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Strength and Durability Aspects of Crushed Stone Sand: A Review

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ABSTRACT

As a result of ban on natural sand obtained from river there is deficiency of fine aggregate used in construction industry. As a replacement for the river sand the crushed stone sand is used nowadays. In this paper a effort is made to summaries the findings done by various researches and conclusive statement is made about till date study carried in regards of crushed stone sand.

KEYWORDS: *Find Aggregate; River Sand; Crushed Sand, Sand; Compressive Strength; Durability; Crushed Stone Dust*

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INTRODUCTION

One of the main ingredients of concrete and mortar used in construction industry is fine aggregate which composes of natural river sand and crushed stone sand and many other crushed sands depending upon availability of materials in the locality. As nowadays the scarcity of natural river sand is there. Dependability on crushed stone sand is increased but at same time research data available on performance of crushed stone sand is insufficient so as its use is increasing the requirement of related data is need of time. The data regarding the compressive strength of concrete for different percentage of crushed stone sand in concrete. Also, durability of the concrete made from crushed stone sand is a major concern. Shrinkage and expansive properties also not fully known. So here it is briefed about status of study carried in this regard.

LITERATURE REVIEW

1. Sarvesh P.S.Rajput (2018). Conducted study about Crushed Stone Dust as Fine Aggregate in Cement Concrete. the nominal mixes were prepared for grades M-20 and M-30 of cement concrete as per Indian Standards codes using natural sand (NS) and replacement of NS sand to crushed stone dust (CSD) in different proportions. In each case proportion the slump cone test, compaction factor test, density test, compressive strength test and Ultra-sonic pulse velocity test were carried out. The results of the study show that, the strength properties of cement concrete using crushed rock sand is higher and homogeneous to the conventional concrete. The study has presented that crushed stone dust can be used as readily available solid waste as an alternative to natural sand in cement concrete construction work and it can reduce the cost of material and construction cost and can helpful to mend the environment issues.

2. Er. Paramjeet Malik, Amolak Singh (2014). Conducted study about evaluation of characteristics strength of concrete using crushed stone dust as fine aggregate 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 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.

3. Rameshwar S. Ingalkar, Shrikant M. Harle (2017). conducted study about replacement of natural sand by crushed sand in the concrete. The findings were different crushed sand gives different results for compressive strength depending on different quarries and from study of different research paper at 40% to 50% replacement of crushed sand the maximum compressive strength is obtained. The maximum tensile strength of concrete is obtained at 60% and 70% replacement of natural sand with crushed sand. The concrete with crushed sand performed

better than concrete with natural sand as the property of crush sand is better than that of natural sand.

4. K. Shyam Prakash1 and Ch. Hanumantha Rao2 (2016). conducted study about compressive strength of quarry dust as fine aggregate in concrete. the findings were the results of experimental investigations conducted; it is concluded that the quarry dust can be used as a replacement for fine aggregate. It is found that 40% replacement of fine aggregate by quarry dust gives maximum result in strength than normal concrete and then decreases from 50%. The compressive strength is quantified for varying percentage and grades of concrete by replacement of sand with quarry dust. It is found that the strength of concrete is more for w/c of 0.45 when compared with w/c of 0.5. As the quantity of water increases, the compressive strength decreases when replaced with quarry dust. This is due to the water absorption property of quarry dust. It is well known that the w/c ratio increases as the strength decreases. But the observation regarding compressive strength of quarry dust when compared to sand is nonlinear. it is concluded that the quarry dust can be used as a replacement for fine aggregate. It is found that 40% replacement of sand by quarry dust gives maximum result in strength compared to normal concrete and then decreases from 50%. The results proved that up to 40% replacement of sand by the quarry dust induced higher compressive strength and the workability of concrete decreases as replacement increases. Thus, the environmental effects and waste can be significantly reduced.

5. Guruprasad Jadhav1, Khote Bhagwat2, Gajarmal Amit3, Navagare Akshay4 (2018). conducted study about crushed stone waste as fine aggregate for pumped concrete properties of concrete in which crushed stone waste (CSW) is used as a partial and full replacement for natural sand. The basic strength properties of concrete were investigated by replacing natural sand by CSW at replacement level upto 50%. the findings were the stone dust used is very fine, it can fill the spaces between the larger particles of fine aggregate. Hence the use of this material gives a pleasing finish to the concreted surface. Compressive strength increases by 27% and 39% for grade M20 and M30 respectively. Up to 50% replacement of crushed stone waste. Up to 50% of replacement of sand CSW, Concrete is workable for each grade of concrete.

6. B. Basavaraj1, Ravichandra Honnalli2, Sagar N S3, Praveen Ashok M4, Shwetha K C5 (2017). conducted study about replacement of sand with stone crushed powder in conventional concrete stone crusher powder has the similar characteristics and performances as that of river sand. In this paper an attempt has been made to investigate the replacement of sand with Stone crusher powder. Strength behavior of concrete with the use of stone crusher powder as a replacement of fine aggregates in different proportions is discussed. Test results are also discussed pertaining to strength and values are compared with conventional concrete. the findings were

1. Concrete acquires maximum increase in compressive strength at 50% sand replacement. The percentage of increase in strength with respect to control concrete is 24.04 & 6.10 in M20 and M25 respectively.
2. After heated to 100^{o}C, the maximum compressive strength is obtained at 50% sand replacement. The percentage of reduction in strength with respect to control concrete is 6.67 & 13.80 in M20 and M25 respectively.
3. Due to thermo shock also the compressive strength is maximum at 50% sand replacement only. The percentage of reduction in strength with respect to control concrete is 13.01 & 16.22 in M20 and M25 respectively.

The above conclusion gives clear picture that quarry dust can be utilized in concrete mixtures as a good substitute for natural river sand with higher strength at 50% replacement.

7. Sanjay Mundra a, P.R. Sindhi b, Vinay Chandwani a,∗, Ravindra Nagar a, Vinay Agrawal a (2016). conducted study about Crushed rock sand — An economic and ecological alternative to natural sand to optimize concrete mix. the findings were use of crushed rock sand as viable alternative to Natural River sand that is being conventionally used as fine aggregate in cement concrete. Various mix designs were developed for different grades of concrete based on IS, ACI and British codes using Natural River sand and crushed rock sand. In each case, the cube compressive strength test, and beam flexure tests were conducted. The results of the study show that, the strength properties of concrete using crushed rock sand are nearly similar to the conventional concrete. The study has shown that crushed stone sand can be used as economic and readily available alternative to river sand and can therefore help to arrest the detrimental effects on the environment caused due to excessive mining of river sand.

1. Expect that a higher blend ratio of crushed stone to natural sand will decrease workability. Even the best shaped manufactured sands are usually more poorly shaped than Silicious river sand. It is viable to use mix with high percentage of micro-fines in all concrete type. The workability is decreased, but it can be restored by increasing the paste content and including water reducing admixture, especially high range water reducing admixture (HRWRA).
2. Considerable reduction in compressive strength was noticeable at and beyond 50% CRS replacement. Therefore for mix with 70–100% CRS replacement it is desired to mix washed crushed rock sand along with proper screening at crushing stages so that one gets compressive strength higher than the designed strength.
3. The properties of concrete (Compressive and flexural strength) made with partial or full replacement with CRS are comparable to natural sand results.
4. The cost of concrete can be decreased by increasing the amount of crushed stone sand. The price can further be lowered by including the PFA in mix.
5. Besides being a cost effective alternative, use of CRS as fine aggregates in concrete helps in sustaining the ecological balance.

8. Irfan Prasetia1 and Achmad Maulana1 (2019). conducted study about Effects of crushed stone waste as fine aggregate on mortar and concrete properties. the findings were effects of crushed stone waste from Katunun's quarry as fine aggregate on mortar and concrete properties will be examined. Samples with varying crushed stone waste replacement ratio, ranging between 0% until 100%, will be analysed at 3, 7- and 28-days curing time. Mortar sample is using 0.5 w/c ratio, while concrete sample is using 0.45 w/c ratio. The mixture of mortar sample is based on SNI 03-

6825-2002, whilst concrete sample is based on SNI 03-2834-2000. The examination of concrete samples workability was conducted based on the slump test according to SNI 1972:2008. Moreover, the compressive strength test of mortar sample is based on SNI 03-6825-2002. In addition, the compressive strength test of concrete sample is based on SNI 1974:2011. Regarding compressive strength of mortar samples, the average compressive strength results of mortar with crushed stone waste rose significantly in line with the increase in replacement ratio. As for the workability of fresh concrete, sample using natural river sand had better workability compared to sample using crushed stone waste. However, the workability of concrete with crushed stone waste is still meet the slump value specified in the job mix formula. In addition, it has been found out that the combination of 75% crushed stone waste with 25% river sand will give the highest compressive strength compared to others combinations. Based on these findings, the utilization of crushed stone waste from Katunun's quarry in mortar and concrete mixture can be proposed.

The purpose of this research was to analyze effects of crushed stone waste from Katunun's quarry as fine aggregate on mortar and concrete properties. In terms of compressive strength of mortar samples, the average compressive strength results of mortar with crushed stone waste rose significantly in line with the increase in replacement ratio. Hence, for mortar applications in construction, it is better to use crushed stone waste then river sand.

However, as for the workability of fresh concrete, sample using natural river sand had better workability compared to sample using crushed stone waste. In general speaking, the workability of concrete with crushed stone waste is still meet the slump value specified in the job mix formula. With a slump value around 8, it can facilitate the casting process in construction work due to the concrete mixture is not too thick.
As for the compressive strength of concrete samples, it has been found out that the combination of 75% crushed stone waste with 25% river sand will give the highest compressive strength compared to others combinations. The difference in strength is quite significant from the three combinations. Based on these findings, the utilization of crushed stone waste from Katunun's quarry in mortar and concrete mixture can be proposed. Especially for the replacement of 75% crushed stone waste, there is a confidence that this fine aggregate could be used to produce a high strength concrete.

9. Radhikesh P. Nanda 1, Amiya K. Das 2, Moharana.N.C 3 (2010). conducted study about Stone crusher dust as a fine aggregate in Concrete for paving blocks. the findings were a parametric experimental study for producing paving blocks using crusher dust is presented. Some of the physical and mechanical properties of paving blocks with fine aggregate (sand) replaced by various percentages of crusher dust are investigated. The test results show that the replacement fine aggregate by crusher dust up to 50% by weight has a negligible effect on the reduction of any physical and mechanical properties while there is a saving of 56% of money.

10. Madiha Z. J. Ammari (2017). conducted study about grading of fine crushed stone and its effect on concrete properties used in the united arab emirates. the findings were For compressive strength determination of the hardened concrete, 45 concrete cubes were prepared for testing. Five different Fineness Moduli and grading were tested 2.4, 2.6, 2.75, 2.92 and 3. All cubes were left in curing until testing at the age of 3, 7 and 28 days respectively. Samples were loaded to failure and the average compressive strength was used for comparison purposes. To measure the workability of fresh concrete mixes, flow table test had been used directly after mixing and the average of the maximum concrete spread parallel to the two edges of the table was recorded. Results confirmed that the optimum Fineness Modulus for the crushed stone to be used as fine aggregate in the concrete mix to get maximum compressive strength is 2.78. The flow table tests revealed an increment in the workability of fresh concrete with higher Fineness Modulus of fine crushed stone used in the concrete mix. The workability of the optimum Fineness Modulus, 2.78, was estimated to be approximately 415 mm which is a mix with considerable workability. All finely graded crushed stone used in this research study checked to match the ASTM grading requirements for fine aggregate.

The research findings revealed that the optimum Fineness Modulus of crushed stone to be used as fine aggregate in concrete mixes is 2.78 which conform to the previous finding [6]. The calculated workability for the optimum grading of fine crushed stone is estimated to be approximately 415 mm which can be considered as a workable mix. Any grading of fine aggregate should be checked and compared with the ASTM grading requirements.

The results of this research work is valuable for aggregate quarries, manufactures, and suppliers in order to improve the different properties of the concrete mixes in terms of compressive strength and workability without extra cost by providing the fine crushed stone to the construction market with optimum Fineness Modulus and grading that meets the ASTM grading requirements for fine aggregate.

CONCLUSION

As above discussion reveals that much of studies are carried out on the performance of crushed stone sand ranging from comparison of compressive strength by varying the its percentage in concrete. Also changing fineness of crushed sand etc. but it should be noted that durability studies are not sufficient to come to any conclusive statements regarding cracks or expansion etc. so there is future scope in this area that should be considered in forthcoming researches to get a sound research base.

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