International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.04, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

CRUSHED STONE WASTE AS FINE AGGREGATE FOR PUMPED CONCRETE

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ABSTRACT

Concrete is a major building material which is used in construction throughout the world. It is extremely versatile and issued for all types of structure. Due to rapid growth in construction activity, the consumption of concrete is increasing every year. This results in excessive extraction of natural aggregates. The use of these materials is being constrained by urbanization, zoning regulations, increased cost and environmental concern. Thus, it is becoming inevitable to use alternative materials for aggregates in concrete which include recycled aggregates, fly ash, manufactured sand, crushed stone waste etc. The use of such materials not only results in conservation of natural resources but also helps in maintaining good environmental conditions. The present investigation aims in the study of 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%.

Keywords: CSW-crushed stone waste, concrete, strength, replacement, natural sand.

I.INTRODUCTION

Concrete is a widely used construction material consisting of cementing material, fine aggregate, coarse aggregate and required quantity of water, where in the fine aggregate is usually natural sand. The use of sand in construction results in excessive sand mining which is objectionable.

Due to rapid growth in construction activity, the available sources of natural sand are getting exhausted. (Palaniraj, 2003) Also, good quality sand may have to be transported from long distance, which adds to the cost of construction. In some cases, natural sand may not be of good quality. Therefore, it is necessary to replace natural sand in concrete by an alternate material either partially or completely without compromising the quality of concrete.

CSW is one such material which can be used to replace sand as fine aggregate. The present study is aimed at utilizing Crushed Rock Powder as fine aggregate in cement mortar and cement concrete, replacing natural sand.

The study on mortar includes determination of compressive strength of different mortar mixes. (Nadgir & Bhavikatti, 2006) The study on concrete includes determination of compressive strength, split tensile strength and flexural strength of different grades of concrete.

Rapid growth in the infrastructure at the global level has made concrete the most widely and commonly used construction material throughout the world. This has create dimmense pressure on the concrete industry to produce large quantum of concrete to meet the growing demand of infrastructure development. The cost of concrete production primarily depends on the cost of its constituent raw materials namely, cement, aggregates (coarse and fine) and water. Among the constituent raw materials, the Natural River sand which forms around 35% of the concrete volume plays an important role in deciding the cost of concrete. Depleting sources of Natural River sand and strict environmental guidelines on mining has gradually shifted the attention of the concrete industry towards a suitable fine aggregate alternative that can replace the presently used Natural River sand. Crushed rock sand has surfaced as110a viable alternative to Natural River sand and is being now used commonly throughout the world as fine aggregate in concrete. It is manufactured by crushing the quarried stone to a size that will completely pass through 4.75 mm sieve. Several studies have been conducted in the past to investigate the effect of partial replacement of Natural River sand with crushed rock sand. Celik and Marar (1996) concluded that partial replacement upto 30% leads to decrease in slump value. However, a significant improvement in the compressive, flexural strength and impact resistance was observed. A significant reduction in the cost of concrete without affecting the strength property was reported in the study conducted by Ilangovan (2000). Sahu et al.(2003) observed that concrete made using crushed rock sand attained the comparable compressive strength, tensile strength and modulus of rupture as the control concrete. Sahul Hameed and Sekar (2009) concluded that the compressive strength, split tensile strength and the durability properties of concrete made of quarry rock dust are nearly14% more than the conventional concrete .A survey of literature has shown that numerous studies have been conducted in the past to utilize crushed rock sand as fine aggregates in concrete. But, an in-depth study has not been performed to optimize the replacement level of crushed rock sand in concrete. The present study has attempted to study the effect of partial to full replacement of Natural River sand with crushed rock sand on the workability, compressive strength and flexural strength of concrete fine aggregates type, grading and blend ratio on the fresh and hardened properties of concrete. The second part of the program focused on the optimization of the selected design mix. The Natural River sand from Banas was mixed with crushed stone sand from Gunavata and Chandwaji and concrete design mixes corresponding to M25 and M30 grade of concrete were prepared. The samples were tested for slump, compressive strength and flexural strength. The effects on each of these properties were examined by changing the percentage replacement of Natural River sand (NS) with crushed rock sand (CRS). An optimization study was performed to study the effect on the properties of concrete when paste content was held constant and the fly ash was considered to be powder instead of aggregates. Other goals of optimization were to examine the effect of partial replacement of cement with fly ash.

II.LITERATURE SURVEY

[1] 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 chosen for natural sand to achieve M20 and M30 grade concrete. The equivalent mixes were obtained by replacing natural sand by stone dust partially and fully. Test result indicates that crushed stone dust waste can be used effectively to replace natural sand in the concrete. Concrete made with this replacement can attain the same compressive strength, comparable tensile strength, modulus of rupture and lower degree of shrinkage as the control.

[2] Concrete is a major building material which is used in construction throughout the world. It is extremely versatile and issused for all types of structures. Due to rapid growth in construction activity, the consumption of concrete is increasing every year. This results in excessive extraction of natural aggregates. The use of these materials is being constrained by urbanization zoning reguand 1:8 were selected for the study of both CRP and CCRP mortars. Moulds of size 70.7mm x 70.7mm x 70.7mm were used which gives cross sectional area of 5000mm2. The compressive strength of both types of mortars are obtained at age of 3days, 7days and 28days.In the third stage of this investigation, fine aggregate in concrete is replaced by CRP at 0%, 20%, 30% and 40% replacement. Three grades of concrete M20, M30 and M40 were selected for the study. The study includes determination of compressive strength, split tensile strength and flexural strength at the ages of 7 days and 28 days. (Jaafer et al., 2002) The strength properties of concrete with CRP replacement are compared with that of Normal Concrete (NC) which does not contain CRP.

[3] Investigation on the use stone crushed dust in the concrete as alternative to the river sand are presented in this paper. The test conducted pertain to concrete with the river sand of strength 28.1Mpa and with the granite stone crusher dust of strength 32.8Mpa.test on strength of concrete and on flexural behaviour of RC Beam under two point loading were conducted. The investigation indicates that stone crusher dust has good potential as a fine aggregate in the concrete construction.

[4] The Properties of High strength concrete are influenced by properties of the aggregate and water cement ratio. Additives are those substances added to concrete that do not fall under the heading of binding agents and aggregate the proper use of additives offer certain beneficial effect to concrete, including improved quality, enhanced frost and sulphate resistance, control of strength development and improve workability. Stone dust in this study is a waste product obtained during the production of manufacture sand, which is verifying in nature.

[5] Stone powder produced from stone crushing zones appears as a problem for effective disposal. Sand is a common fine aggregate used in construction work as a fine aggregate. In this study, the main concern is to find an alternative of sand. Substitution of normal sand by stone powder will serve both solid waste minimization and waste recovery. The study focuses to determine the relative performance of concrete by using powder sand. From laboratory experiments, it was revealed that concrete made of stone powder and stone chip gained about 15% higher strength than that of the concrete made of normal sand and brick chip. Concrete of stone powder and brick chip gained about 10% higher strength than that of the concrete normal sand and stone chip concrete. The highest compressive strength of mortar found from stone powder which is 33.02 Mpa, shows that better mortar can be prepared by the stone powder. The compressive strength of concrete from stone powder shows

14.76% higher value than that of the concrete made of normal sand. On the other hand, concrete from brick chip and stone powder produce higher compressive value from that of brick chip and normal sand concrete.

[6] Conventional Cement Concrete (CCC) consists of Portland Cement (PC) as binder, which binds the inert aggregate system. Concrete has found its wide application in buildings throughout the world because of positive attributes such as durability, high resistance to loads, and the possibility of using local raw materials in the preparation of concrete (Sand, Crushed Stone). The use of river sand in making the concrete is the best Fine Aggregate (FA). Seasonal non – availability and scarcity leads to the higher cost. There is a need to tackle this problem. So the replacement of conventional river sand is necessary. For this the abundantly available material at all season at a cheaper rate is in need. The use of Quarry Dust – the fines which is found as the remains of the crusher industry, as a replacement of sand is being tried at different places, but no authentic results are available for the characteristics strength and the optimum proportion by which it can be included as FA. Properties such as: compressive, split tensile and flexural strengths besides durability of concrete made with Quarry Dust have been investigated. Cement Concrete mix using Quarry Dust as Fine Aggregate is designed using M20

[7] Stone powder produced from stone crushing zones appears as a problem for effective disposal. Sand is a common fine aggregate used in construction work as a fine aggregate. In this study, the main concern is to find an alternative of sand. Substitution of normal sand by stone powder will serve both solid waste minimization and waste recovery. The study focuses to determine the relative performance of concrete by using powder sand. From laboratory experiments, it was revealed that concrete made of stone powder and stone chip gained about 15% higher strength than that of the concrete made of normal sand and brick chip. Concrete of stone powder and brick chip gained about 10% higher strength than that of the concrete normal sand and stone chip concrete. The highest compressive strength of mortar found from stone powder which is 33.02 Mpa, shows that better mortar can be prepared by the stone powder. The compressive strength of concrete from stone powder shows 14.76% higher value than that of the concrete made of normal sand. On the other hand, concrete from brick chip and stone powder produce higher compressive value from that of brick chip and normal sand concrete.

[8] The present investigation shows that the characteristics of mortars and concrete using Crushed stone dust as fine aggregate are superior when compared to the natural river sand as fine aggregate. The results pertain to the most commonly used grading zone – II sand. Crushed stone dust falling within the grading Zone II sand, grading limits specified by IS 383 code and manufactured from the hard rock is suitable as fine aggregate in masonry mortars. Also, IS-2116 and IS 383 codes permit the use of crushed stone fine aggregate in masonry mortars.

[9] 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. In such a situation the Quarry rock dust can be an economic alternative to the river sand. 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. Usually, Quarry Rock Dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of hollow blocks and lightweight concrete prefabricated Elements. Use of Quarry rock dust as a fine aggregate in concrete draws serious attention of researchers and investigators. This paper presents the feasibility of the usage of Quarry Rock Dust as hundred percent substitutes for Natural Sand in concrete. Mix design has been developed for three grades using design an approach IS, ACI, USBR, RN.No.4 and BRITISH for both conventional concrete and quarry dust concrete. Tests were conducted on cubes and beams to study the strength of concrete made of Quarry Rock Dust and the results were compared with the Natural Sand Concrete. An attempt has also been made to durability studies on Quarry Rock Dust when compared with the Natural Sand concrete. It is found that the compressive, flexural strength and Durability Studies of concrete made of Quarry Rock Dust are nearly 10% more than the conventional concrete.

[10] Since ancient period, river sand has been used in the construction industry as a dominant material from the level of foundation to the end of a project .Today demand for sand continues to increase to meet the needs of growth in population. Excessive instream sand mining causes the degradation of rivers and creating ecological imbalance. Instream mining lowers the stream bottom, which may lead to bank erosion and may lead for river meandering. It is the need of the hour to investigate for a suitable alternative material for sand like stone crusher powder and granite fines etc. which are available abundantly from crusher units and granite industries. Use of stone crusher powder proves to be economical and eco-friendly which generally considered as unused. The investigations indicate that 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.

III. MIX DESIGN

To produce concrete of required strength and properties, selection of ingredients and their quantity is to be found which is called concrete mix design. Proper mix design will solve every problem arises in concrete while placing or curing etc.. The mix design also helps to produce economical concrete.

Generally, cement is more costly than other ingredients of concrete. So, quantity and quality of cement is designed by proper mix design concept. In this article we are going to discuss about the concrete mix design concept as per IS 10262-2009.

1. SELECTION OF MIX PROPORTION

- Selection of water cement ratio.
- Selection of water content.
- Calculation of cement content.
- Estimation of fine aggregate proportion

- Combination of different coarse aggregate fractions.
- Estimation of coarse aggregate proportion.
- Trial mixes.
- Determination of final mixed proportion to be used

2. TEST ON CONCRETE

2.1. Compressive Strength of Concrete:

The materials required for the number of specimens were dry mixed and then mixed with calculated amount of water. The quantity of water is obtained as per IS4032-1988. It is given by Percentage of water equal to (P/4 +3) percent of combined weight of cement and fine aggregate, where P is the percentage of water required to produce a cement paste of standard Consistency. While preparing the specimens for each proportion, a reference mix using cement and natural sand is prepared. This is done in order to compare CRP mortar with the normal mortar. For each CRP replacement, the total fine aggregate quantity is obtained as the combination of natural sand and CRP. For example, the first set of specimens consists of 20% CRP and 80% of natural sand.

2.2.Flexural Strength on Concrete:

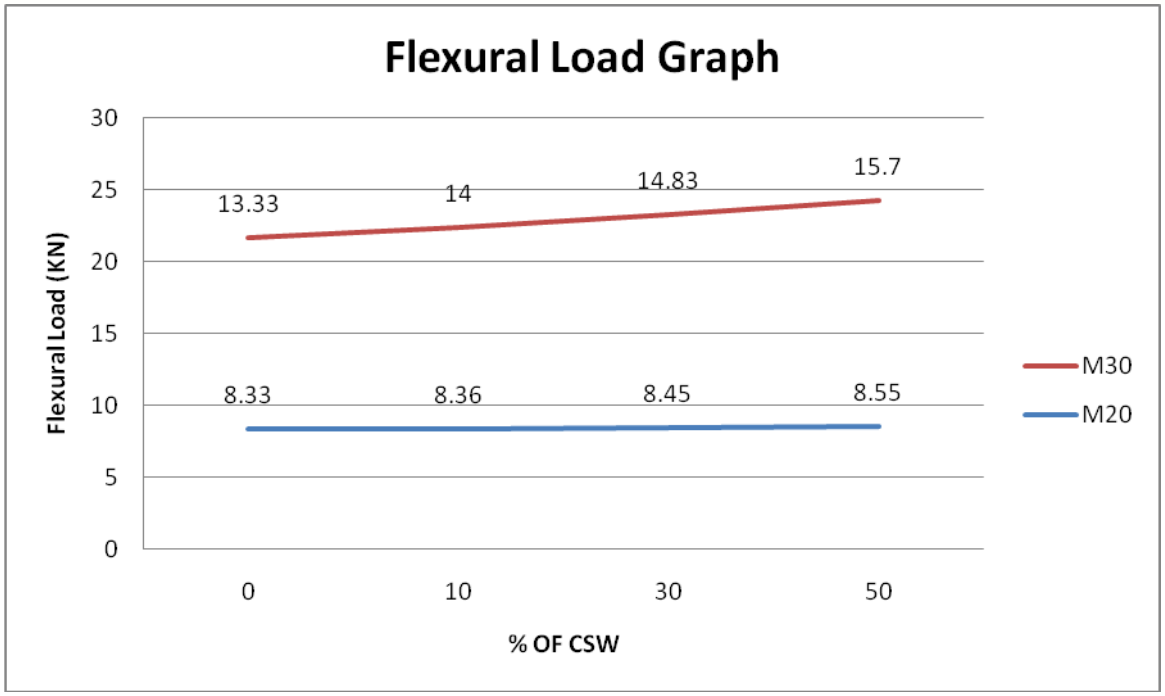
Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 6 x 6 inch (150 x 150-mm) concrete beams with a span length at least three times the depth. The flexural strength is expressed as Modulus of Rupture (MR) in psi (MPa) and is determined by standard test methods ASTM C 78 (third-point loading) or ASTM C 293 (center-point loading).

Flexural Strength of Concrete Flexural MR is about 10 to 20 percent of compressive strength depending on the type, size and volume of coarse aggregate used. However, the best correlation for specific materials is obtained by laboratory tests for given materials and mix design.

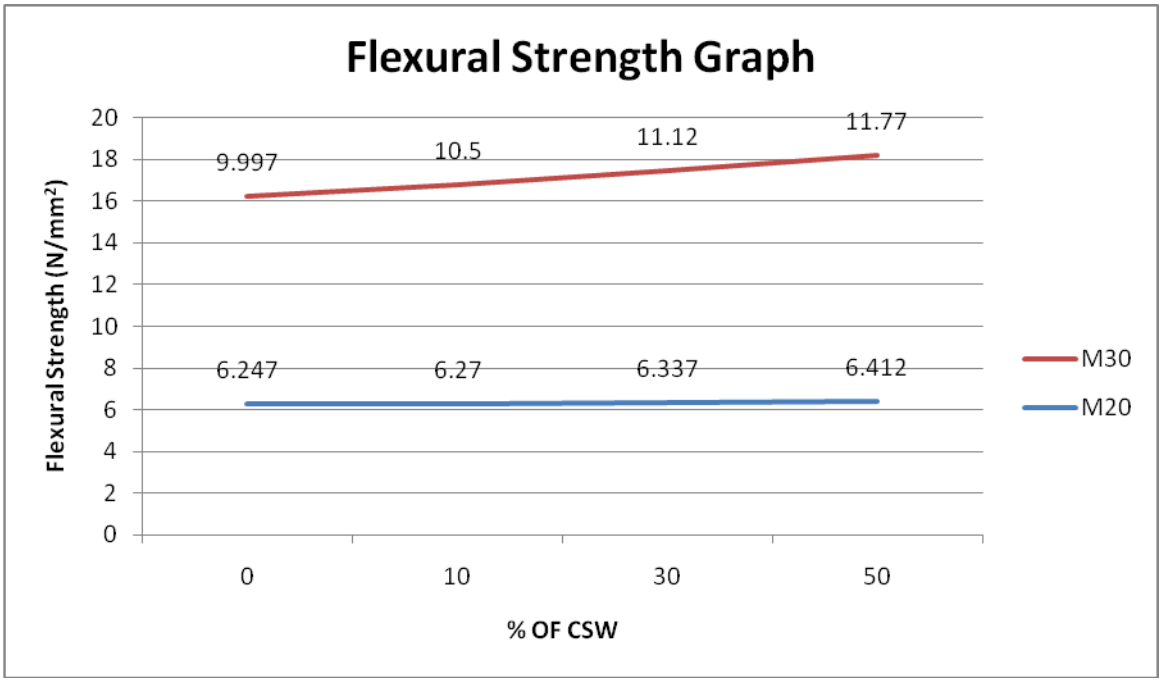
Designers of pavements use a theory based on flexural strength. Therefore, laboratory mix design based on flexural strength tests may be required, or a cementitious material content may be selected from past experience to obtain the needed design MR. Some also use MR for field control and acceptance of pavements. Very few use flexural testing for structural concrete. Agencies not using flexural strength for field control generally find the use of compressive strength convenient and reliable to judge the quality of the concrete as delivere

IV.FIGURES

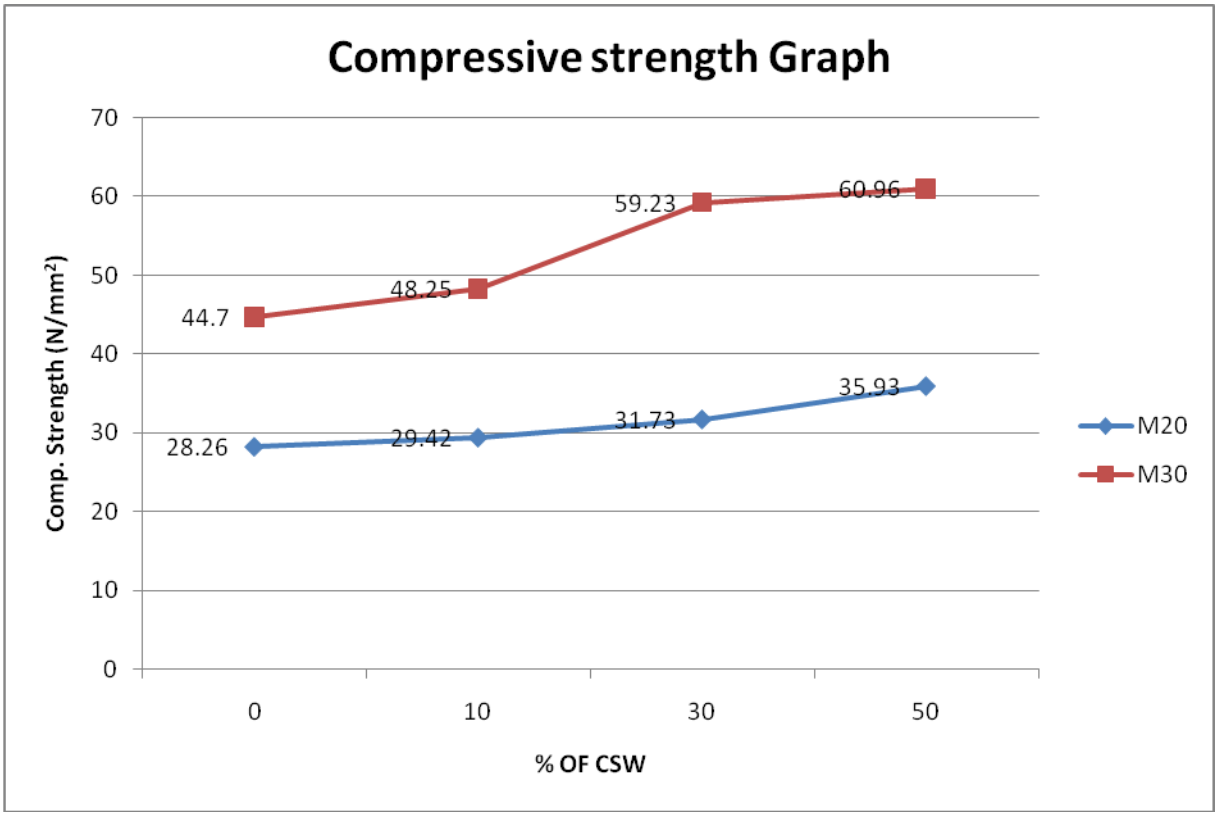
Graph 1. Variation of 28 Days Flexural Load of Concrete



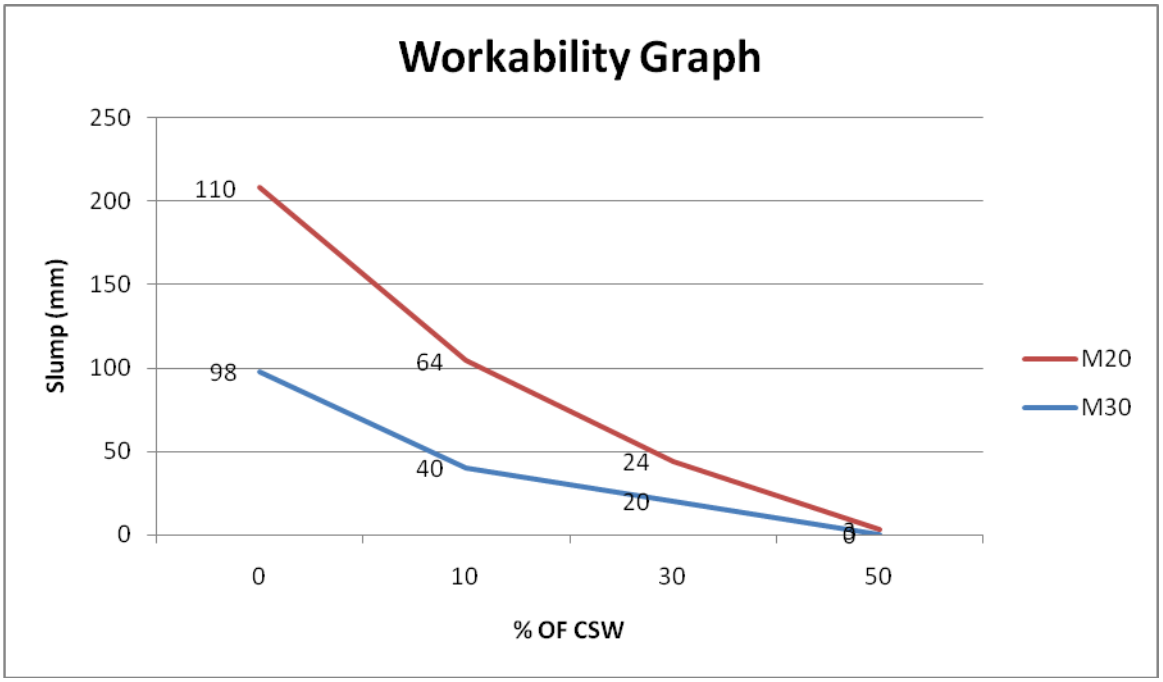
Graph 2. Variation of 28 days flexural strength of concrete



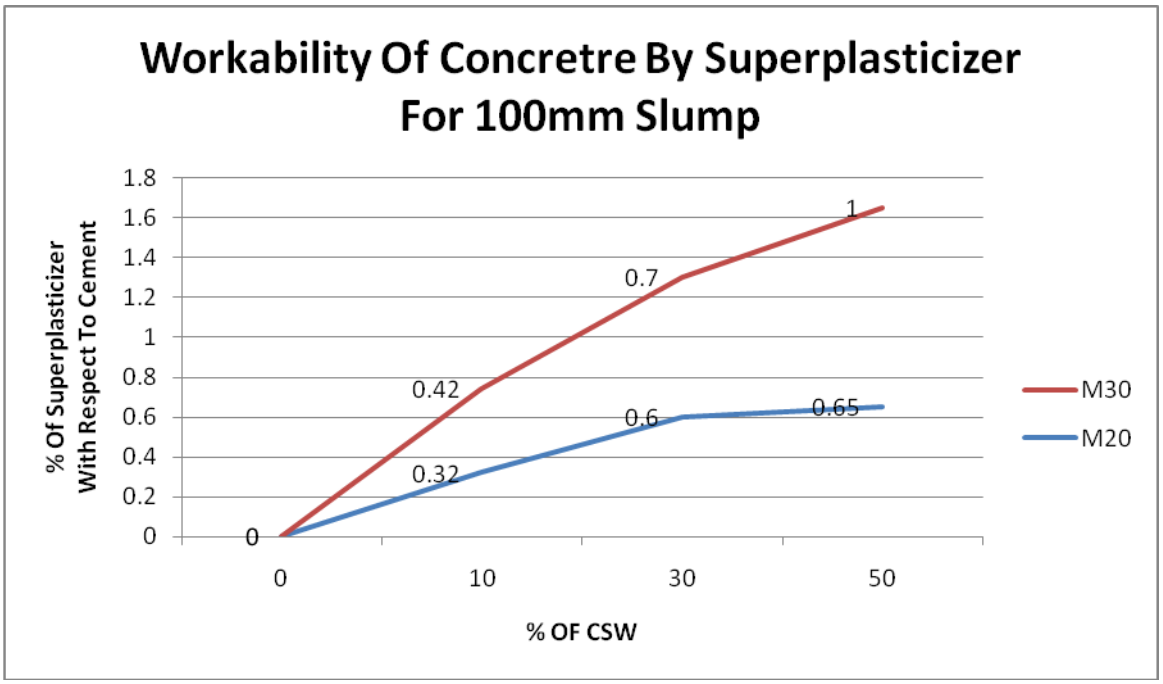
Graph 3. Variation of 28 days compressive strength of concrete



Graph 4. Workability of concrete by slump test



Graph 5. Workability of concrete by superplasticizer



V. CONCLUSION

As 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. Upto 50% replacement of crushed stone waste. Upto 50% of replacement of sand CSW, Concrete is workable for each grade of concrete.

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