Experimental Analysis of Quarry Dust And Metallic Dust As A Partial Replacement of Fine Aggregate In Concrete

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Abstract- *Naturally available sand is most important component of concrete, currently it's very much costly due to over population or increasing infrastructure projects or in large scale depletion of naturally available resources creating ecological issues. For neglecting this problem we require alternative or efficient resources in construction industry. Quarry Dust is obtained by the process of quarrying; it's used as a filling materials and Metallic dust is a by-product of carbon steel which is obtained from industry. The demand of sand is increasing day by day in developing countries. So serious problem for thousands of workers labors and civil engineers has been arise due shortage of sand for construction. The construction industries one of the largest industries in the world, and sand is a crucial contributor in everything to do with construction materials. More than 50 billion tons of sand is used in construction globally. In this Thesis work sand is half replaced by Mild Steel Scrap or Quarry Dust. This Thesis is about the experimental study on Strength of Concrete of M20 Grade with half substitute of Sand by Mild steel Scrap and Quarry Dust.*

For the Analysis of Mechanical Properties of Concrete like Compressive Strengthening and Split Tensile Strengthening etc. different types of concrete mix prepared.

In earlier stage sand has been differentially replaced by 5% of Mild Steel Scrap or Quarry Dust having 10%, 15%, 20%, 25%, 30% partial replacement. In second stage sand has been differentially replaced by Mild Steel Scrap proportion of 10%, 15%, 20%, 25%, 30% and Quarry Dust by 40%, 35%, 30%, 25% and 20% partial replacement.

I had also done various trial of mix, control mix etc. Compressive Strength test was done on mould size cube 150 mm x150mm x 150mm for 7th or 28th days and Split Tensile Strength is also done by UTM machine. The entire concrete cube specimen was cured for 7th or 28th days in deep water tank on standard temperature of 27oC.

Keywords- Cube Compressive Strength, Mix Design, Mild Steel Scrap, Workability, Quarry Dust, metallic dust, Split Strength, UTM.

I. INTRODUCTION

Naturally available sand is most prominent for fine aggregate element of concrete, but heavily use of this material leading atmospheric concerns. Then its desire to attain cheap, environmental friendly substitutes for river sand. World average consumption of sand is generally around 1000 million tons per year. The extreme or non-scientific methods of mining sand creating the problem and as well as its also responsible for lower down water level and sinking of bridge. And its also creating environmental degradation like removal of minerals from topsoil due to erosion and making soil infertile so its directly affects the crop production, and leading to flood. Therefore civil engineers search alternative source in construction industry where we should be partly or completely replacing naturally available sand in concrete by using unwanted or unused materials which is obtained by recycling, and don't compromise the properties and quality of product. In the recent years, construction industries searched out many waste materials like fly ash, slag, limestone powder or silicious stone powder use in traditional concrete. Quarry dust is one of the waste materials which is obtained by stone crushing industry and its largely available waste and used for land filling purposes. Concrete is a vastly used construction material in world. Concrete having cement sand aggregate and water its enough hard and chemically inert. Concrete is used for many construction work. The process of selecting proper component of concrete. And determine their relative quantity with the purpose of obtain desire strength durability and workability of concrete and its called concrete mix design. For attain good strength and properties of fresh concrete and harden concrete several engineers or scientists are trying to find various unwanted or waste material which is responsible for giving same and equal strengthening to concrete. This addition material increases the strengthening or properties of harden as well as in fresh concrete. Another material like lathe steel scrap in concrete mix as fibrous material helps to

decrease the main solid waste such as lathe steel scrap from the steel manufacturing industries, which is a main concern in the world. First is the financial saving obtained by replacing a considerable part of the sand or other ingredients with these materials and second is an improvement in the properties of concrete. The environmental aspects of Sand are now taking more concern of researchers, as Sand developing is responsible for about a large amount of total worldwide waste emissions from manufacturing sources. The trend of mixing several kinds of additional materials in building engineering is now growing. This has a double advantage to diminish the extent of deposited Experimental Analysis of Quarry Dust and Metallic Dust as a Partial Replacement of Fine Aggregate in Concrete waste material and the second is to conserve natural resources for sustainable development. silica fume.

II. MATERIALS

The materials used in concrete mix projects are cement, fine aggregate, coarse aggregate, Fly ash, Glass Powder as described in detail below:

1. Concrete Composition: The most important purpose of this research is to calculate the effect on the mechanical properties of concrete when OPC is partially replaced by 10%, 20%, 30% and 40% of glass powder, fly-ash and their combinations. Different material and experimental tests are performed to check the quality of concrete. The materials should be appropriate for future use in concrete or doesn't hold harmful ingredients in some amounts that can damage the quality or durability of the concrete.

2. Cement: its one of the main imprtant component of concrete, since the binding medium for the distinct ingredients is created. Produced from naturally occurring raw materials and then mixing with toxic waste or underground. For the analysis, OPC 53 grades of Ordinary Portland Cement (OPC) conforming to IS12269-1987 were used. The mix configuration is made with ordinary Portland cement of grade 43. Concrete's most essential component is cement. The ability of cement to create improved microstructure in concrete is one of the most important criteria for cement selection. The hard Cement of Grade 43 was used in this analysis. Since it is an essential ingredient of concrete, mortar, stucco, and most non-specialty grout, Portland cement (often referred to as OPC, from ordinary Portland cement) is the most common form of cement in general use around the world.

3. Fine Aggregate: Aggregates that cover almost 70 to 75 % concrete volume are often used in more than one way as inert ingredients. This is well known now a day, however, that the (i) physical (ii) chemical (iii) thermal properties of aggregates drastically affect the property of 23 mm and concrete results. To extract all pebbles, fine aggregates (sand) use as fresh dry sand sewn in a 4.75 mm sieve. Clean river sand of maximum size 4.75 mm used such as fine aggregate.

4. Coarse Aggregate: For making concrete, coarse aggregate is used. They are generally in form of irregular broken stone, or gravel that naturally occurs. Coarse aggregates are called material that is wide to be held at 4.75 mm sieve size. Up to 20 mm may be its maximum span. And angular aggregate of size between 4.75mm to 20 mm is used as coarse aggregate.

5. Water: water plays an important role as it engages in a heat of hydration with cement. In concreting water is present in the form of gel which help to increase the concrete's strength. For mixing, portable water is usually considered satisfactory. The pH value of water shall not be lower than the maximum allowable values expressed in the following concentrations.

a) Limits of acidity: Not more than 5 ml of 0.02 NaOH should be needed to neutralize a 100 ml solution of water using phenolphthalein as an indicator. The test details are as stated in IS 3025.

b) Limits of alkalinity: Using a mixed indicator, neutralizing a 100 ml solution of water does not need more than 25 ml of 0.02 natural H_2SO_4. The specifics of the tests are as stated in IS 3025.

c) Percentage of solids: When measured in compliance with IS 3025, the maximum allowable limits of solids are as set out in IS 3025.

a) The chemical and physical properties of groundwater shall be tested in conjunction with the soil investigation and if there is no water found to comply with the necessities of IS 456-2000, it shall be clearly specified in the tender documents that contractor has to organize for the construction of good quality water indicating the source.

b) Water is to be found satisfactory for mixing as well as curing. For curing water shall not, however, create on the surface any undesirable stain or unsightly deposit.

c) For mixing or curing, sea water must not be used.

d) Water available for every source is to be tested before start any construction work and every three months thereafter until the end of work. In case of groundwater, different test can also be performed for a separate drawdown point.

6. Quarry dust Its a typical byproduct of mining and quarrying, and instead of being a waste product, it can be used in building. Quarry dust of a white colour was gathered from the Stone Development Centre (CDOS). Quarry dust can be

utilised as a low-cost sand replacement that improves concrete shrinkage and water demand. Its also use as concrete aggregate to create unique textures, as well as a concrete substitute when constructing paths and driveways. An experiment was perform to calculate out the impact of varying dust content proportions on the characteristics of fresh and cured concrete. Before preparing the mix, it was initially dry and completely kept on an IS 150 sieve. IS 383-1997 zone III was also validated by the Quarry dust. Stone dust had a fineness modulus of 3.15 and sp. gravity is 2.97

7. Mild Steel Scarp It's obtained from steel plant .it is ductile material it provide indication in form of yielding before fracture. In my work I used this material because it have thermal coefficient which is equal to the thermal coefficient of concrete and it also have young modulus which is approximately same to concrete. it is easily available because it is waste material and have less cost compare to other materials it is homogeneous and after sieve analysis I used this material in project. The automotive and other transportation industries, as well as agricultural and industrial equipment, building and construction, oil and gas, defence, machinery, and consumer goods industries, continue to employ iron and steel as their primary metals. About 70% of Canadian demands comes from the automobile, construction,oil and gas industries combined. Iron and steel have numerous advantages, including great strengthening, ease of fabrication, recycling, availability, and low cost. With highest every February result of 71.1 million metric tons1, Experimental Analysis of Quarry Dust and Metallic Dust as a Partial Replacement of Fine Aggregate in Concrete global crude steel output from the 63 countries reporting to the International Iron and Steel Institute set a new record. This is a 7.5 percent rise from February 2002's figures. In February, crude steel production in North America reached 9.7 million tonnes, up 4.7 % of same month in 2002. The steel market in North America accounts for roughly 18% of global demand. The United States makes up around 84 percent of the North American total, with Canada accounting for 11 percent and Mexico for 5%.

III. METHODOLOGY

3.1 CONCRETE MIX DESIGN AS PER IS 10262:2009

Target Mean Strength (*f*'ck) = *f*ck + (1.65 x S)
Where, S = Standard Deviation
fck = Characteristic Strength
f' ck =20+ (1.65x4) = 26.6 MPa or N/mm2
W.C.R. = 0.50
W.C. - 186 + (6x186)/100 (for estimated 100mm slump) = 197 litres
Cement content = 168/.50 = 394.21 Kg
394Kg/m3>300 Kg/m3
%Ratio of 10mm: 20mm = 40: 60 Volume of Concrete (A) = 1.00 m3
Volume of Cement (B) = 0.1256m3 Volume of Water (C) = 0.197 m3
Vol. of all in Aggregate (E) = A - (B+C+D) = 0.678 m3
Wt. of C.A. (F) = E x (% by weight) x Specific Gravity x 1000= 1159Kg
Therefore, Weight of 10 mm Coarse Aggregate = 463.44 Kg
20 mm Coarse Aggregate = 686.16 Kg
Weight of Fine Aggregate (G) = E x (% by weight) x Specific Gravity x 1000= 675 Kg

Table 3.1 mix design

proportion Cement	Aggregate		Water
F.A		C.A	
394kg/m3	675kg	1159kg	197 litre
1	1.8	3.2	

3.2 CASTING OF CONCRETE CUBES

First of all, lubricating oil is applied to all the moulds so that during opening time after 24 hrs will open mould easily without damaging the concrete cube and before pouring ensures that all the bolts of cubes are tight, this prevents the leakage of concrete mix and help in setting of perfect cube shape (150 mm × 150 mm × 150 mm).The concrete mix of M-20, grade was designed to. All mixer of concrete were mixed in Institute laboratory. Slump test were conducted on fresh concrete to determine slump, compaction factor for Workability. From each mix three cubes of standard sizes was casting to calculate the compressive strength. The cubes were compacted by standard vibration machine. After casting the strength of different concrete is determined for 7day, 14 day and 28days.

3.3CURING OF CUBES

After opening the cubes, cubes will be named for their specification by the help of water resistant paint & paint brush taken to the curing tank and rested there for 7th day, 14th day & 28th day with the cover of fresh and clean water. Specification denotes the cube specimen name; type of reinforcement shape used, casting date. During time period of curing of cubes, always watch the curing tank that water level does not reaches below the cubes due to concrete heat releasing property and then fill the tank to cover the cubes. water which is used for curing purpose must be tested at the interval of 7 days or temperature of water should be 27°C.
The cubes carry out from the tank safely and properly. After 28 days without shock put that cube in the tray for few hours

like ½ to 1 hour for releasing free running water from the concrete cubes. After this, the cubes are taken to the compressive strength testing machine to test compressive strengthning of cubes and note down the values

3.4 SLUMP TEST

Slump Cone Consist Of Cone Like Structure Which Is Used To Find Workability of freshen concrete .This test is done by the guidelines of IS: 1199-1959 and procedure followed to evaluate workability.

3.5 COMPRESSIVE STRENGTH

Compressive strength is capacity of material which withstand with load and resist compression at some extent. The size of specimens should be 150mm X 150mm X 150mm. As per IS: 516- 1959. This code suggest the method of testing for compressive strengthening of concrete. There should be at least 3 specimens of same mix should be prepared .And compressive strengthening was evaluated for 7 and 28 days respectively.

The procedure suggested by IS: 516-1959 is as follows:

The standard mould of size should be 150mm X 150mm X 150mm Grease should be applied between bottom surface of the mould and the side plate, to make sure that no water escape take place and prevent from adhesion of concrete. The mould should be filled in 3 layers with concrete and tamped by a steel rod of 16 mm dia. having 0·6 m long length. The concrete was compacted for 25 strokes per layer. At last surface finished was done by help of trowel. The moulds were kept at relative humidity of temperature of 27º ± 2°C for 24 hours ± 30 minutes at the time of water addition to the ingredients. After 24 hours ± 30, specimens were unmolded and further kept for curing for 7 & 28 days.

The cube was taken out from curing tank, clean & wipe the surface of specimen with dry cotton cloth. The specimen is put on compressive strength testing machine and the compressive strength was found out using the following formula:

Compressive strength = P/A (Unit: - N/mm2or MPa)
Where, P = Load (N) and A = Area of specimen (mm2)

3.6 SPLIT TENSILE STRENGTH

Tensile Strength Is Important Property Of Concrete However Concrete have so much less tensile strengthening in Comparison To compressive strengthening .This test done by Two indirect Methods.

- Split Cylinder Test
- Flexural Test

3.11.1 Split cylinder test: IS 5816:1999 was used to evaluate splitting tensile strengthening. The size of cylindrical specimen was 300mm (length) x 150mm (diameter).the specimens were tested after curing for 7 and 28 days. The test was performed on universal testing machine.

Splitting Tensile Strength:- split tensile strength = 2p/ΠLD (Unit=N/mm2or mpa)
Where P= Load (N)
L= Length of cylinder in mm
D =Diameter of cylinder (mm)

1)

IV. CONCLUSION

4.1 Conclusion for Mix 1

After analyzing the results for all tests including Slump test, Compressive Strength test, Splitting Tensile Strength test ,Following conclusions have been drawn in Mix 1 having 5 mixes (mix1,mix2,mix3,mix4,mix5) in which Quarry Dust and fine aggregate having different proportion and mild steel scrape having 5% (constant) proportion.

Mix ratio of M20 (cement: aggregate: sand+ Quarry Dust + Mild Steel Scrap) give the optimum strength in this study.

As the percentage of Quarry Dust + mild steel scrape gradually increases, Compressive strengthening of concrete will also increase with condition that percentage of Quarry Dust (20%) +mild steel scrap (5%) should not exceed (20+5) % and the strength is 20.52 N/mm2 for 7 days and 25.01N/mm2 in 28 days. After this proportion a slight decrement was observed which is shown in table 4.5 and 4.6. The compressive strengthening of concrete increases with the increase of age of maturity.

The split tensile strengthening of Mix 1 tends to increases up to 20% then decrement of concrete strength observed. According to compressive strength its value is high and shows that Quarry Dust + mild steel scrap is preferable for use as sand replacement up to (20+5)%. Every values of C.S. surpasses the min. values of C.S. for normal concrete So, Quarry Dust + mild steel scrape can apply as sand replacement in concrete . The workability of concrete is decreased by

adding % of Quarry Dust. But its overcome by addition of metallic dust, because it increases the workability of concrete.

4.2 Conclusion of Mix 2

The strength characteristic and split tensile strengthening of concrete work have been analyze .In This thesis work, replacement of sand by Quarry Dust and mild steel scrape of proportion (40+10), (35+15), (30+20), (25+25), (20+30) percentage replaced in sand .After analyzing the results for all tests including Slump test, Compressive Strength test, Splitting Tensile Strength test, Following conclusions have been drawn in Mix 2 having 5 mixes (Mix1, Mix2, Mix3, Mix4, Mix5) in which Quarry Dust and mild steel scrape having different proportion and sand having 50% (constant) proportion.

The compressive strength is gradually increased as the % of Quarry Dust (20% decreases) and mild steel scrap (30% increased) is increased and the value of compressive strengthening is 39.04 N/mm2 for 7 days and 49.12 N/mm2 in 28 days. The split tensile strengthening is also increased at increase percentage of mild steel scrap and decrease % of Quarry Dust is 2.08N/mm2 for7 days and 2.85N/mm2 in 28 days. The early age strength gains higher as compare to normal mix. The split tensile strengthening of Mix 2 tends to increases up to (20+30)% This study has brought out positive results that compressive strength and split tensile strengthening is increased as the Quarry Dust and mild steel scrape increased. The workability of concrete is decreased by adding some % of Quarry Dust. But its overcome by addition of metallic dust, and its increases the workability.

REFERENCES

[1] Ananthayya M.B Prema Kumar W. P., Vijay K. " Effect On Sand Partially Replaced By Iot And Cement Partially Replace By Ggbfs" *Ijert International Journal Of Engineering Research & Technology* Ijert Volume. 3 Issue 8 August 2104,

[2] Bahoria Parbat D.K And Naganaik P.B "Replacement Of Natural Sand By Waste Product" *Jerd Journal Of Environmental Research And Development* Volume. 7 June 2013

[3] Baskaran Karthickkumar., Krishnamoorthysaravanan,Hemath Naveen, Effect Of Replacement Of Sand By Ggbs (Ground Granulated Blast Furnace Slag) The Properties Of Concrete", *Ssrg International Journal Of Civil Engineering (Ssrg-Ijce)*- Vol. 3 Issue 6, April 2017

[4] Is 10262-2009, Recommended Guidelines For Concrete Mix, Bureau Of Indian Standard, New Delhi.

[5] Is: 10262-1982,"*Guidelines For Concrete Mix Design*", Bureau Of Indian Standards, New Delhi, India.

[6] Is: 2386-1963 (Part I To Part Iii), " *Indian Standards Method Of Test For Aggregate Forconcrete*", Bureau Of Indian Standards, New Delhi, India.

[7] Is: 383-1970, " *Indian Standard Specification For Coarse And Fine Aggregates Fromnatural Source For Concrete*", Bureau Of Indian Standards, New Delhi, India.

[8] Is: 456-2000, " *Plain And Reinforced Concrete - Code Of Practice*" Bureau Of Indian Standards, New Delhi, India.

[9] Is: 516-1959, " *Indian Standard Code Of Practice-Methods Of Test For Strength Ofconcrete*", Bureau Of Indian Standards, New Delhi, India.

[10] Is: 5816-1999, " *Method Of Test Splitting Tensile Strength Of Concrete"* , Bureau Of Indian Standards, New Delhi, India.

[11] Is: 8112-1989, " *Specifications For 43-Grade Portland Cement*", Bureau Of Indian Standards, New Delhi, India.

[12] Is: 9013-1978, " *Method Of Making, Curing And Determining Compressive Strength Of Cured Concrete Test Specimens*", Bureau Of Indian Standards, New Delhi,India.

[13] *Jain Achal, Thakur Nitin,* "Effect Of Replacement Of Sand By Glass Powder And Steel Powder Properties Of Concrete" Ijarit *International Journal Of Advance Research, Ideas And Innovations In Technology*, Vol. 4 Issue 3, Mayl 2017.

[14] K. Karthika, G. Snekha, R Sinduja, S Priyadharshini, "Experimental Study Of Quarry Dust And Metallic Dust As A Partial Replacement Of Sand" *Ijert International Journal Of Engineering Research And Techonology* Volume. 6, Issue 7 July 2017

[15] M.S Shetty, Concrete Technology, New Delhi: S.Chand& Company Ltd, 2012.

[16] N.Sreeivasulu,A.Roopa,M.Venkateswarlu,P.Pavani, "A Case Study On Couper Slag As Partiall Replacement Of Fine Aggregate" *Irjet International Research Of Journal Of Engineering And Technology, Ideas And Innovations In Technology*, Vol. 3 Issue7, July 2016.

[17] *Pujitha .B, Swathi .N, Saheb Sk. Jain*, " Experimental Investigation Of Compressive Strength Properties Of Eco Friendly Concrete" (Plastic Waste And Rubber Tyre)(Ijarit) *International Journal Of Advance Research, Ideas And Innovations In Technology*, Vol. 3 Issue 6, April 2017.

[18] Shankar Meena, Rashmi Sakalle, Nitin Tiwari, "An Experimental Study Of Concrete As A partial Replacement Of Sand With Quarry Dust And Steel powder",Irjet, *International Research Of Journal Of Engineering And Technology*, Vol. 5 Issue5, May 2018.

[19] Shilpa Thakur, Amit Mittal, " M Sand As Fine Aggregate Replacement In Concrete: Effect On Compressive

Strength" *Int. Journal Of Engineering Research And Application Vol. 8, Issue5 (Part -Ii) May 2018,*

[20] Sumi Chauhan, Raju A.Bondre " The Experimental Study To Investigated The Partial Replacement Of Sand With Quarry Dust," *International Journal Of Scientific And Research Publications,* Volume 5 Issue 7, July 2015.