PARTIAL REPLACEMENT OF FINE AGGREGATES WITH QUARRY DUST AND MARBLE POWDER IN CONCRETE

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Abstract- Quarry dust and Marble powder are the most used among such materials to replace river sand, which can be used as alternative to fine aggregate in concrete. In the present investigation workability and strength of concrete was evaluated by replacement of natural sand by Quarry dust and marble powder in equal proportions of 0%,10%, 20%, 30%,40%,50% and 60% is studied for M25grade concrete cubes. Slump cone method is taken for finding workability. For strength parameters for each grade of concrete Cubes were casted and tested at the age of 7 and 28 days. In this present experimental study on concrete having grades of M25 are prepared by replacing natural sand by Quarry dust and Marble powder.

The main cause of concern is the non-renewable nature of natural sand and the corresponding increasing demand of construction industry. River sand which is one of the basic ingredients in the manufacture of concrete has become highly scarce and expensive. Therefore looking for an alternative to river sand has become a necessity. Hence, the crusher dust which is also known as Quarry dust and Marble powder can be used as an alternative material for the river sand. Quarry dust and Marble powder contains similar properties as that of river sand and hence accepted as a building material. The present paper focuses on investigating maximum percentage replacement of river sand by Quarry dust and Marble powder in varying equal percentages 0%, 10%, 20%, 30%, 40%, 50%, and 60% for M25 mix designations. The cubes and cylinders are casted for each proportion and tests conducted for obtaining the compressive strength, split tensile strength of concrete.

Keywords: Quarry dust**,** Marble powder**,** Natural sand**,** Workability**,** Compressive Strength**,** Split Tensile Strength.

I. INTRODUCTION

Concrete is a widely used creation fabric such as cementing fabric, satisfactory mixture, coarse mixture and required quantity of water, where within the great mixture is generally natural sand. The use of sand in creation outcomes in excessive sand mining which is objectionable. Due to fast growth in production pastime, the to be had resources of natural sand have become exhausted. Also, properly first-class sand may additionally have to be transported from lengthy distance, which provides to the price of construction. In some cases, natural sand won't be of good first-class. Therefore, it's far necessary to update herbal sand in concrete by means of an exchange fabric both partly or completely without compromising the satisfactory of concrete. CRP is one such cloth which may be used to update sand as great aggregate. CRP is likewise generally known as QUARRY DUST. The gift task is geared toward using Crushed Rock Powder (CPR)/Quarry dust (QD) as exceptional aggregate in cement concrete, changing natural sand. The observe on concrete includes determination of compressive strength and cut up tensile energy of different grades of concrete.

Properties of mixture affect the sturdiness and performance of concrete, so satisfactory mixture is an important element of concrete. The maximum generally used exceptional combination is herbal river or pit sand. Fine and coarse mixture constitute approximately 75% of total volume. It is therefore, critical to acquire right type and precise first-rate aggregate at web page, due to the fact the combination shape the principle matrix of concrete or mortar. The global consumption of herbal sand may be very excessive, due to the significant use of concrete. In widespread, the call for of natural sand is quite high in developing countries to meet the fast infrastructural increase, in this example developing united states like India facing scarcity in proper nice herbal sand. Particularly in India, herbal sand deposits are being depleted and inflicting extreme hazard to environment in addition to the society. Increasing extraction of natural sand from river beds causing many issues, loosing water retaining sand strata, deepening of the river publications and inflicting bank slides, lack of vegetation on the financial institution of rivers, exposing the intake nicely of water supply schemes, disturbs the aquatic lifestyles in addition to affecting agriculture due to lowering the underground water table and many others are few examples. In past decade variable price of natural sand used as first-class combination in concrete elevated the fee of construction. In this situation research commenced for less expensive and without difficulty available alternative fabric to natural sand.

Some alternatives materials have already been used as part of natural sand e.G. Slag limestone and siliceous stone powder were utilized in concrete combinations as a partial replacement of herbal sand. However, scarcity in required satisfactory is the predominant challenge in a number of the above substances. Now an afternoon's sustainable infrastructural increase demands the alternative fabric that have to fulfill technical requirements of pleasant combination as well as it ought to be to be had abundantly.

Conventionally concrete is mixture of cement, sand and aggregate. Properties of aggregate affect the durability and performance of concrete. Generally cement and coarse aggregates is factory made products and their quality and standards can be easily controlled and maintained. Water used for mixing of concrete is usually tap water. Fine aggregate is an essential component of concrete. The most commonly used fine aggregate is Natural River sand .Now a day's good sand is not readily available; it should be transported from long distance. Those resources are also exhausting very rapidly .Now-a-days huge extraction of natural aggregates, due to constant sand mining the natural sand is depleting at an alarming rate, which occupy 65 to 80% of the total volume of concrete. Out of the total composition of concrete, fine aggregate consumes 20 to 30 % of volume. Natural sand is mainly excavated from river beds and always contain high percentage of in organic materials, chlorides, sulphatates, silt and clay that adversely affect the strength, durability of concrete & reinforcing steel there by reducing the life of structure, when concrete is used for buildings in aggressive environments, marine structures, nuclear structures, tunnels, precast units, etc. Fine particles below 600 microns must be at least 30 % to 50% for making concrete will give good results. Normally these particles are not present in river sand up to required quantity. The deep pits dug in the river bed, affects the ground water-level.

When fine particles are in proper proportion, the sand will have lessvoids. The cement required will be less when there will be less void in sand. Such sand will be more economical. Sand dragging from river beds have led to several environmental issues. Due to various environmental issues Government has banned the dragging of sand from rivers. This has led to a scarcity and significant increase in the cost of natural sand. Scarcity of good quality Natural River sand due to depletion of resources and restriction due to environmental consideration has made concrete manufactures to look for suitable alternative fine aggregate. One such alternative is "Manufactured sand".It is also called as robo sand or m sand. Robo sand or M sand is a product of crushed stone, here the stones are crushed into smaller granular sizes that are to the size of river sand granules and washed to remove the fine rock dust to enhance the quality.

Fig.1 quarry dust mining

The following are some advantages of the Quarry dust:

- The cubical particle shape makes concrete more cohesive.
- A perfect gradation ensures fever voids and increases the compressive strength.
- Well balanced physical and chemical properties in quarry dust makes for more durable building.
- Quarry dust is produced under controlled conditions with raw materials from a single source resulting very consistence quality with no seasonable fluctuations.
- The complete absences of deleterious materials eliminate wastage and workout economical for use in concrete.
- An optimum level of fine content helps overcome deficiencies of concrete such has segregation, bleeding, voids and honey combing.
- Easy availability of quarry sand in huge quantities around the year leads to execution of construction projects on time.
- quarry sand is a eco-friendly product and its usage helps conserve nature by preventing depletion of ground water table
- quarry sand is used for both site mixed concrete and ready mixed concrete.
- The relative higher specific gravity of quarry sand compared to natural sand results in less coverage of area.

II. LITERATURE REVIEW

B. V.M. Sounthararajan et.al (2013) A Study has been conducted on Effect of the Lime Content in MDP for Producing High Strength Concrete. They found that the MDP up to 10% by weight of cement was investigated for hardened concrete properties. Furthermore, the effect of different percentage replacement of MDP on the compressive strength, splitting tensile strength and flexural strength was evaluated. It can be noted that the influence of fine to coarse aggregate ratio and cement-tototal aggregate ratio had a higher influence on the improvement in strength properties. A phenomenal increase in the compressive strength of 46.80 MPa at 7 days for 10% replacement of MDP in cement content was noted and also showed an improved mechanical property compared to controlled concrete

C. Corinaldesi V et al., (2010) Marble as a building material especially in palaces and monuments has been in use for ages. However the use is limited as stone bricks in wall or arches or as lining slabs in walls, roofs or floors, leaving its wastage at quarry or at the sizing industry generally unattended for use in the building industry itself as filler or plasticizer in mortar or concrete. The result is that the mass which is 40% of total marble quarried has reached as high as millions of tons. This huge unattended mass of marble waste consisting of very fine particles is today one of the environmental problems around the world.

III. METHODOLOGY OF EXPERIMENTAL WORK

In this study it deals with the materials that are used in the study, namely: Cement, Coarse aggregate, Fine aggregate and crushed rock powder. The test methods adopted to measure the properties of Concrete such as Compression Test, Split tensile Test are to be explained. Compression and split tensile tests are conducted on cubes of standard dimensions respectively. Based on the result of the tests conducted in the laboratory, conclusions are drawn.

MATERIALS USED:

CEMENT:

Cement is a binder material which sets and hardens independently, and can bind other materials together. Cement is made up of four main compounds tricalcium silicate (3CaO SiO2), dicalcium Silicate (2CaO SiO2), tricalcium acuminate (3CaO Al2O3), and tetra-calcium aluminoferrite (4caco Al2O3 Fe2O3).tetra-calcium aluminoferrite (4CaO Al2O3 Fe2O3). In an abbreviated notation differing from the normal atomic symbols, these compounds are designated as C3S, C2S, C3A, and C4AF, where C stands for calcium oxide (lime), S for silica and A for alumina, and F for iron oxide. Small amounts of uncombined lime and magnesia also are present, along with alkalis and minor amounts of other elements.

Cement is material, generally in powder form, that can be made into a paste usually by the addition of water and, when molded or poured, will set into a solid mass. Numerous organic compounds used for adhering, or fastening materials, are called cements, but these are classified as adhesives, and term cement alone means a construction material. The most widely used of the construction cements is Portland cement. It is a bluish gray colour obtained by finely grinding the clinker made by strongly heating an intimate mixture of calcareous and argillaceous minerals. The chief raw material is a mixture of high calcium lime stone, known as cement rock, and clay or shale. Blast furnace slag may also be used in some cements is called Portland slag cement. The colour of the cement is due chiefly to iron oxide. In absence of impurities, the colour would be white, but neither the colour nor the specific gravity is a test of quality.

Ordinary Portland cement is by far the most important type of cement. Prior to 1987, there were only one grade of OPC which is governed by IS 269-1976.After 1987 higher grade cements were introduced in India. The OPC was classified into three grades, namely 33 grade, 43 grade, 53 grade depending upon the strength of the cement at 28 days when tested as per IS 4031-1988. If the 28 days strength is not less than 33 N/mm2, it is called 33 grade cement. If the strength is not less than 43 N/mm2, it is called 43 grade cement. If the strength is not less 53 N/mm2, it is called 53 grade cement. But the values of actual strength obtained by this cements at the factory are much higher than BIS specifications.

Ordinary Portland cement 43 grade was used conforming to IS 456-2000 and physical property was given below:

AGGREGATES:

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. Earlier, aggregates were considered as chemically inert materials but now it has been recognized that some of the aggregates are chemically active and also that certain aggregates exhibit chemical bond at the interface of aggregate and paste. The mere fact that the aggregates occupy 70-80 per cent of the volume of concrete, their impact on various characteristics and properties of concrete is undoubtedly considerable. To know more about the aggregates which constitute major volume in concrete.

Aggregates are divided into two categories from the consideration of size .

- Coarse aggregates
- Fine aggregates

The size of the aggregate bigger than 4.75 mm is considered as coarse aggregates and aggregate whose size is 4.75 mm and less is considered as fine aggregates.

All aggregates are to be sampled properly before taking them for testing. The purpose of sampling is to get representative material for testing the wrong sampling of aggregate may lead to any of the following:

- Consuming of bad quality of aggregates in concrete by accepting the bad quality of materials at site Disputing with the suppliers.

FINE AGGREGATES:

Fine aggregates or sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by size of the grains or particles, but is distinct from clays which contain organic materials.

Sands that have been stored out and separated from the organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains. Usually commercial sand dunes originally formed by the action of winds.

Much of the earth's surface is sandy, and these sands are usually quartz and other siliceous materials. The most useful commercially are silica sands, often above 9% pure. Beach sands usually have smooth, spherical to overload particles from the abrasive action of waves and tides and are free of organic matter. The white beach sands are largely silica but may also be of zircon, monazite, garnet, and other minerals, and are used for extracting various elements. Sand is used for making mortar and concrete and for polishing and sand blasting.

River sand was used throughout the investigation. The sand was air dried andsieved to remove any foreign particles prior to mixing.

Sand conforming to Zone-III was used as the fine aggregate, as per I.S 456-2000. The sand was air dried and free from any foreign material, earlier than mixing.

COARSE AGGREGATES:

Coarse aggregates are the crushed stone is used for making concrete. The commercial stone is quarried, crushed, and graded. Much of the crushed stone is granite, limestone, and trap rock.

The last is a term used to designate basalt, gabbros, diorite, and other dark coloured, fine grained igneous rocks. Graded crushed stone usually consists of only one kind of rock and is broken with sharp edges. The sizes are from 0.25 to 2.5 in (0.64 to 6.35 cm) although larger sizes may be used as coarse aggregates. The maximum size of coarse aggregates was 20 mm and specific gravity of 2.70.

Rainbow granite may have a black or dark green background with pink, yellowish, and reddish mottling or it may have a pink or lavender background with dark mottling. Crushed granite stone aggregates 10 to 20 mm size was used for cement concrete for comparison. Granite concrete was produced as normal weight concrete to compare with coconut shell aggregate concrete. The bulk density, specific density, water absorption, aggregate impact value, aggregate crushing value, aggregate abrasion value, and particle size distribution were determine

Water:

The quality of water is important because contaminants can adversely affect the strength of concrete and cause corrosion of the steel reinforcement. Water used for producing and curing concrete should be reasonably clean and free from deleterious substances such as oil, acid, alkali, salt, sugar, silt, organic matter and other elements which are detrimental to the concrete or steel. If the water is drinkable, it is considered to be suitable for concrete making. Hence, potable tap water was used in this study for mixing and curing. The PH value of water should be in between 6.0 and 8.0 according to IS 456 – 2000.

IV. RESULTS AND DISCUSSIONS

TEST RESULTS:

After conducting the necessary tests on materials for mix design and the concrete with various proportions are prepared and tested for its workability as slump cone and compaction factor test with the strength of concrete assessed by compressive strength test and spilt tensile test .

WORKABILITY TESTS:

The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product. Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labor and appearance of the finished product. Concrete is said to be workable when it is easily placed and compacted homogeneously i.e. without bleeding or Segregation. Unworkable concrete needs more work or effort to be compacted in place, also honeycombs &/or pockets may also be visible in finished concrete. . Two tests basically have done for workability namely slump test and compaction factor test with fresh mix.

STRENGTH TESTS:

Strength test results are used to find out the resistive strength of the material when we used that material. In this experiment we conduct two strength tests namely COMPRESSIVE STRENGTH AND SPILT TENSILE STRENGTH

WORKABILITY TEST RESULTS:

SLUMP CONE TEST VALUES:

Replacement percentage Sand : Quarry dust : Marble powder	Slump values in mm
100 : 0: 0	70
90 : 5: 5	67
80 : 10 : 10	64
70 : 15 : 15	60
60 : 20 : 20	55
50 : 25 : 25	53
40 : 30 : 30	50

GRAPH OF SLUMP CONE VALUES:

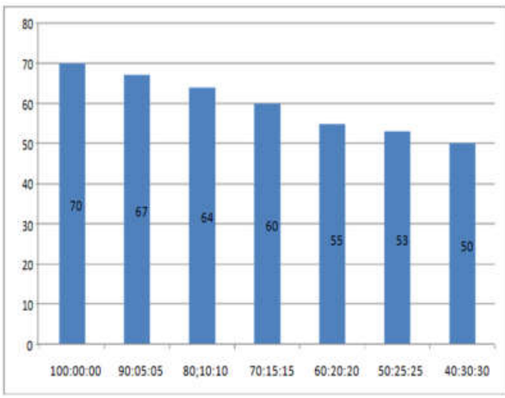

Fig.2 Graph of slump cone values

COMPACTION FACTOR RESULTS:

Replacement percentages Sand : Quarry dust : Marble powder	Compaction factor values
100 : 0 : 0	0.922
90 : 5 : 5	0.914
80 : 10 : 10	0.905
70 : 15 : 15	0.891
60 : 20 : 20	0.870
50 : 25 : 25	0.869
40 : 30 : 30	0.855

GRAPH OF COMPACTION FACTOR VALUES:

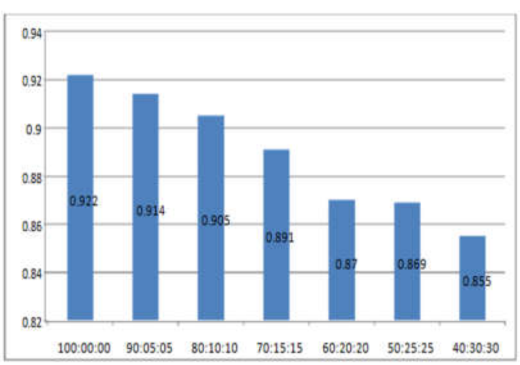

Figure.3 Graph of compaction factor values

STRENGTH TEST RESULTS:

COMPRESSIVE STRENGTH VALUES:

For 7 days

S no	Replacement percentage Sand Quarry dust(QD) Marble powder(MP) Sand:QD:MP	Compressive strength values At 7 days N/mm^2			Final compressive Strength value N/mm^2
		Cube1	Cube2	Cube3	
1	100:0:0	21.78	21.52	21.73	22.21
2	90 : 5 : 5	21.76	22.15	21.86	22.54
3	80 :10:10	21.96	22.53	22.58	23.97
4	70:15:15	21.83	23.65	21.83	24.12
5	60 : 20 : 20	23.67	23.82	24.77	24.89
6	50 : 25 : 25	23.92	25.83	26.93	25.59
7	40 : 30 : 30	20.17	218	21.23	21.12

GRAPH OF COMPRESSIVE STRENGTH AT 7 DAYS VALUES:

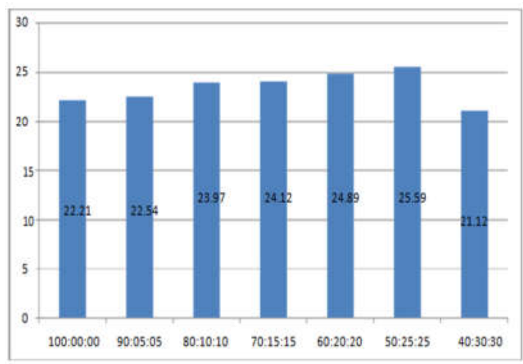

Fig.4 Graph of compressive strength values at 7 days

For 28 days

S no	Replacement percentage Sand Quarry dust(QD) Marble powder(MP) Sand : QD : MP	Compressive strength values at 28 days N/mm^2			Final compressive Strength value N/mm^2
		Cube1	Cube2	Cube3	
1	100 : 0 : 0	29.97	31.77	32.22	31.67
2	90 : 5 : 5	31.93	31.57	31.71	32.09
3	80 : 10 : 10	31.97	32.82	34.68	33.12
4	70 : 15 : 15	33.17	34.83	33.87	33.97
5	60 : 20 : 20	33.67	34.31	35.67	34.52
6	50 : 25 : 25	34.67	34.81	34.78	35.37
7	40 : 30 : 30	32.04	33.12	33.60	33.12

GRAPH OF COMPRESSIVE STRENGTH AT 28 DAYS VALUES:

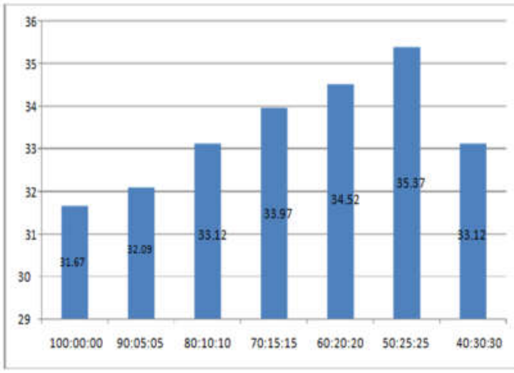

Fig.5 Graph of compression strength values at 28 days

SPLIT TENSILE VALUES:

For 7 days

S no	Replacement percentage Sand Quarry dust(QD) Marble powder(MP)	Split tensile strength values at 7 days N/mm^2			Final split tensile Strength value
	Sand : QD : MP	Cylinder 1	Cylinder2	Cylinder3	N/mm^2
1	100 : 0 : 0	1.85	2.0	2.12	1.90
2	90 : 5 : 5	1.94	2.15	2.28	2.11
3	80 : 10 : 10	2.17	2.25	2.31	2.23
4	70 :15 :15	2.28	2.41	2.35	2.30
5	60 :20 :20	2.31	2.38	2.41	2.37
6	50 :25 :25	2.28	2.37	2.49	2.41
7	40 :30 :30	2.05	2.01	2.12	2.06

GRAPH OF SPILT TENSILE STRENGTH VALUE AT 7 DAYS:

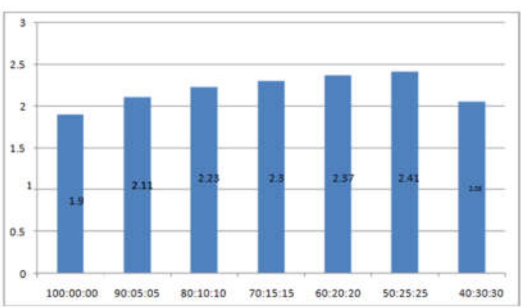

Fig.6 Graph of spilt pensile strength values at 7 days

For 28 days

S no	Replacement percentage Sand Quarry dust(QD) Marble powder(MP)	Split tensile strength values at 28 days N/mm^2			Final split tensile Strength value
	Sand : QD : MP	Cylinder1	Cylinder2	Cylinder3	N/mm^2
1	100 : 0 : 0	2.94	3.15	3.29	3.17
2	90 : 5 : 5	3.36	3.25	3.48	3.35
3	80 :10 :10	3.38	3.48	3.52	3.42
4	70 :15 :15	3.31	3.58	3.79	3.52
5	60 :20 :20	3.47	3.61	3.52	3.60
6	50 :25 :25	3.58	3.70	3.75	3.72
7	40 : 30 : 30	3.31	3.38	3.42	3.37

GRAPH OF SPILT TENSILE STRENGTH VALUE AT 28 DAYS:

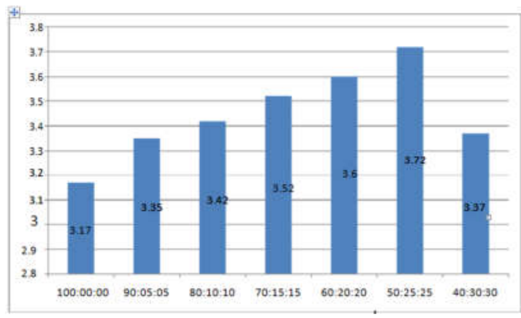

Fig.7 Graph of split tensile values at 28 days

V CONCLUSION

After conducting all testes like workability, compression strength and split tensile strength tests on the prepared cubes and cylinders with the replacement of sand with **quarry dust and marble powder concrete.** The above all results were obtained, with those the following conclusions are drawn:

- The replacement of fine aggregates is done in the combination of quarry dust and marble powder in equal proportions
- Workability of concrete mix decreases with increase in quarry dust and marble powder content.
- The concrete (After replacement) is acceptable with the values obtained
- The compressive strength of concrete increases up to 50% of replacement(25% quarry dust+25% marble powder)
- The spilt tensile strength of concrete increases up to 50% of replacement(25% quarry dust+25% marble powder)
- The strength of concrete increases because of the rough texture of quarry dust and marble powder which providing higher bonding while reducing the workability compared to conventional concrete
- We also concluded that environmental pollution is reduced by using quarry dust and marble powder as replacement

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