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A REVIEW ON USE OF MANUFACTURED SAND IN CONCRETE PRODUCTION

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ABSTRACT

A review is presented in this paper about the application of crushed sand as a smart material in concrete. After a brief outline of the theoretical as well practical studies few measures are reviewed to replace natural sand with manufactured crushed sand. This helps in reducing the likely damage to the ecological balance due excessive sand lifting from river beds, affecting the ground water level. Crushed sand as replaced materials to natural sand has become beneficial and is common in the world. Different researchers have carried out research to study the effect of use of crushed sand on properties of concrete. Hence, in this paper review of various operational parameters viz. workability, water absorption, compressive strength, flexural strength, tensile strength is highlighted.

Keywords- crushed sand, workability, water absorption, compressive strength, flexural strength, tensile strength

1. INTRODUCTION

Concrete is the most widely used man-made construction material in the world & is second only to water as the most utilized substance on the planet. It is obtained by mixing cementations material, water & aggregates in required proportions. The mixture when placed in form & allowed to cure hardens into a rock-like mass known as concrete. The main components of concrete are; cement coarse aggregate, fine aggregate, water and admixtures. Sand is the one of main constituents of concrete making about 35 % of volume of concrete used in construction industry. Natural sand is mainly excavated from river beds and always contains high percentages of inorganic materials, chlorides, sulphates, silt and clay that adversely affecting the strength & durability of concrete & reinforcing steel there by reducing the life of structure. Digging sand, from river bed, in access quantity is hazardous to environment. The deep pits dug in the river bed, affects the ground water level. Erosion of nearby land is also due to excessive sand lifting. In order to fulfil the requirement of fine aggregates, some alternative material must be found. Crushed sand as replaced materials to natural sand has become beneficial and is common in the world. Crushed sand is manufactured by crushing larger stones of quarry to particular size of sand. Its chemical &physical properties such as colour, size & shape, surface texture up particles depend upon types of stone & its source. Use of crushed sand has become a good substitute for natural sand and it has become essential keeping in view of technical, commercial & environmental requirements. Proper quality control while using crushed sand or manufactured sand can result in better results. Different researchers have carried out research to study the effect of use of crushed sand on properties of concrete.

2. AIM AND OBJECTIVE

This paper presents a detailed review about crushed sand as recycled materials that can be effectively used in concrete as a sand replacement. Waste management options with cost effectiveness and research published on the effect of waste materials on the fresh and hardened properties of concrete.

3. DISCUSSION

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.

Rajendra P. Mogre et. al. (2013) studied the replacement of natural sand by artificial sand. They concluded from experimental results that, mixes with artificial sand as a fine aggregate gives better strengths than mixes of natural sand due to sharp ages of the particle in artificial and provide better bond with cement than rounded particle of natural sand.

M.Adams Joe et al (2013) investigate the effect of M-Sand in structural concrete by replacing river sand and develop a high performance concrete. It is proposed to determine and compare the differences in properties of concrete containing river sand and M-sand. It is also proposed to use steel fibres and chemical admixtures to increase the strength and workability of concrete respectively. The investigations are to be carried out using several tests which include workability test, compressive test, tensile test, and flexural test.

B. Vijaya et al (2013) observed the behaviour of concrete for different grades of M25 to M60. In their study they found that the standard Mix with 100% manufactured sand has attained a maximum of 53Mpa strength whereas for mix with Natural sand has got 49 MPa. They also found that the manufactured sand have good physical properties and it has better particle packing results in producing better binding effect and good strengths.

G. Balamurugan and P. Perumal (2013)studied the variation in the strength of concrete when replacing sand by quarry dust from 0% to 100% in steps of 10%. M20 and M25 grades of concrete were taken for study keeping a constant slump of 60mm. The compressive strength of concrete cubes at the age of 7 and 28 days were obtained at room temperature. Also the temperature effect on concrete cubes at 100oC on 28th day of casting was carried out to check the loss of strength. From test results it was found that the maximum compressive strength is obtained only at 50% replacement at room temperature and net strength after loss due to hike in temperature was above the recommended strength value due to 50% replacement itself. This result gives a clear picture that quarry dust can be utilized in concrete mixtures as a good substitute for natural river sand giving higher strength at 50% replacement.

M. Ranjitham and Vennila (2014) investigated high performance concrete wit partial replacement of fine aggregate by foundry sand with cement by mineral admixtures. In this project, investigations were carried out on strength properties such as compressive strength, split tensile strength and flexural strength of M75 grade of HPC mixes with different replacement levels such as 10%, 20%, and 30% of foundry sand with fine aggregate and 10%, 20%, 30% and replacing cement by mineral admixtures such as fly ash and ground granulated blast furnace slag by adopting water-binder ratio of 0.3. Conplast SP430 is based on Sulphonated Napthalene Polymers can be used as a super plasticizer for better workability for high performance concrete. In this study it has been found that adding optimum superplasticizers dosage the workability is reached. So that the required slump value can be obtained for HPC. The slump value for M75 grade using foundry sand and fly ash is reduced. For 30% fly ash and 30% GGBS replacement, the fresh properties observed were good as compared to 10%, 20% replacement. The presence of foundry sand and mineral admixtures increasing the compressive strength and also withstanding the maximum load. Compare to fly ash GGBS attains good strength as cement replacement.

Nimitha Vijayaraghavan and A S Wayal (2013) concluded from experimental research that the river sand can be fully replaced by manufactured sand.

Priyanka A. Jadhav and Dilip K. Kulkarni (2013) designed mortar mix having proportion as 1:2, 1:3 and 1:6 with water cement ratio of 0.5 and 0.55 respectively is used in experimental study. Mortar cube specimens are tested for evaluation of compressive strength. The mortar exhibits excellent strength with 50% replacement of natural sand by manufactured sand. This paper puts forward the applications of manufactured sand as an attempt towards sustainable development. It will help to find viable solution to the declining availability of natural sand to make eco-balance.

Sheetal A. Sahare et al (2015) has been investigate an effects of artificial sand with quarry dust on compressive strength, split tensile strength and flexural strength of different concrete mixes when natural sand is completely replaced by artificial sand.

P Daisy Angelin and P Ravi Kishore (2015) discussed the properties of concrete such as workability and compressive strength of concrete which is prepared by replacing natural sand with artificial sand at different replacement levels (0%, 20%, 40%, 60% , 80% and 100%). The results have predicted that replacement of natural sand with manufactured sand in order of 60% will produce concrete of satisfactory workability and compressive strength. Durability of the concrete is also tested by immersing the cubes in 5% hydrochloric acid solution. The specimens are studied for M20 & M30 grades of concrete for replacement of natural sand with manufactured sand when immersed in hydrochloric acid, the strength results of the specimens that are immersed in hydrochloric acid solution is found out.

Nithyambigai. G (2015) investigated the strength of concrete mix at 28-day and 56-day age containing 0%, 25% & 50% of fine aggregate by M. Sand and 0%, 25% & 50% of cementitious materials by fly ash. The concurrent use of the two byproducts will lead to an economic and environmental benefit. The present study attempts to investigate the influence of partial replacement of fly ash for cement and M. Sand for fine aggregate on the mechanical properties and compared with the conventional concrete.

Harshlata R. Raut and Ashish B. Ugale (2016) presented review of research work on effects of artificial sand on compressive strength and workability of concrete. A brief summary of the most significant investigations on the behaviour of concrete by replacing natural sand with artificial sand due to which environmental and social problems arise due to acute shortage of natural sand will be overcome.

S. Suresh and J. Revathi (2016) investigated the performance of this concrete in term of its compressive strength and split tensile strength. This paper puts forward the applications of manufactured sand as an attempt towards sustainable development in India. It will help to find viable solution of the declining availability of natural sand to make eco-

balance. Manufactured sand is one among such materials to replace river sand, which can be used as an alternative fine aggregate in mortars and concretes. The use of manufactured sand in concrete is gaining momentum these days. The present experimental investigations have been made on concrete using manufactured sand as fine aggregate and observed the effects of crushed manufactured sand on strength properties of concrete.

Roshan Sasidharan and Ranjan Abraham (2016) found an alternative material, as fine aggregate. The alternative material selected here is fine aggregate from Weathered Crystalline Rock. This type of rock is abundantly available at low cost in tropical areas. This paper discusses the fresh state & mechanical properties of high strength concrete using weathered crystalline rock sand as fine aggregate.

Swastik S. Shinde et al (2016) studied the influence that manufactured sand have in compressive strength of concrete, and to access the prospects of using manufactured sand as replacement of natural sand. The results of the hardened properties of the mixes have shown that concrete mixes with partial proportions of manufactured and natural sand achieved a higher compressive strength at all test ages. It can therefore, be concluded from the finding of this study that when the availability of natural sand is scarce or in cities where the price of natural sand is as expensive as manufactured one, manufactured sand concrete mix is a viable and better alternative to the use of natural sand.

Muthukumar T and Sirajudeen K (2016) performed the experimental investigation on high performance concrete using M50 grade mix proportion. High performance concrete achieved by, 100% replace the fine aggregate by crusher wash sand and partial replacement of cement by micro silica (i.e., 5%, 10%, 15%, 20% & 25%). Glenium b233 were added for workability of concrete mix. A result data obtained has been analyzed and compared with a control specimen. A relationship between Compressive strength vs. days, Tensile strength vs. days, and Flexural strength vs. days represented graphically. Result data clearly shows percentage increase in 7 and 28 days Compressive strength, Tensile strength and Flexural strength for M-50 Grade of Concrete. Combination of micro silica, crusher wash sand and super plasticizer in this experimental study show a great improvement in the compressive strength as well as tensile properties .Cement was replaced by micro silica by 20%, however strength increases by 16.5%. High Performance Concrete strength is achievable using micro silica.

Prasanna K and Anandh K S (2017) conducted experiments on M60 grade concrete with fine aggregate replacement proportion 0%, 25%, 50%, 75% and 100%. The properties such as compressive strength, split tensile strength and ultrasonic pulse velocity are determined from cubes and cylinders cast with manufactured sand procured from kundrathur and river sand taken from Araniar basin. The replacement of 75% natural sand by manufactured sand recommended as this proportion gives comparatively better results in special concrete such as high performance concrete. Hence the manufactured can be used in high performance without any doubt which will also improve the environment as well as sustainability of construction industry.

Chandrasekar R et al (2017) carried out for utilization of waste foundry sand (WFS) in High strength concrete. The waste foundry sand was replaced in the place of normal sand with four different percentages (10%, 20%, 30%, and 40%). The several tests such as compressive strength, split tensile strength, modulus of elasticity, flexural strength, ultrasonic pulse velocity (UPV), rebound hammer test, are performed for 7 days and 28 days to obtain the behavior the concrete due to foundry sand. The temperature effects of concrete were observed for the different temperatures such as (200, 400, 600, 800, and 1000℃) for 28 days. In this test results there is sudden decrease in compressive strength due to the increase in percentage of foundry sand from 30%. But moreover 10% to 20 % replacement of foundry sand almost has similar strength as to that of the control mixture.

M. Manoj Pravarly and S. Mahesh (2017) focused on achieving high performance characteristics of concrete by comparing M80 and M90 grades. The strength, workability and Durability properties for both grades are compared by varying the percentages of ROBOSAND with natural sand by 0%, 25%, 50%, 75% and 100% together with fly ash of 20% replacement in cement. The compressive strength, split tensile strength and flexural strength are compared for both grades and results are tabulated and the optimum percentages are concluded.

Anjali Prajapati et al (2017) studied the effect of performance of HPC using mineral admixture i.e. fly ash and GGBS with M-60 grade of IS cube specimen

We partially replaced Portland cement by weight of binder. Fly ash and GGBS replacement varies from 10% to 30%. We used Conplast SP430-Sulphonated Naphthalene Polymers as a superplasticizer for better workability for high performance concrete. Dosage for superplasticizers is same for all mix proportions. Also, we have replaced fine aggregate in different proportions with foundry sand. We have investigated compressive strength, split tensile strength and flexural strength for all different cases. The HPC mix, grade M60concrete is designed as per Indian standards "Guide for selecting proportions for high strength concrete with Pozzolana Portland cement and other cementitious materials".

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4. CONCLUSION

A survey of journal articles published between 2010 and 2017 yields studies that vary in scope and level of analysis, yet with consistently good results.

A review of different experimental studies performed by various researchers have been carried out to examine various operational parameters viz. workability, durability and compressive strength of concrete with crushed sand as replacement to the natural sand. The data assembled during the course of investigation lead to the following conclusions;

- The concrete with crushed sand performed better than concrete with natural sand as the grade of concrete mix increased.
- The flexural strength of concrete with crushed sand was marginally increased on the strength of concrete with natural sand.
- The workability of concrete manufactured with crushed sand was lesser than that manufactured with natural sand.
- The round shape and smooth surface texture of natural sand reduces the inter particle friction in the fine aggregate component so that the workability is higher in natural sand. Manufactured sand particles are angular in shape and their rough surface texture improves the internal friction in the mix. Because of that the workability is reduced.
- Manufactured sand is free from chemical impurities such as sulphates and chlorides which improves the properties of concrete like strength and durability.
- Manufactured sand contains no organic impurities; hence it gives increased strength of Concrete with same cement content. And does not harm the environment in any way. No wastage since Sand is already sieved in the required size (below 4.75 mm).
- Manufactured sand is economical as compared to natural river sand.

5. FUTURE SCOPE

The concrete with crushed sand was found to be stronger, workable, durable, economical and eco-friendly. Thus crushed sand may be used as a substitute to natural sand.

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