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Evaluation of Strength Characteristics of Concrete Using Crushed Stone Dust as Fine Aggregate

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Abstract -- The purpose of this study was to investigate the possibility of using crushed stone dust as fine aggregate partially or fully with different grades of concrete composites. The suitability of crushed stone dust waste as fine aggregate for concrete has been assessed by comparing its basic properties with that of conventional concrete. Two basic mixes were selected for natural sand to achieve M25 and M30 grade concrete. The equivalent mixes were obtained by replacing natural sand by stone dust partially and fully. The test result indicates that crushed stone dust waste can be used effectively used to replace natural sand in concrete. In the experimental study of strength characteristics of concrete using crushed stone dust as fine aggregate it is found that there is increase in compressive strength , flexural strength and tensile strength of concrete.
Keywords: concrete, strength, fine aggregate, crushed stone dust.

I. INTRODUCTION

Conventionally concrete is mixture of cement, sand and aggregate. Properties of aggregate affect the durability and performance of concrete, so fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river or pit sand. Fine and coarse aggregate constitute about 75% of total volume. It is therefore, important to obtain right type and good quality aggregate at site, because the aggregate form the main matrix of concrete or mortar. The global consumption of natural sand is very high, due to the extensive use of concrete. In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructural growth, in this situation developing country like India facing shortage in good quality natural sand. Particularly in India, natural sand deposits are being depleted and causing serious threat to environment as well as the society. Increasing extraction of natural sand from river beds causing many problems, loosing water retaining sand strata, deepening of the river courses and causing bank slides, loss of vegetation on the bank of rivers, exposing the intake well of water supply schemes, disturbs the aquatic life as well as affecting agriculture due to lowering the underground water table etc are few examples. In past decade variable cost of natural sand used as fine aggregate in concrete increased the cost of construction. In this situation research began for inexpensive and easily available alternative material to natural sand.

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Some alternatives materials have already been used as a part of natural sand e.g. flyash, slag limestone and siliceous stone powder were used in concrete mixtures as a partial replacement of natural sand.
However, scarcity in required quality is the major limitation in some of the above materials. Now a day's sustainable infrastructural growth demands the alternative material that should satisfy technical requisites of fine aggregate as well as it should be available abundantly.

II. LITERATURE REVIEW

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?

Materials And Methods

Cement

Ordinary Portland Cement (43 Grade) with 28 percent normal consistency Conforming to IS: 8112-1989 [3] was used.

Quarry rock dust

The Quarry Rock Dust obtained from local resource AMC Crushers (P) Ltd., Dindigul was used in concrete to cast test cubes and beams. The physical and chemical properties of Quarry Rock Dust obtained by testing the samples as per Indian Standards are listed in Tables 1 and 2, respectively.

Fine aggregate (Natural river sand)

River sand having density of 1460 kg/m^3 and fineness Modulus (FM) of 2.51 was used. The specific gravity was found to be 2.6.

Coarse aggregate

Natural granite aggregate having density of 2700kg/m^3 and fineness modules (FM) of 6.80 was used. The specific gravity was found to be 2.60 and water absorption as 0.45%.

Admixture

Commercially available Super-plasticiser has been used to enhance the workability of fresh concrete for selected proportions of ingredients.

Mix Design

Since there is No standard method of designing concrete mixes incorporating Quarry Rock Dust as fine Aggregate.

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The method mix design proposed by IS, ACI, USBR, RN No.4, BS were first employed to design the Conventional Concrete mixes and finally natural sand was fully replaced by Quarry Rock Dust to obtain Quarry Rock Dust concrete mixes. The purpose of mix proportioning is to produce the required properties in both plastic and hardened concrete by working out a combination of available materials, with various economic and practical standards.

III. RESEARCH SIGNIFICANCE

Based on the above discussions, following conclusions are drawn:

(a) The Physical and chemical properties of quarry rock dust is satisfied the requirements of code provision in properties studies Natural river sand, if replaced by hundred percent Quarry Rock Dust from quarries, may sometimes give equal or better than the reference concrete made with Natural Sand, in terms of compressive and flexural strength studies

(b) Studies reported here and elsewhere have shown that the strength of Quarry Rock Dust concrete is comparatively 10-12 percent more than that of similar mix of Conventional Concrete. Also the result of this investigation shows that drying shrinkage strains of Quarry Rock Dust concrete are quite large to the shrinkage strain of Conventional Concrete. However, at the later age, they have shown equal strain than Conventional Concrete. The Durability of Quarry Rock Dust concrete under sulphate and acid action is higher inferior to the Conventional. Permeability Test results clearly demonstrates that the permeability of Quarry Rock Dust concrete is less compared to that of conventional concrete. The water absorption of Quarry Rock Dust concrete is slightly higher than Conventional Concrete. Therefore, the results of this study provide a strong support for the use of Quarry Rock Dust as fine aggregate in Concrete Manufacturing.

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Table-1. Physical properties of quarry rock dust and natural sand.

Property	Quarry rock dust	Natural sand	Test method
Specific gravity	2.54-2.60	2.60	[5] IS 2386 (Part III) 1963
Bulk relative density (kg/m^3)	1720-1810	1460	IS 2386 (Part III) 1963
Absorption (%)	1.20-1.50	Nil	IS 2386 (Part III) 1963
Moisture content (%)	Nil	1.50	IS 2386 (Part III) 1963
Fine particles less than 0.075mm (%)	12-15	06	[5] IS 2386 (Part I) 1963
Sieve analysis	Zone II	Zone II	[4]IS 383 - 1970

Table-2. Typical chemical composition of quarry rock dust and natural sand.

Constituent	Quarry rock dust (%)	Natural sand (%)	Test method
SiO_2	62.48	80.78	[10]IS: 4032-1968
Al_2O_3	18.72	10.52	
Fe_2O_3	06.54	01.75	
CaO	04.83	03.21	
MgO	02.56	00.77	
Na_2O	Nil	01.37	
K_2O	03.18	01.23	
TiO_2	01.21	Nil	
Loss of ignition	00.48	00.37	

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