An Assessment on Properties of Material used in Concrete as a Partial Replacement of Sand with Stone Dust and Steel Scrap: A Review

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Abstract— With the still increase in the require of natural river fine aggregate and decrease in its availability, there is an immediate need for finding suitable alternatives which can replace fine aggregate partially or at a high proportion. Many research studies investigates the effect of several waste products such as Glass sheet powder, Incinerated Sewage sludge, foundry bed waste, crushed rock flour, building demolition waste in the partial replacement of river fine aggregate. Utilization of Stone dust and steel scrap are one of the active research area that encompass the effectiveness of replacement in all the aspects of construction materials. It is very essential to develop eco-friendly concrete from ceramic waste. This thesis deals with the experimental study on the mechanical strength properties of M20 grade concrete with the partial replacement of fine aggregate by using stone dust and Steel Scrap. In order to analyze the mechanical properties such as Compressive Strength, Flexural Strength, and Workability the samples were casted with 10%, 20%, 30%, 40% & 50% replacement of fine aggregate using stone dust and steel scrap and tested at a different periods of curing 7 days, 14 days and 28 days. The optimum of percentage addition of stone dust and steel scrap are analyzed considering the requirements of mechanical properties of concrete.

Key words: Stone Dust, Steel Scrap, Mechanical properties, Silt content, Crushing value and Consistency

I. INTRODUCTION

Concrete is a most commonly used construction material which is a mixture of cement, fine aggregate, coarse aggregate and water. It is used for construction of multi-storey buildings, dams, road pavement, tanks, offshore structures, canal lining. The compressive strength of harden concrete is commonly considered to be an index of its extra properties depends upon a lot of factors e.g. worth and amount of cement water and aggregates batching and mixing placing compaction and curing. The cost of concrete prepared by the cost of materials plant and labour the variation in the cost of material begin from the information that the cement is very costly than the aggregates thus the intent is to produce a mix as feasible from the practical point of view the rich mixes may lead to high shrinkage and crack in the structural concrete and to development of high heat of hydration is mass concrete which may cause cracking. The genuine cost of concrete is related to cost of materials essential for produce a minimum mean strength called characteristic strength that is specific by designer of the structures. This depends on the quality control measures but there is no doubt that quality control add to the cost of concrete. The level of quality control is often an inexpensive cooperation and depends on the size and type of job nowadays researchers, engineers and scientists are trying to enhance the strength of concrete by adding the several other economical and waste material as a partial substitute of cement , fine aggregate or as a admixture fly ash, silica fume, steel slag steel chips etc are the few examples of these types of materials. These materials are generally by-product from further industries for example fly ash is a waste product from power plants and stone dust.

If the large amount of waste material generated is used instead of natural material in the construction and industry, there would be three benefits:

1) Conserving natural resources
2) Disposing of waste materials and
3) Freeing up valuable land for their uses

II. MATERIALS & METHODOLOGY

A. *Material used*

1) Fine Aggregate
2) Cement (OPC)
3) Aggregate
4) Stone Dust
5) Steel Scrap

1) Fine aggregate:

a) Properties of Fine Aggregate:

Specific Gravity: 2.53
Fineness Modulus: 3.08.
Density: 1.63 gm/cc.
Void ratio: 0.55.

Fine aggregate is a naturally occurring coarse material collected of finely separated rock and mineral particles. Fine aggregate is a naturally occurring granular material collected of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Fine aggregate may also consign to a textural class of soil or soil type; i.e. a soil contain more than 85% fine aggregate-sized particle (by mass).

The composition of fine mixture vary, rely on the native rock supply and state of affairs, apart from the for most frequent constituent of fine mixture in upcountry continental settings and non-tropical coastal setting is silicon dioxide sometimes within the style of quartz

In terms of particle size as used by geologists, fine aggregate particle range in diameter as of 0.0625 mm to 2 mm. An individual particle in this range size is termed a fine aggregate grain. Fine aggregate grains are among gravel (with particles ranging from 2 mm up to 64 mm) and silt (particles smaller than 0.0625 mm down to 0.004 mm). The dimension specification between fine aggregate and gravel has remained even for other than a century, but particle diameter as small as 0.02 mm be considered fine aggregate under the Albert Atterberg standard in utilize during the early on 20th century. A 1953 engineering standard published by the American Association of State Highway and Transportation Officials set the least fine aggregate size at 0.074 mm. A 1938

specification of the United States Department of Agriculture was 0.05 mm. Fine aggregate feel granular when rubbed between the fingers (silt, by comparison, feels like flour).

2) Cement (OPC):

a) Properties of Cement:

Specific gravity: 3.10
Grade of cement: 53
Initial setting time: 38 min.
Final setting time: 8 hrs.
Fineness: 8% residue on IS 90 micron sieve.

Ordinary Portland cement is used to prepare the mix design of M-20 grade. The cement used was fresh and \without any lumps Water – cement ratio is 0.42 for this mix design using IS 456:2007. Cement is a particularly ground material having adhesive and cohesive properties which offer a binding medium for the distinct ingredients. Chemically cement constitutes 60-67% Lime (CaO), 17-25% Silica (SiO_2), 3-8% Alumina (Al_2O_3), 0.5-6% Iron Oxide (Fe_2O_3), 0.1-6% Magnesia (MgO), 1-3% Sulphur Trioxide (SO_3), 0.5-3% Soda And Potash (Na_2O+K_2O).

3) Aggregate:

a) Properties of Aggregate:

Maximum size Stone: 20 mm
Specific Gravity: 2.98
Fineness Modulus: 6.36
Density: 1.58 gm/cc.

Aggregate are the essential constituent in concrete. They provide body to the concrete, decrease shrinkage and effect economy. Construction aggregate, or basically "Aggregate", is a wide group of coarse particulate material used in construction, as well as fine aggregate, gravel, crushed stone, slag, recycled concrete and geosyenthetic aggregates. Aggregates are the mainly mine material in the world. Aggregates are an element of composite materials such as concrete and asphalt concrete; the aggregate serve as reinforcement to add strength to the overall combined material. Due to the comparatively high hydraulic conductivity value as compare to most soils, aggregates are generally used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and road side edge drains. Aggregates used as support material underneath foundations, roads, and railroads.

4) Stone Dust:

a) Properties of Aggregrate:

Specific Gravity: 2.57
Fineness Modulus: 2.41.
Density: 85 gm/cc.
Void ratio: 0.42

Stone Dust is a byproduct of washing Crushed Ores inside the Ore Washing Plant. It can also be obtained by placing cobblestone inside the Thermal Centrifuge. This material is especially useful in rebuilding worn out soils but can be beneficial on most any soil. First one must have the proper stone available. Glacial till is a good source, also volcanic and sites, lavas or volcanic ash, new or old. However the stones used must have a wide range of minerals available. The problem of producing rock dust is also the energy involved in the grinding and the cost of the equipment.

5) Steel Scrap:

Scrap consists of recyclable materials left over from product manufacturing and consumption, such as parts of vehicles, building supplies, and surplus materials. Unlike waste, scrap has monetary value, especially recovered metals, and non-metallic materials are also recovered for recycling.

III. TESTING OF MATERIALS

1) Cement
2) Fine aggregate
3) Aggregate

A. Cement

1) Consistency test
2) Initial and final setting time

1) Consistency test:

This is a test conducted to estimate the quantity of water to be mixed with cement to form a paste of standard consistency for make use of in other tests.

2) Initial and final setting time test:

Sr. No.	Properties	Test Result
1.	Consistency	34%
2.	Initial Setting Time	38min.
3.	Final Setting Time	8hrs.
4.	Specific Gravity	3.10

Table 1: Cement Test

B. Fine Aggregate

1) Silt Content:

1) Fill 1% solution of common salt and water in the measuring cylinder up to 50 ml mark.
2) Now add sand to be tested to this solution till the level of the salt solution shows 100 ml mark.
3) Top up the level of salt solution up to 150 ml mark.
4) Shake the mixture of sand and salt solution well and keep it undisturbed for about 3 hours.
5) The silt being of finer particles than sand, will settle above the sand in a form of layer.
6) Measure the thickness of this silt layer.

S.NO.	Description	Sample
1	Vol. of Sample V_1 (ml) ⟹	500 ml
2	Vol. of Silt after 3hr V_2(ml)	38 ml
3	% Silt by Vol. (V_2/ V_1)X100	7.2%

Table 2: Silt Content

C. Aggregate

1) Crushing Test:

The aggregate passing 12.5mm IS sieve and retained on 10mm IS sieve is selected for standard test. The aggregate should be in surface dry condition before testing. The aggregate may be dried by heating at a temperature 1000C to 1100C for a period of 4 hours and is tested after being cooled to room temperature.

Aggregate crushing value = (W_2/W_1) x 100%.

Wt. of Aggregate W_1(kg)	Wt. of residue after passing 2.36 mm sieve W_2(kg)	% Crushing Value
0.330	0.050	15.15

Table 3: Observation of Crushing Value

IV. LITERATURE REVIEW

Ashish Patel and S.K. Jaiswal In this Research, [1] In the given analysis, a fraction of fine mixture utilized in concrete is replaced by stone dust, a by-product of stone crushing and therefore the sample cube is tested to work out the compressive strength of concrete. Tests to work out the physical properties of sample cube like relative density, fineness modulus, and wetness content are performed. Stone dust is best various for the fine mixture as a result of fine mixture (natural fine aggregate) and stone dust has similar physical and mechanical properties. This paper shows some relevant studies relating to the impact of stone dust on mechanical property like compressive strength.

MD. Nuruzzaman1, MD Saiful Islam2, M.Salauddin1, MD. Saiful Islam1, [2] This research's aim is to search out the strength of concrete by stone dust as a partial replacement of fine combination. These take a look at specimens were made up of 3 totally different grades of concrete i.e. combine ratios 1: 1.5: 3, 1: 2: 4, 1: 2.5:5 and each compressive yet as strength tests were conducted. The fundamental strength properties of concrete were investigated by replacement natural fine combination by Stone dust at replacement levels of, 10%, 20%, 30%, 40%, 50% & 60%.

K. Shyam Prakash1 and Ch. Hanumantha Rao2, [3] The thought of replacement of natural fine combination by quarry dust that is highlighted within the study may boost the consumption of quarry dust generated from quarries. By replacement of quarry dust, the need of land fill space will be reduced and might conjointly solve the matter of natural fine combination inadequacy. It even causes burden to dump the device dust at one place that causes environmental pollution. From the results of experimental investigations conducted, it's complete that the quarry dust will be used as a replacement for fine combination. The compressive strength is quantified for variable share and grades of concrete by replacement of fine combination with quarry dust.

Amit Kumar Singh, Vikas Srivastava, V.C. Agarwal., [4] In the present investigation, an experimental program was carried out to study the workability and compressive strength of concrete made using stone dust as partial replacement of fine aggregate in the range of 10% - 100%. M20 grade of concrete was designed using Portland pozzolana cement (PPC) for referral concrete. Workability and Compressive strength were determined at different replacement level of fine aggregate viz a viz referral concrete and optimum replacement level was determined based on compressive strength. Results showed that by replacing 60% of fine aggregate with stone dust concrete of maximum compressive strength can be made as compared to all other replacement levels.

A. Suribabu1, Dr U.Rangaraju 2, Dr.M. Ravindra Krishna3, [5] River fine aggregate is most typically used fine combination within the production of concrete poses the matter of acute shortage in several areas. Quarry rock dust may be Associate in Nursing economic different to the water course fine aggregate. Quarry Rock dust as 100% substitutes for Natural Fine combination in concrete. Combine style has been developed for M20 and M40 grades victimization style approach IS for each standard concrete and quarry dust concrete. Tests were conducted on cubes and beams to review the strength of concrete manufactured from Quarry Rock dust and therefore the results were compared with the Natural Fine combination Concrete. It's found that the compressive and flexural strength of concrete manufactured from Quarry Rock dust are nearly 100% over the standard concrete. Tests were additionally conducted on cubes and beams that are exposed to temperatures of 300°C for 1hr, 3hr durations severally

Dr. A.D. Pofale1. Syed Raziuddin Quadri2., [6] The present investigation was taken up with a view to verify the suitability, feasibility and potential use of crusher dust, a waste product from aggregate crushing plant in concrete mixes, in context of its compressive strength and workability and in terms of slump, compacting factor, flow table and modified flow respectively. In view of above discussion, an attempt is made to replace the natural fine aggregate in concrete control mixes of M20 and M30 grades designed for 100 to 120mm slump at replacement levels of 30%, 40%, 50% and 60% using Portland Pozzolana Cement. There were in all 5 mixes in each grade of concrete including control mix and four mixes with crusher dust as a partial replacement of natural fine aggregate. It was observed that with use of crusher dust at all replacement levels, the workability of concrete was reduced from 1-6%. From the test results, it was observed that the replacement of natural fine aggregate by crusher dust increased the compressive strength of concrete by 5-22%. It was also found that amongst all the mixes, the highest compressive strength was obtained for 40% replacement of fine aggregate by crusher dust. Hence it could be concluded and recommended that crusher dust could be effectively used in concrete of above grades for replacement levels of fine aggregate by 30-60% economically leading to sustainable development.

G.Balamurugan*, Dr.P.Perumal, [7] this experimental study presents the variation in the strength of concrete when replacing fine aggregate by quarry dust from 0% to 100% in steps of 10%. M20 and M20 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 fine aggregate giving higher strength at 50% replacement.

Brajesh Kumar Suman, Vikas Srivastava, [8] This study aims owing to increased construction activities for different regions and utilities scaring of natural resources is being forced due to its over exploitation. Depleting natural resources posed threat to the environment. Hence conservation of natural resources is great challenge for civil engineers since construction activities cannot be diminished as it is intimate able. In the present investigation an experimental programmed was carried out to study the suitability and potential use of stone dust as partial replacement of fine aggregate in concrete. To accomplish this specimen were cast for different replacement level at an

interval of 10 percent to determine workability and compressive strength of concrete at different level of fine aggregate with stone dust. Results show that optimum replacement with stone dust is 60 percent based on compressive strength.

Joffrey Cheruiyot, Sylvester Ochieng Abuodha, Charles Kabubo, [9] This research evaluated the suitability of stone dust in the design and production of High Performance Concrete (HPC). HPC mix was designed, tested, costed and a comparison of concrete classes used in the market (Class 25, 30 and 35) done using Cost Benefit Analysis (CBA). The cost benefit was analyzed using Internal Rate of Return (IRR) and Net Present Value (NPV). Laboratory tests established the properties concrete obtained from the design mix. Compressive strength, slump, and modulus of elasticity were tested and analyzed. Structural analysis using BS 8110 was done for a 10 storey office building to establish the structural member sizes. Members obtained from concrete Classes 25, 30, 35 and the new compressive strengths from HPC (Class 80) were obtained and compared. Analysis was done for structural members' sizes and area freed as a result of designing with HPC as well as the steel reinforcement used.

Ankit Nileshchandra Patel 1, Prof. Jayeshkumar Pitroda 2, [10] This Research Study describes the feasibility of using the Stone Waste dust in concrete production as partial replacement of cement (OPC and PPC) and to reduce disposal and pollution problems. The innovative use of Stone Waste in concrete by replacing OPC and PPC cement with this material was the other alternative of the traditional concrete. The aim of this research is to replace the OPC and PPC cement by Stone Waste accordingly in the range of 0%, 10%, 20%, 30% 40%, & 50% by weight for M-25 Grade concrete. The Split Tensile Strength Test is carried out to evaluate the mechanical properties for 28 days. As a result, the Split Tensile Strength increased up to 30% replacing of Stone Waste in OPC and 20% replacing of stone waste in PPC. This research work is concerned with the experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing OPC and PPC cement via 0%, 10%, 20%, 30%, 40% and 50% of stone waste.

H. M. A. Mahzuz1*, A. A. M. Ahmed2 and M. A. Yusuf3, [11] in this study, the main concern is to find an alternative of fine aggregate. Substitution of normal fine aggregate 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 fine aggregate. 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 fine aggregate and brick chip. Concrete of stone powder and brick chip gained about 10% higher strength than that of the concrete normal fine aggregate 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 fine aggregate.

V. Syam Prakash, Dhanya Krishnan, G. Jeenu, [12] Increase in construction activities have led to an increase in demand for the various raw materials in concrete, especially river fine aggregate which is the conventionally used fine aggregate. Due to increase in mining process, the availability of this river fine aggregate is becoming scarce. This led to researches on alternate materials as ingredients of concrete that are in no way inferior to the conventional materials. Manufactured fine aggregate was one of the alternate materials proposed. Though manufactured fine aggregate has many advantages, one of the major areas of concern is the fine material of size 150 micron and down removed during the manufacturing process and accumulated as a waste material. The paper presents the laboratory investigations and a comparative study on the mechanical properties and behavior of high strength concrete and mortar using fine stone dust, the residue produced during the production of manufactured fine aggregate.

Saranya C. V, [13] The present study is focused on the influence of fiber addition in a high strength concrete mix by adding both the scrap extracted from waste flux sheet and lathe industrial waste. Now-a-days flux sheets are most widely used for various advertisement works which is non-biodegradable material. Hence the main focus in this paper to reuse the waste flux sheet and reduce soil pollution. HSC production and the application technologies are most updated. This study is the part of the research program on evaluating the performance of high strength concrete using lathe waste and Waste flux sheet. The compressive strength for all mix proportions of scrap combinations showed a favorable improvement in the strength properties due to crack arresting mechanism of fibers at different scales of cracking

Pooja Shrivastavaa, Dr.Y.p. Joshib, [14] This paper work assessment on the study of the workability and mechanical strength properties of the high strength concrete reinforced with industrial waste fibers. This waste steel scrap material which is available from the lathe is used as a steel scrapfor innovative construction industry and also in pavement construction. Lathe waste is generated by each lathe industries and dumping of these wastes in the barren soil contaminating the soil and ground water, which creates an unhealthy environment. In addition to get sustainable development and environmental benefits, lathe scrap as recycled fibers with concrete are likely to be used. Experimental studies are done to know about fresh and hardened concrete properties of SFRC and their mechanical properties such as compressive strength, flexural strength and split tensile strength are found to be increased due to the addition of steel scrap scrapin the concrete. When compared with conventional concrete to SFRC, steel scrapincreases flexural strength by 40% and considerable increase in compressive and tensile strength.

A Thirumurugan1 and M.Sivaraja2, [15] This paper investigated the shear, impact and fracture strengths of high-strength concrete reinforced with two different industrial waste fibers. Locally available steel lathe waste and nylon waste were used at different volume fractions as fiber cocktails in concrete. Steel lathe wastes were used as-received lengths and nylon fibers were chopped into 40 mm lengths in this investigation. In total, 12 hybrid mixes were casted and tested at four different volume fractions (0.5%, 1.0%, 1.5% and 2.0%). The experimental programmed was used the slump test and the air content test on the fresh concrete. The hardened concrete was tested for its shear and

impact strength. A flexural test on notched beams under three-point bending was also carried out according to the RILEM 50-FMC committee recommendations.. The best performance was obtained in hybrid which was enhanced due to the hybrid nature of the fiber cocktails of all the mixes, 2% volume fraction with a combination of steel ½ + nylon ½ fibers gives the best performance. The steel lathe waste fibers mainly contributed to limiting the crack initiation and lightweight non-metallic nylon fibers restricted the crack propagation. The combined advantages of these fibers provide high mechanical and fracture strength.

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