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A Review of Evaluation of Cement Concrete by Partial Replacement of Natural Sand

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Abstract: ***Although fly ash as a partial replacement for cement has been utilized for many years, it has been almost exclusively used in low-volume percentages, such as 10 or 20% cement replacement. In this study partial replacement of Natural sand with Crushed stone waste for M 15 grade of concrete. The compressive strength of concrete of OPC concrete and with natural sand and Crushed stone waste is compared and it has been found that the strength of concrete got increased. Work may be extended with use of stone waste from different crushing plant. Different zones of stone waste can be formed from the result which will give better understanding of type of stone waste that can be replaced for each zone. Thus it can be concluded that use of stone dust can be effectively done for partial replacement of natural sand and better concrete can be achieved for structural use. Optimum replacement value is about 30 to 40 percent. Thus its use will also ensure less cost and use of waste material causing less environmental pollution.***

Keywords: Compressive strength, natural sand, crushed stone, environmental pollution.

I. INTRODUCTION

Concrete is a product obtained artificially by hardening of the mixture of cement, sand and coarse aggregate in predetermined proportions. When these ingredients are mixed, they form plastic mass which when placed in form and cured with water becomes hard. This hardening is the result of chemical action between water and the cement, which binds sand and coarse aggregates. This process continues for a long period and consequently the concrete grows stronger in compression with age.

In today's world concrete is used in each and every construction activity. Today we have various types of cement, which can give us the concrete of desired strength. In Maharashtra largely Ordinary Portland cement (OPC), basalt stone aggregates and river sand, which is available locally is used. Strength of concrete varies with different proportion of the concrete ingredients, e.g. 1:2:4 known as nominal mix refers to a particular concrete manufactured by mixing cement, sand and broken stone in 1:2:4 ratio (with specified type of cement, water cement ratio and maximum size of aggregate.) Thus, selection of proportion is an important task in any construction with concrete.

A. Effect Of Size Of Coarse Aggregate

When large size aggregates are used surface area of coarse aggregate is small as compared to small size. This result in lower water cement ratio, hence it was thought that this would result in increase of strength of concrete. But due to lower surface area on which gel bond is formed is responsible for lower strength of concrete. Use of large size aggregate adversely affects the strength in rich concrete. Whereas use of large aggregate in lean concrete gives higher strength. Hence suitable graded selection of coarse aggregate is achieved by mix design.

B. Role Of Fine Aggregate In Cement Concrete

IS 389-1970 allows use of river satisfying condition mentioned in its table IV. Where sands have been classified in different zone based on sieve analysis result. Natural sand is round in shape hence surface area of is less. Fine aggregate fill void between the coarse aggregate and forms bond with coarse aggregate. When fine aggregate used is angular it needs extra amount of water for workability. This causes decrease in strength hence use of fine aggregate completely with sand will give less strength.

II. LITERATURE REVIEW

It is widely known that normal concrete is good in compressive strength and low in tensile strength. Also cost of normal concrete is increasing with shortage of natural resources. Hence to cut down the cost of concrete, at the same time to get some advantage or enhanced properties of concrete various researchers have studied behaviour of concrete by replacing cement, natural sand and coarse aggregate with waste materials. A brief literature review with reference to replacement of natural sand with various types of stone dust is presented in this chapter.

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A. Feasibility Of Use Of Stone Dust

We are using a coarse aggregate processed in stone Crusher tones of crushed stone powder is produced per day. Also sources of sands are becoming scarce day by day due to continuous and extensive demand of naturally available sand. Use of stone dust will help in reducing the cost at the same time reduce the pollution. Shukla M. et al. (2) has indicated that if sand is replaced in cement - sand mortar with 40 to 60% of Granite stone dust there is increase in compressive strength, any further addition of stone dust decreases the compressive strength. A.D. Pofale (1) has conducted similar kinds of test on cement concrete replacing sand partially with stone dust and studied compressive strength, modulus of rupture and compaction factor so as to obtain generalized data for further research work. He concluded that use of stone dust replacing partially or fully is feasible and practicable for plastic and cohesive mixes of Normal, Medium and High strength. Tahir Celik (4) investigated that when stone dust particles finer than 75 micron were used impact resistance increased at 5% sand replacement, water permeability decreased as percentage of dust increased.

B. Use Of Crushed Limestone Dust As Partial Replacement To Natural Sand

Disposal of limestone dust is serious problem in North America. Performance of concrete incorporating limestone dust as a partial replacement for fine aggregate was studied. V. M. Malhotra (6) studied effect of limestone dust, thirteen concrete mixtures were made with water cement ratios ranging from 0.4 to 0.7 and with 5,10,15 and 20 percent limestone dust as replacement for sand. Tests were performed on concrete to determine the compressive strength development and drying shrinkage, flexural strength, resistance to repeated cycles of freezing and thawing. It was observed that incorporation upto 10 % limestone dust as partial replacement for fine aggregate in concrete with 0.7 water cement ratio and 5 % limestone dust in concrete with 0.53 water cement ratio does not significantly affect properties of fresh and hardened concrete. Concrete incorporating more than 10% limestone dust, regardless of water cement ratio shows considerable loss in entrained air content and slump. There is increase in strength for lean concrete. For concrete with water cement ratio 0.53 and 0.40 there is an increase in shrinkage with increasing amount of limestone dust. But this is not marked as for concrete with 0.7 water cement ratio. Compressive strength with water cement ratio of 0.7 and limestone dust percent 15 and 20 showed increase in compressive strength of about 20 to 30 percent at 7 days. For ower water cement ratio 0.53 no significant change in compressive strength was noted. The increase in compressive strength of concrete incorporating limestone dust is probably due to filler effect of the dust, accelerated hydration of cement paste. Flexural strength of concrete improved slightly with incorporation of limestone dust at 0.7 water cement ratio. But no effect on concrete with water cement ratio 0.53. Regardless of water cement ratio concrete incorporated with limestone dust showed good performance under the action of repeated cycles of freezing and thawing. Limestone dust showed no significant effect on expansion of specimen during exposure. In research carried out by J. K. Kim and et al (3) fracture characteristics of crushed lime stone sand concrete were experimentally investigated through wedge splitting test. This was compared with crushed granite sand concrete and river sand concrete. Strength of lime stone sand concrete was also investigated. In mix proportion crushed limestone sand, mixed sand (50% crushed limestone and 50% river sand), and river sand were used as fine aggregate. VFS (very fine sand) content were adjusted to 0.3 to 6 % by weight of fine aggregate.

C. Use Of Crushed Recycled Concrete Coarse And Fine Aggregates

As a result of demolished concrete large amount of building rubble is available. These wastes were primarily used for landfills. Studies were carried out to use these waste in new concrete. Alan D. Buck (5) carried out investigation on recycled aggregates. He reported that the fine produced by crushing old concrete may be used as fine aggregate without modification of grading. With the fines that he studied required 34 to 46 kg more cement for 0.8 cubic meter as compared to concrete with natural sand of specified grading were used. He observed that specific gravity of aggregate obtained from demolished structure is lower than natural aggregate of same stone. The use as aggregate of crushed concrete having compressive strength less than 14 N/mm2 does not affect strength in new concrete. Use of crushed concrete aggregate cause no problem in respect of workability. Amjad Masood and et al (9) assessed safe and economic use of recycled aggregate for housing industry. They carried extensive research for determining structural properties such as compressive strength, flexural strength and split tensile strength of recycled concrete. They observed that workability decreases as percentage of demolished waste increases and a trend is observed to be similar when fine aggregate is replaced with demolished waste fines. Cubes with higher percentage of demolished waste show decrease in their compressive strength. 28 days compressive strength of cubes with 20 % replacement of cement and similarly 20 % fine aggregate replacement by demolished waste are close to each other. Which is between 75 to 80 % strength of normal concrete cubes. Also, with percentage of demolish waste increasing split tensile strength decreases and for 40 % replacement of cement the strength is about 43 % that of plain concrete.

D. Replacing Natural Sand With Crushed Stone Dust, Manufactured Sand Foundry Sand Etc.

Tahir and et al (4) studied behaviour of concrete using crushed stone dust passing through 75 micron and 150-micron sieve. In test carried out percentage of dust was varied from 0 to 30 %. It was observed that as percentage of dust increases slump of concrete decreases. Hence more water was required to wet concrete, thus workability decreased. Compressive strength increased up to 10 percent replacement of sand. As the dust content exceed 10 percent compressive strength decreased. The reason for this is, when dust content exceed 10 percent the amount of fines in the concrete increases so much that there is not enough cement paste to coat all coarse aggregate and fine aggregate particles and this consequently leads to decrease in compressive strength. A.D. Pofle and et al (1) found that compressive strength of concrete with stone dust increases up to 80 percent at 7 days. Shukla M and et al(2) carried out test on use of Stone Dust partially replacing sand in mortar and in concrete and concluded compressive strength increases when replacement is upto 40-60 %. If percentage of stone dust was increased beyond 60 % test result gave decreased compressive strength B. P. Hudson (11) used Manufactured sand, which contains particle of size less than 75 micron about 15-20%. He investigated that it does not have detrimental effect on concrete quality. Reason is unlike natural sand risk of contamination in this size is minimized. His investigations were based on test he carried out by varying fine particle percentage in natural and crushed sand from 0 to 20 %. Compressive Strength of concrete with manufactured sand increased with fine particle as compared with concrete containing natural sand and fine particle. Due to fine particle resulting concrete with crushed stone sand is dense. Denser concrete is more durable and less permeable. T.S. Nagraj and Zahida Banu (12) carried series of test using granite stone dust as fine aggregate and pebbles as coarse aggregate in concrete mix designed for 65 N/mm2 and low workability. Test results revealed that more cement is required as in comparison with sand to satisfy workability. In the hardened state rock dust and sand mixes reflect same concrete strength thus enhancing the utilization of rock dust. Pebbles due to smooth edge surface texture reduce concrete strength, thus reflecting the effect of mortar aggregate bond strength. Paul Tikaslsky and et al (8) used foundry sand in Controlled Low Strength Material (CLSM). CLSM is a self-compacting and self-leveling cementious material use primarily as a back fill in lieu of compacted fill. Typically, CLSM consist of sand, Fly Ash, Cement and water (mortar) Typical mixture contains 80 to 85 % of sand, 10 to 15 % Fly ash, and 5 to 10 % cement by mass. He observed that foundry sand assist in keeping strength from exceeding the upper compressive strength limit.

E. Use Of Crushed Clink-Or Brick Bat

Ali R. Khaloo (7) used Clinker brick waste as coarse aggregate. Experiments were conducted on concrete with 100 % clinker brick, 50% clinker brick and 50 % Stone aggregate and 100 % Stone aggregate concrete. They concluded use of brick clinker resulted in concrete which is 33 % lighter and porous than ordinary crushed stone. Crushed brick show lower specific gravity and less resistance to abrasion compared to ordinary crushed stone. Total substitution of crushed clinker for crushed stone as coarse aggregate produced a concrete of compressive, tensile, flexural strengths higher than the 50 percent volume substitution of crushed clinker brick for crushed stone at 28 days.

III.FUTURE SCOPE

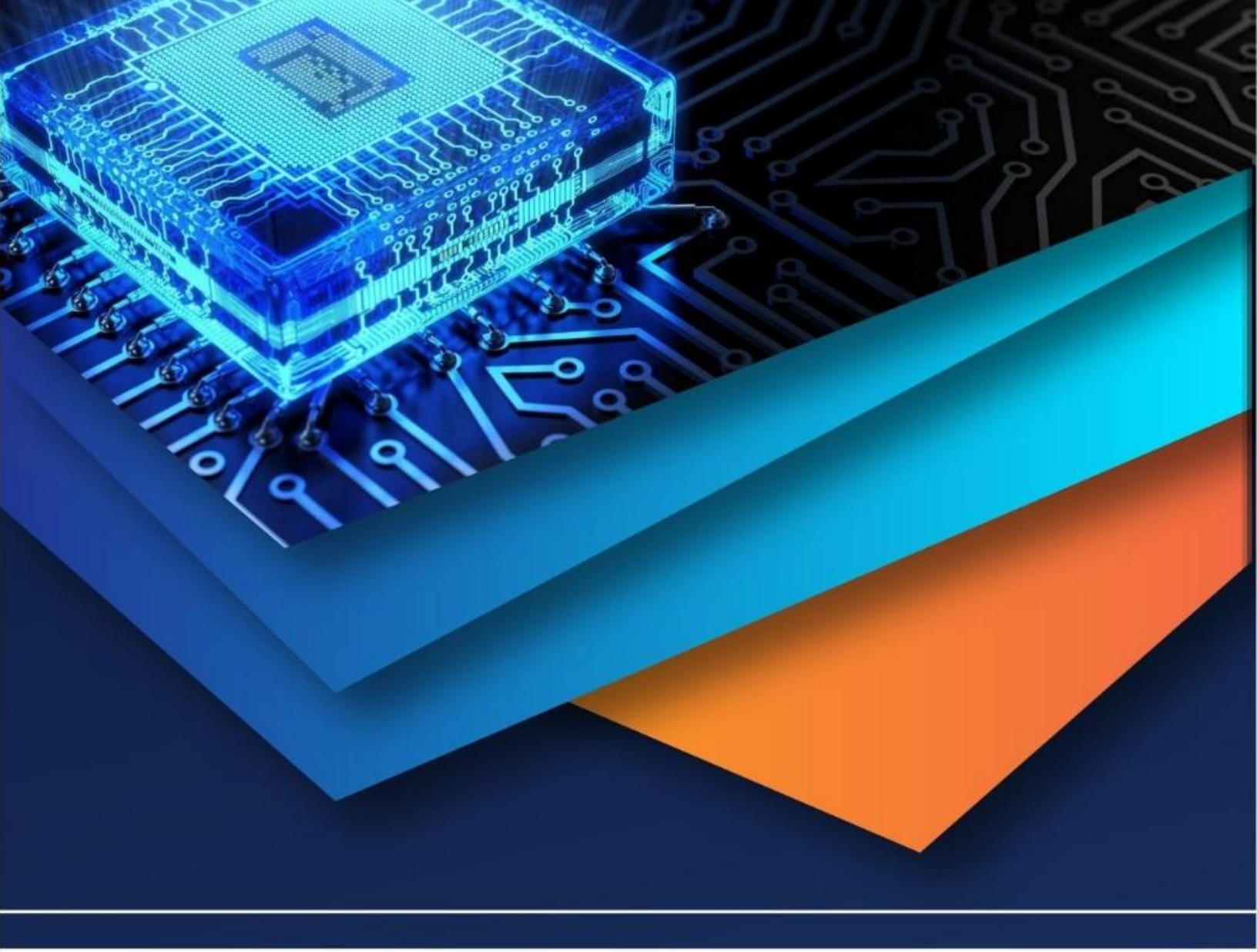
1) Work may be extended with use of stone waste from different crushing plant. Different zones of stone waste can be formed from the result which will give better understanding of type of stone waste that can be replaced for each zone.
2) Work may be extended to study the effect on permeability of concrete.
3) Long term work may be carried to study behaviour of CCSD under creep load.
4) Also at higher percentage of stone waste mix becomes stiff, hence with use of different admixture, plasticizer for improving workability can be done.

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