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"Study of Compressive Strength of Concrete by Partially Replacing Fine Aggregate with Quarry Dust"

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Abstract - *Nowadays the availability of Natural fine aggregates reduced, so we want to find substitute materials, so we have to search for any other easily available materials like Quarry dust, Copper slag, Granulated blast furnace slag , Bottom ash, Foundry sand, Construction and demolition waste etc.., By replacing the substitute materials we can check whether the strength remains same or varies. Anyhow we are getting quarry dust easily and it is eco Friendly also so we can use quarry dust as a substitute for fine aggregate and we can check the strength, if strength remains same we can replace quarry dust as a substitute in the construction fields. In the production of concrete, fine aggregate place a vital role.*

In Warangal district resources material of fine aggregate of natural sand is less available. So my studies on compressive strength test by partial replacing fine aggregate with quarry dust. Partially replacing quarry dust in fine aggregate mixing ratios at an interval of 10%, 20% and 30%. Mix proportions for M_{15} concrete is prepared with reference to IS: 10262-2009 and IS: 456-2000 for the study of workability. Compression testing machine test results with the conventional concrete. The strengths were obtained at the ages of 7 days, 14 and 28 days. Compression test compressive strength increased marginally from 0% to 20% replacement. There is a slight decrease in the corresponding compression test compressive strength at 30% replacement. Good correlation was observed between compression test compressive strength. It was observed that the addition of quarry dust that would replace the fine material at particular proportion has displayed an enhancing effect on properties of concrete. This investigation proves that quarry dust can be used as a partial substitute for natural sand in preparing concrete.

Key words: *compression test, quarry dust…*

I. INTRODUCTION

Common river sand is expensive due to excessive cost of transportation from natural sources. Also large-scale depletion of these sources creates environmental problems. As environmental transportation and other constraints make the availability and use of river sand less attractive, a substitute or replacement product for concrete industry needs to be found. River sand is most commonly used fine aggregate in the production of concrete poses the problem of acute shortage in many areas. Whose continued use has started posing serious problems with respect to its availability, cost and environmental impact?

A comparatively good strength is expected when sand is replaced partially or fully with or without concrete admixtures.

Quarry dust has been used for different activities in the construction industry such as road construction and manufacture of building materials such as light weight aggregates, bricks and tiles. This paper presents the results for compressive strengths by compression testing machine test by partially replacing fine aggregate with quarry dust. Quarry dust is used an alternative for natural sand is collected from nearby quarry. Quarry dust is easily available, effective usage of quarry dust as a partial or full replacement to natural sand can reduce the demand for natural sand, pollution in environment and topography of the area. Hence, it is essential to find some way to use the quarry dust.

This study initiated to assess the suitability of quarry dust as partial substitute for fine aggregate in concrete. The evaluation is based on parameters such as gradation results, compressive strength with both compression testing machine and Rebound hammer test.

II. SCOPE OF PRESENT STUDY

In this study, M15 grade of concrete was obtained and the mixtures were modified by partially replacing natural sand with quarry dust. The strength of concrete was evaluated in terms of compressive strength by compression testing machine.

1. To check the compressive strength of concrete by replacing quarry dust.
2. To observe whether the compressive strength varies with percentage of substitute material.
3. To know whether can we use query dust as a substitute material for fine aggregate.

III. COLLECTION OF SAMPLES

The quarry dust was collected from the dumps of quarry near Warangal.

IV. MATERIAL PROPERTIES

Materials:

The constituent materials used in this investigation were procured from local source. Necessary tests are carried out on these materials to choose the kind and type of materials. We are using cement, Sand, Quarry Dust, Coarse aggregate, Fine aggregate, water.

Definition of OPC: Cement can be defined as the bonding material having cohesive & adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly. Ordinary/Normal Portland cement is one of the most widely used types of Portland cement.

The name Portland cement was given by Joseph Aspdin in 1824 due to its similarity in colour and its quality when it hardens like Portland stone. Portland stone is white grey limestone in island of Portland, Dorset.

Composition of OPC:

The chief chemical components of ordinary Portland cement are:

1. Calcium
2. Silica
3. Alumina
4. Iron

Calcium is usually derived from limestone, marl or chalk while silica, alumina and iron come from the sands, clays & iron ores. Other raw materials may include shale, shells and industrial byproducts.

Basic Composition:

Table 1: Basic Composition of OPC

Contents	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	Alkalis	SO_3
%	60-67	17-25	3-8	0.5-6.0	0.5-4.0	0.3-1.2	2.0-3.5

The chief compounds which usually form in process of mixing:

- Tri-Calcium Silicate ($3CaO.SiO_2$)
- Di-Calcium Silicate ($2CaO.SiO_2$)
- Tri-Calcium Aluminates ($3CaO.Al_2O_3$)
- Tetra-Calcium Alumino Ferrite ($4CaO.Al_2O3.Fe_2O_3$)

Uses of OPC (Ordinary Portland cement):

It is used for general construction purposes where special properties are not required. It is normally used for the reinforced concrete buildings, bridges, pavements, and where soil conditions are normal. It is also used for most of concrete masonry units and for all uses where the concrete is not subject to special sulfate hazard or where the heat generated by the hydration of cement is not objectionable. It has great resistance to cracking and shrinkage but has less resistance to chemical attacks.

Quarry Dust:

Quarry Rock Dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm

Necessity of using Quarry dust sand (Environmental significance):

Common river sand is expensive due to excessive cost of transportation from natural sources. Also large-scale depletion of these sources creates environmental problems. As environmental transportation and other constraints make the availability and use of river sand less attractive, a substitute or replacement product for concrete industry needs to be found. River sand is most commonly used fine aggregate in the production of concrete poses the problem of acute shortage in many areas. Whose continued use has started posing serious problems with respect to its availability, cost and environmental impact.

Advantages:

1. The addition of quarry dust has shown significant increase compared to plain cement concrete with natural sand. This can be safely concluded that quarry dust concrete can lead to significant improvement in microstructure due to different size fractions.

2. Permeability Test results clearly demonstrate that the permeability of Quarry Rock Dust concrete is less compared to that of conventional concrete.

3. The water absorption of Quarry Rock Dust concrete is slightly higher than Conventional Concrete.

Chemical Composition of Quarry dust

Table 2: Typical Chemical Composition of Quarry Dust and Sand

Constituent	Quarry rock dust(%)	Natural sand(%)	Test Method
SiO_2	62.48	80.78	
Al_2O_3	18.72	10.52	
Fe_2O_3	6.54	1.75	
CaO	4.83	3.21	
MgO	2.56	0.77	IS : 4032 -
Na_2O	Nil	1.37	1968
K_2O	3.18	1.23	
TiO_2	1.21	Nil	
Loss of ignition	0.48	0.37	

Physical Properties

Table 3: Physical properties of Quarry Rock Dust and Natural Sand

Property	Quarry dust	Natural sand	Test method
Specific gravity	2.54-2.60	2.60	IS2386(PartIII)1963
Bulk relative density(kg/m^3)	1720-1810	1460	IS2386(PartIII)1963
Absorption (%)	1.20-1.50	Nil	IS2386(PartIII)1963
Moisture content (%)	Nil	1.50	IS2386(PartIII)1963
Fine particles less than 0.075mm (%)	12-15	6	IS2386(PartI)1963
Sieve analysis	Zone –II	Zone-II	IS383-1970

Coarse Aggregate:

Normal aggregate that is crushed blue granite of maximum size 20 mm was used as coarse aggregate. We are conducting tests on coarse aggregate are Water Absorption Capacity, Specific Gravity and Fineness Modulus of coarse aggregate.

Fine Aggregate:

Well graded river sand passing through 4.75 mm was used as fine aggregate. The sand was air-dried and sieved to remove any foreign particles prior to mixing. We are conducting tests on fine aggregate are Water Absorption Capacity, Specific Gravity and Fineness Modulus of fine aggregate.

Water:

The quality of water is important because contaminants can adversely affect the 3strength of concrete and cause corrosion of the steel reinforcement. Water used for producing and curing concrete should be reasonably clean and free from deleterious substances such as oil, acid, alkali, salt, sugar, silt, organic matter and other elements which are detrimental to the concrete or steel. If the water is drinkable, it is considered to be suitable for concrete making. Hence, potable tap water was used in this study for mixing and curing.

V .METHODOLOGY

The experimental work is broadly classified into three stages, namely

a) Sieve analysis
b) Evolving mix proportions
c) Strength studies

Sieve Analysis

The main objective of the investigation is to partially replace natural sand with quarry dust and study the behavior of concrete in the fresh and hardened state. The materials used for the investigation is first sieved and grading of aggregates is carried out then the zone value is obtained.

Natural sand replaced with quarry dust at an interval of 0% up to 30%.

Mix Proportions

Water cement ratio is an important factor in the process of mix proportioning. Primary requirement of good concrete is satisfactory compressive strength in its hardened state. Many of the desirable properties like durability, impermeability and abrasion resistance is highly influenced by the strength of concrete. The strength can be considered to be solely dependent on water cement ratio for low and medium strength concrete mixes. Workability of concrete varies with water cement ratio and quantity of cementitious material. In this investigation, Mix proportions for M_{15} concrete were obtained as per the guidelines given in IS: 10262-2009. The mix proportion is obtained as 1:2:4 with water cement ratio of 0.6.

Strength Studies

Compressive Strength:

Compression Testing Machine: Standard moulds of 150mmx150mmx150mm size are used for casting concrete cubes. The cubes were compacted in three layers. Nine concrete cubes were casted for each mix. A total of forty five concrete cubes were casted. Cubes were immersed in water for curing till the date of testing. The specimens were prepared as per IS: 516-1989 and tested for uniaxial compressive strength at 7, 14 and 28 days. The results obtained are the average of three specimens tested and the results are presented.

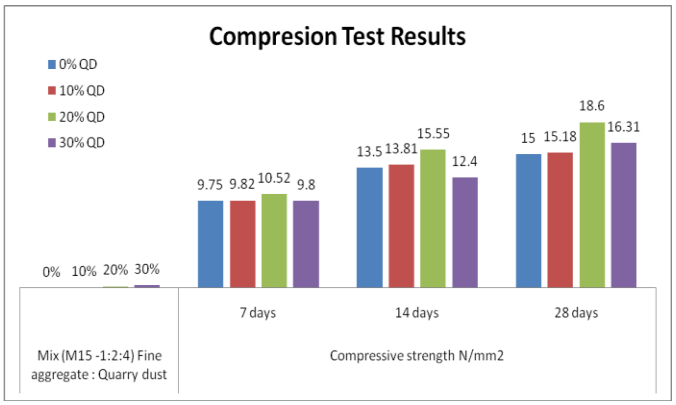
The standard method of determining strength of hardened concrete consists of testing concrete cubes in compression. The quality of entire concrete of a structure cannot be fully assessed by testing a few concrete cubes. The results obtained in testing cubes do not always reflect the actual strength of concrete in construction.

In addition, the number of test cubes is generally so small that they can only be considered as random tests. Sometimes, in case of failure of cubes, doubtful concrete, cracks, deterioration of concrete, etc. it becomes necessary to assess the quality and strength of concrete of the structure.

VI. RESULTS AND DISCUSSIONS

Compression testing Machine Test results:

Mix design (% of replacement)	Avg. Compressive Strength (N/mm²)		
	7 Days	14 Days	28 Days
0	9.75	13.5	15
10	9.82	13.81	15.18
20	10.52	15.55	18.6
30	9.8	12.4	16.31



VII. CONCLUSIONS

In this experimental investigation, an attempt has been made to use Quarry dust to replace the fine aggregates in concrete.

Following are the some of the conclusions drawn from the results of this investigation:

1. Quarry dust can be used as a finer material which can reduce the voids in concrete.
2. Up to 10% replacement of fine aggregates by quarry dust, the results obtained are satisfactory.
3. From the above results 20% replacement of quarry dust gives high Compressive Strength.
4. By using quarry dust substitute instead of conventional materials, which would not only be preserving the natural precious resources.
5. Construction of buildings from quarry dust is eco-friendly as it utilizes rocky dust and reduces air, land and water pollution. It is energy efficient and also cost effective.

Future scope of study

1. In this study we substitute quarry dust in proportions of 10%, 20% & 30%, so further can do the increasing of proportions like (40%, 50%, 80% & 100%).
2. 2. As we make the concrete with the Mix ratio of M_{15}, so we can do further mix ratios like M_{20} & M_{25}.
3. In this present study we have Replaced Quarry dust, further we can replace substitute materials like Copper slag, Granulated blast furnace slag , Bottom ash, Foundry sand, Construction and demolition waste etc.., to get same Compressive strength or varies.

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