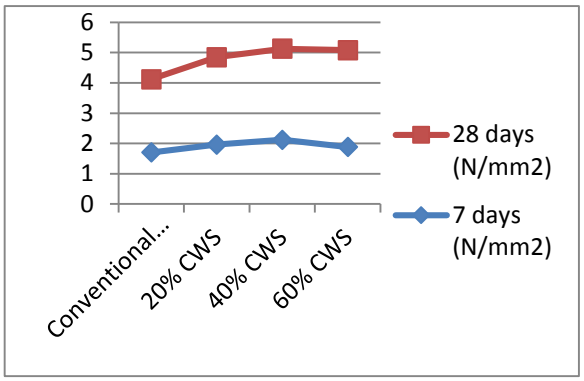

Figure 2. Split tensile strength for 7 & 28 days

CONCLUSION

Based on the results obtained from the experiment the following conclusions are drawn:

Compared to conventional concrete, the compressive strength of Cuddapah stone replaced coarse aggregate concrete was gradually increased up to 4.45% and 9% in 20% and 40% of coarse aggregate by CWS was replaced. Hence, replacement of coarse aggregate with Cuddapah stone achieved excellent strength. Effect on compression with 40% replacement of aggregate has been found to be achieving higher compressive strength. Again the strength decreased when 60% of CWS were replaced by coarse aggregate.

Using Cuddapah stones as paver aggregate is most suitable for building paver blocks. This method can also be used in heavy weight concrete as it gives better strength than natural aggregate.

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