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EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF SAND WITH M-SAND AND CEMENT WITH DOLOMITE POWDER IN CEMENT CONCRETE

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Abstract: Cement is one of the most important constituents of concrete. Most of the properties of concrete depend on cement. Cement is manufactured by calcining argillaceous and calcareous materials at a high temperature. During this process, large amount of CO2 is released in to the atmosphere The properties of materials for cement, fine aggregate, coarse aggregate, sand with M-sand were studied for mix design. The various strength of concrete like compressive, split tensile, flexural were studied for various replacement of fine aggregate using sand with M-sand that are 0%,20%, and 40%.Dolomite powder has some similar characteristics of cement. Using dolomite powder in concrete can reduce the cost of concrete and may increase the strength to some extent. and cement with Dolomite powder in cement concrete. The replacement percentages tried were 0%, 20%, and 40% by weight of cement. The results indicate that replacement of cement with dolomite powder increases the compressive, split tensile and flexural strengths of concrete.

Keywords: Dolomite Powder, Compressive strength, Split tensile strength, flexural strength.

I. INTRODUCTION

Cement is the essential building material utilized in the greater part of the building structure. Numerous materials are utilized to make great quality concrete. Cement, coarse aggregates, fine aggregates, chemical admixtures, mineral admixtures, water are the constituents of concrete. Cement is the most significant constituent material, since it holds together the aggregates and opposes the climatic activity. Be that as it may, production of cement transmits about 0.8 tons of Co2 into the air for 1 ton of cement made. Dolomite is a carbonate material made out of Calcium Magnesium Carbonate (CaMg(Co3)2). Dolomite is a stone forming mineral which is noted for its astounding wettability and dispersibility. Dolomite has a decent enduring weather resistance. Dolomite is favored for building material because of its higher surface hardness and thickness. Dolomite is preferred as a filler material for asphalt and concrete applications as it has higher strength and hardness.

Definition of M-sand:

Crushed stone sand is produced by crushing boulders. Manufactured sand is produced by rock-on-rock or rockon-metal Vertical Shaft Impactor (VSI) in which the process that produced alluvial deposits is closely simulated. Particle size reduction and achieving equidimensional shape is critical to get desired properties. If rock is crushed in compression lot of inherent properties exhibited by natural river sand are lost.

SAND:

- Sand is a naturally occurring granular material composed of finely divided rock and mineral particles.
- the most common constituent of sand is silica (silicon dioxide, or SiO2), usually in the form of quartz.

ADVANTAGES OF COPPER SLAG:

- Reduces the construction cost due to saving in material cost.
- Reduces the heat of hydration.
- Refinement of pore pressure.
- Reduces permeability.
- Reduces the demand for primary natural resources.
- Reduces the environmental impact due to quarrying and aggregate mining.

Aspects of River sand

Now-a-days, Vastu Shastra is more popular, consults Vastu by many people while constructing a house. As per Vastu Shastra, the building material must be free from traces of human or animal body. The river sand contains bones of human beings and animals. The shells are also a kind of bone. It is not easy to take out all such things present in the river sand. Hence, the best solution for this is to use artificial/crushed sand of good quality for human wellbeing.

Advantages of Dolomite Powder:

- Dolomite has good weathering resistance
- Higher degree of purity, wet ability and whiteness.
- Dolomite is popular for its shear and compressive strength.
- Fire resistive and solid. ¬ Long lasting life and stiffness.

Need of the study:

Concrete is widely used in making architecture structure, foundation, highway construction, runway, parking structure, pools/reservoir, pipes, concrete making, and concrete consist of mainly sand which is about 35%, It may be natural sand made from river or artificial sand there are many kinds of rocks could be used to make sand there are granite, pebbles, basalt etc. In construction industry natural sand is used as an important building material and world consumption of sand in concrete alone is around 1000 million tons per year making it scarce and limited.

II. LITERATURE REVIEW

Kamal M.M, (2012) evaluated the bond strength of self-compacting concrete mixes containing dolomite powder. The result showed that the bond strength increased as the replacement of Portland cement with dolomite powder increased. All SCC mixes containing dolomite powder up to 30 % yielded bond strength that is adequate for design purpose.

Deepa Balakrishnan S and Paulose K.C (2013) carried out an investigation on the workability and strength characteristics of self-compacting concrete containing fly ash and dolomite powder. They made high volume fly ash self-compacting concrete with 12.5percent, 18.75percent, 25percent and 37.5percent of the cement (by mass) replaced by fly ash and 6.25percent, 12.5percent and 25percent of the cement replaced by dolomite powder.

Bhavin K, (2013) presented the details of the investigation carried out on paver blocks made with cement, dolomite block and different percentages of polypropylene fibres.They reported that addition of 0.3% and 0.4% of polypropylene fibres improved the abrasion resistance and flexural strength of paver block.

Salim Barbhuiya (2011) carried out an investigation to explore the possibilities of using dolomite powder for the production of SCC. Test results indicated that it is possible to manufacture SCC using fly ash and dolomite powder.

III. METHODOLOGY

Mix design for self-compacting concrete (SCC) are made using the properties constituents of concrete. Grade of concrete is taken as M40 and the mix design are done as per IS:10262-2009 and IS: 456-2000 for different dolomite powder percentage replacing of cement, using M-sand as fine aggregate. All mixtures are prepared for room temperature.

- •Test specimens of prescribed mix designs are done and allowed them to cure in water for 7, 14 and 28days at room temperature.
- •Finally, tests on Compressive Strength, Split Tensile Strength on 7th ,14th, and 28th day respectively

Materials:

a) Cement b) coarse aggregate c) Fine aggregate(river sand), d)M-sand, e) copper slag, f) Sulphonated Naphthalene Formaldehyde SP430, g)Water. a) Cement: Ordinary Portland Cement of 53-grade was used as it satisfied the requirements of IS: 269- 1969 and results have been tabulated in table

Properties of cement	
Specific gravity	3.15
Consistency	33%
Fineness	6.3
Initial Setting Time	45 minute
Final Setting Time	480 minutes

Coarse Aggregate: coarse aggregate shall comply with the requirement of IS 383 as for as possible crushed Aggregate shall be used for ensuring adequate durability. The aggregate used for concrete the nominal maxi size of coarse aggregate used in Production of shall be 20 mm.

Fine aggregate: Fine aggregate shall conform to requirement of IS 383 for river sand

Test	Types of Aggregate		
	Coarse	Fine	copper
Specific Gravity	2.9	2.88	3.51
Water Absorption	0.5%	3.5%	Nil
Moisture content	Nil	Nil	Nil

Cement:

Cement, commonly Portland cement, and other cementitious materials such as fly ash and slag cement, serve as a binder for the aggregate. The cement used in this study is of OPC 53 grade conforming to IS 12269

Dolomite Powder:

The dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate and it is also used to describe as sedimentary carbonate rock. Dolomite is also known as dolostone. The dolomite powder is the crushed mineral from dolostone. The dolomite powder is used to replacement of cement.

Dolomite powder

Design Mix procedure:

Due to many reasons, it shows no sign of decreasing any time soon, hence found the concept of M sand, which was much cheaper, compared to river sand. The M-sand which is formed by the crushing of aggregates loses its angularity. Either of these two different fine aggregates is the main component deciding the strength of the mortar. The aggregates have an impact on mechanical and also rheological properties of cement mortars. In the new state, Physical properties, shape, Particle-size distribution and surface notably impact different properties of mortar. In the solidified state, Elasticity modulus, Mineralogical structure, durability, and level of adjustment of Aggregates are by and large found to influence their properties.Here an effort has been completed to accumulate the various studies done on the replacement of copper slag in fine aggregate to judge the strength of concrete.

Dolomite powder in concrete mixing

M40 Grade Concrete Mix Design Procedure

The mix design M-40 grade for Pier (Using Admixture – Fosroc) provided here is for reference purpose only. Actual site conditions vary and thus this should be adjusted as per the location and other factors.

- Grade Designation = M-40
- Type of cement = O.P.C-43 grade
- Brand of cement = Vikram (Grasim)
- Admixture = Fosroc (Conplast SP 430 G8M)
- Fine Aggregate = Zone-II
- Sp. Gravity Cement = 3.15
- Fine Aggregate = 2.61
- Coarse Aggregate (20mm) = 2.65
- Coarse Aggregate (10mm) = 2.66
- Minimum Cement (As per contract) = 400 kg / m3
- Maximum water cement ratio (As per contract) = 0.45

Calculation of cement content: – Assume cement content 400 kg / m3

(As per contract Minimum cement content 400 kg / m3) Preparation and Casting of Test Specimens.

Calculation of water: –

400 X 0.4 = 160 kg Which is less than 186 kg (As per Table No. 4, IS: 10262)

Calculation for C.A. & F.A.: – As per IS: 10262, Cl. No. 3.5.1

$V = [W + (C/S_c) + (1/p). (f_a/S_{fa})] \times (1/1000)$

$V = [W + (C/S_c) + \{1/(1-p)\}, (ca/S_{ca})] \times (1/1000)$

Where:

V = absolute volume of fresh concrete, which is equal to gross volume (m^3) minus the volume of entrapped air,

W = mass of water (kg) per m^3 of concrete,

C = mass of cement (kg) per m^3 of concrete,

S_c = specific gravity of cement,

(p) = Ratio of fine aggregate to total aggregate by absolute volume,

(fa),(ca) = total mass of fine aggregate and coarse aggregate (kg) per m^3 of Concrete respectively

- 150 mm x 150 mm x 150 mm cubes were cast for compression test with replacement of 0%, 20%, and 40% replacement of dolomite powder and M-sand. The specimens were demolded after 24 hours and tested for 7 days, 14 days and 28 days of curing.
- 150 mm x 300 mm cylinders were cast for split tensile test with replacement of 0%, 20%, 40% replacement of dolomite powder and M-sand. The specimens were demolded after 24 hours and tested for 7 days, 14 days and 28 days of curing.

Compressive Strength:

Compressive Strength For the determination of cube compressive strength of concrete Specimens, of size 150X150X150mm size were cast and cured for 7, 14 and 28 days in tap water. After the specimens are dried in open air, subjected to cube compression testing under digital compressive testing machine The cube compressive strength (f) was computed from the fundamental principle as F =P/A Where f =load at failure /cross sectional area (N/mm2) P = load at failure (N) A = Area of the specimen (mm2)

Compression Testing Machine

Split tensile strength:

Moreover, the concrete is very weak in tension due to its brittle nature. Hence. it is not expected to resist the direct tension. So, concrete develops cracks when tensile forces exceed its tensile strength. Therefore, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

- Firstly, it shall conform to the requirements of Test Method C 39/C 39M.
- Thirdly, it should be able to apply loads at a constant rate within the range 0.7 to 1.4 MPa/min (1.2 to 2.4 MPa/min based on IS 5816 1999) splitting tensile stress until the specimen fails

Split tensile strength Machine

Curing of Specimen

- Casted specimen should be stored in a place at a temperature of 27° +/- 2°C for 24 +/- 0.5hrs from the time addition of water to the dry ingredients.
- After that, the specimen should be marked and removed from the mould and immediately submerged in clean fresh water or saturated lime solution and kept there until taken out just prior to the test.
- The water or solution in which the specimens are kept should be renewed every seven days and should be maintained at a temperature of 27° +/- 2°c.
- For design purpose, the specimen cured for 28 days.
- At last, for each reading, three specimens shall be casted and tested. Then, the average tensile strength will be taken.

IV. REPLACEMENT OF FINE AGGREGATE USING SAND WITH M-SAND

Compressive StrengthTest:

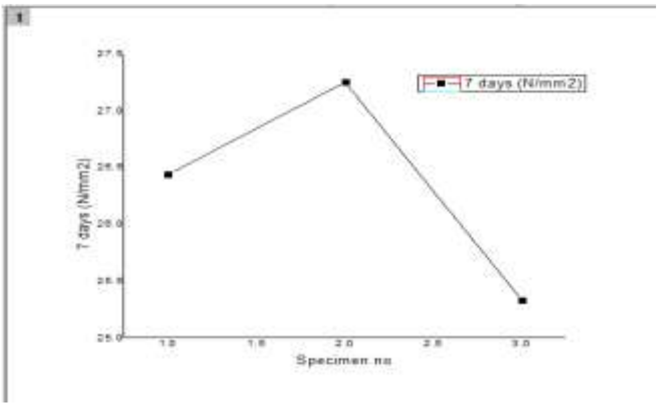
Cubes of size 150 X 150 X 150 mm are used in the present work. The cubes are cured for 28 days. After 28 days of curing, the cubes are tested in a Compression Testing Machine(CTM).

Cube under Loading under CTM

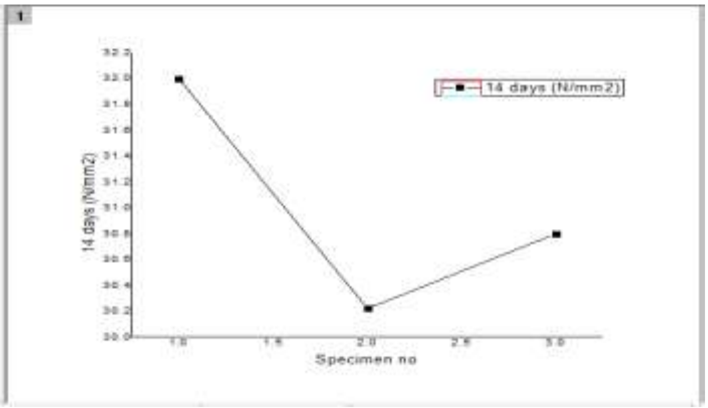
Cube After Crushing

Table 4.1:-Compressive strength of cube with replacement of 20% of M- sand

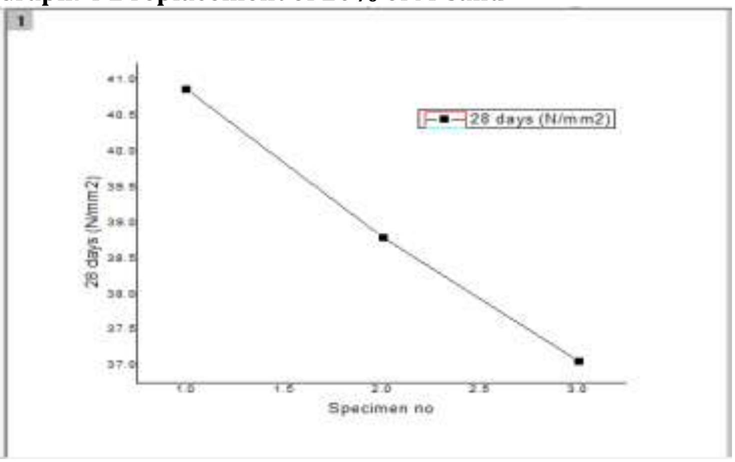
Specimen no	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
1	26.44	32	40.88
2	27.25	30.22	38.8
3	25.33	30.8	37.06
Avg Compressive Test	**26.35**	**31.00**	**38.91**



Graph: 4.1 Compressive strength of cube with replacement of 0% of M- sand



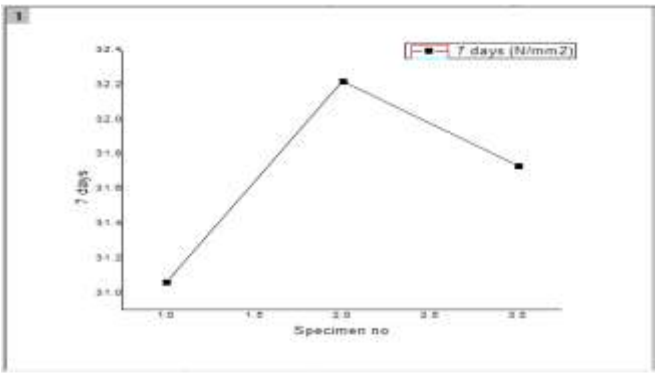
Graph: 4.2 replacement of 20% of M-sand



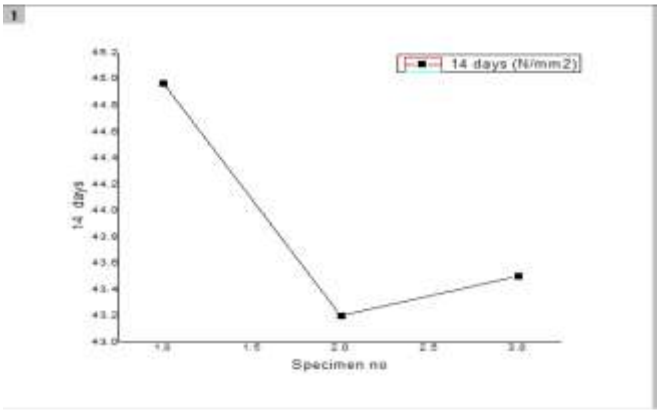
Graph: 4.3 replacement of 40% of m-sand

Table:-4.2 Compressive strength of cube with Replacement of 40% of M-sand

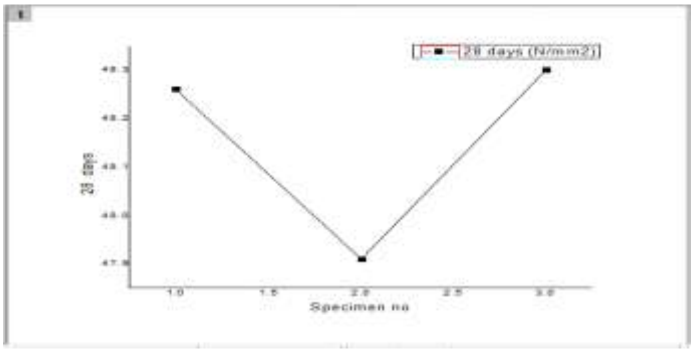
Specimen no	**7 days (N/mm^2)**	**14 days (N/mm^2)**	**28 days (N/mm^2)**
1	31.06	44.97	48.26
2	32.22	43.2	47.91
3	31.73	43.5	48.3
Avg Compressive Test	**31.67**	**43.89**	**48.15**



Graph: 4.4 Compressive strength of cube with Replacement of 40% of M-sand



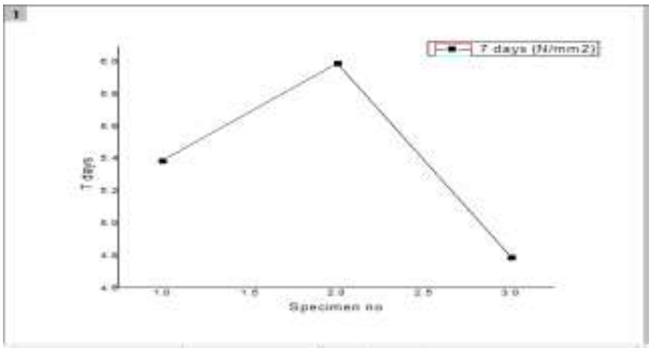
Graph:-4.5 Compressive strength of cube with Replacement of 20% of M-sand 14 days



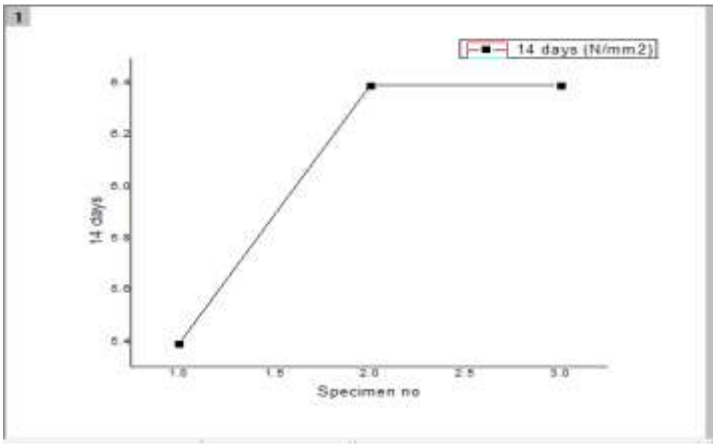
Graph:-4.6 Replacement of Compressive strength of cube with Replacement of 40% of M-sand ash 28 days

Table -4.3 Flexure strength for nominal concrete and mixtures

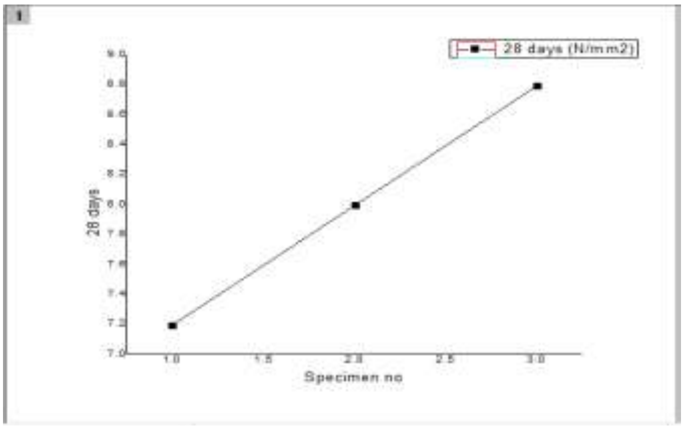
Specimen no	**7 days (N/mm^2)**	**14 days (N/mm^2)**	**28 days (N/mm^2)**
1	5.39	5.39	7.19
2	5.99	6.39	7.99
3	4.79	6.39	8.79
Average flexural strength	**5.48**	**6.06**	**7.72**



Graph: 4.7 Flexure strength for nominal concrete and mixtures curing 7 days



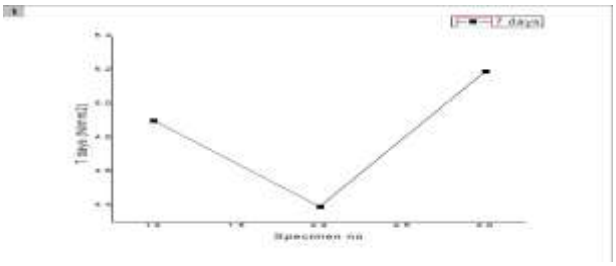
Graph: 4.8 Flexure strength for nominal concrete and mixtures curing 14 days



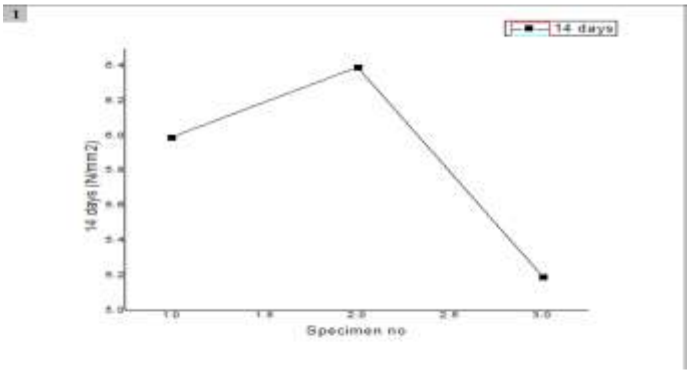
Graph: 4.9 Flexure strength for nominal concrete and mixtures curing 28 days

Table 4.4 Flexure strength for 20% replacement ofM- sand

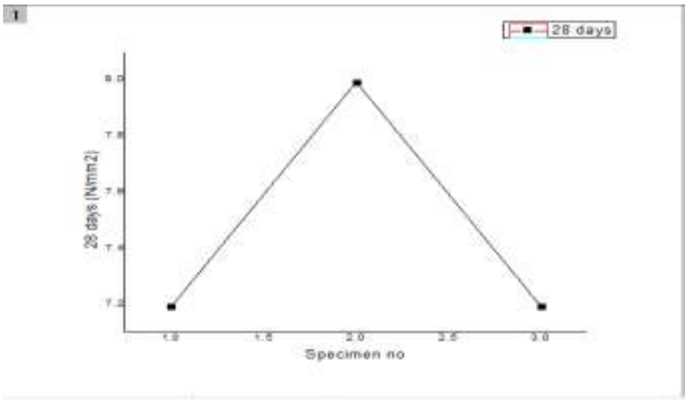
Specimen no	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
1	4.9	5.99	7.19
2	4.39	6.39	7.99
3	5.19	5.19	7.19
Average flexural strength	4.82	5.85	7.45



Graph: 4.10 Flexure strength for 20% replacement ofM- sand



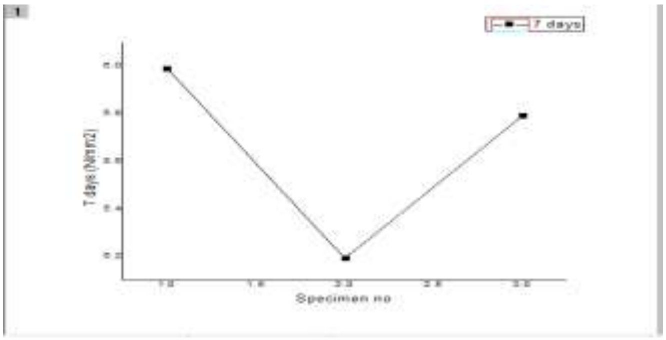
Graph 4.11 Flexure strength for 20% replacement ofM- sand 14 days



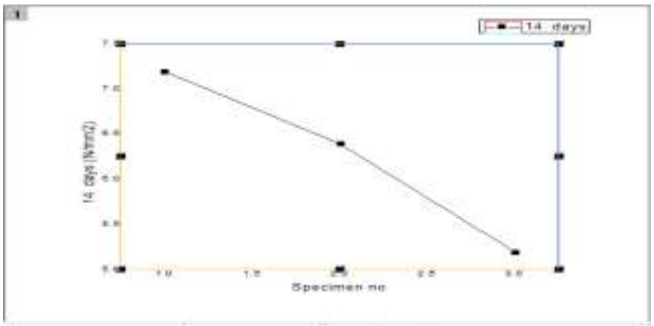
Graph 4.12 Flexure strength for 20% replacement ofM- sand 28 days

Table: 4.5 Flexure strength for 40% replacement ofM- sand

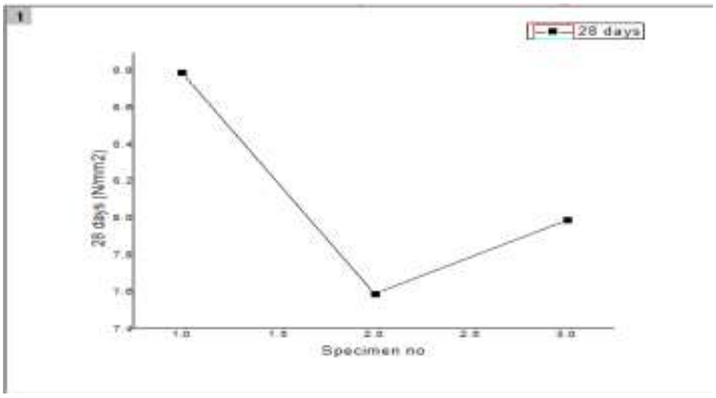
Specimen no	**7 days (N/mm^2)**	**14 days (N/mm^2)**	**28 days (N/mm^2)**
1	5.99	7.19	8.79
2	5.19	6.39	7.59
3	5.79	5.19	7.99
Average flexural strength	5.65	7.19	8.79



Graph 4.13:- Flexure strength for 40% replacement ofM- sand



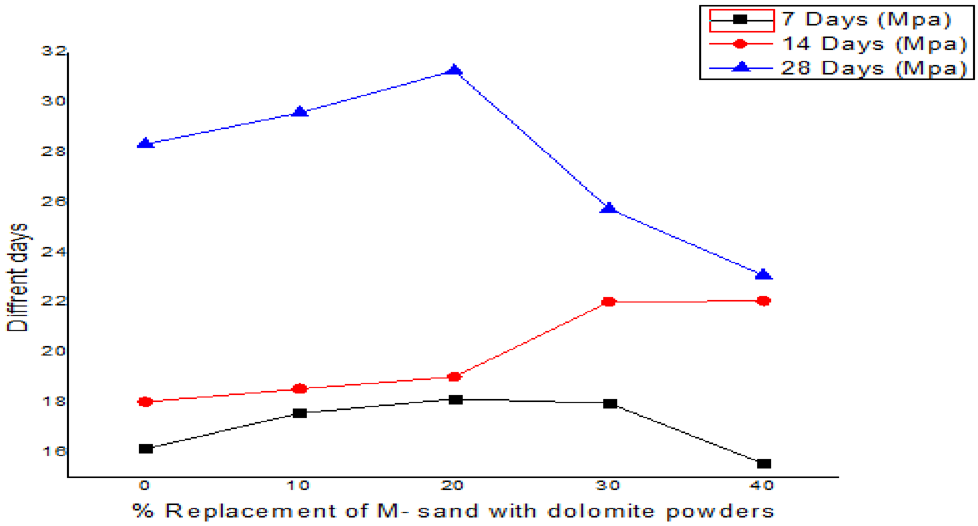
Graph 4.14:-Flexure strength for 40% replacement ofM- sand 14 days



Graph 4.15:-Flexure strength for 40% replacement ofM- sand 28 days

Table: Compressive Strength of M40 Concrete at 7th & 28th Days

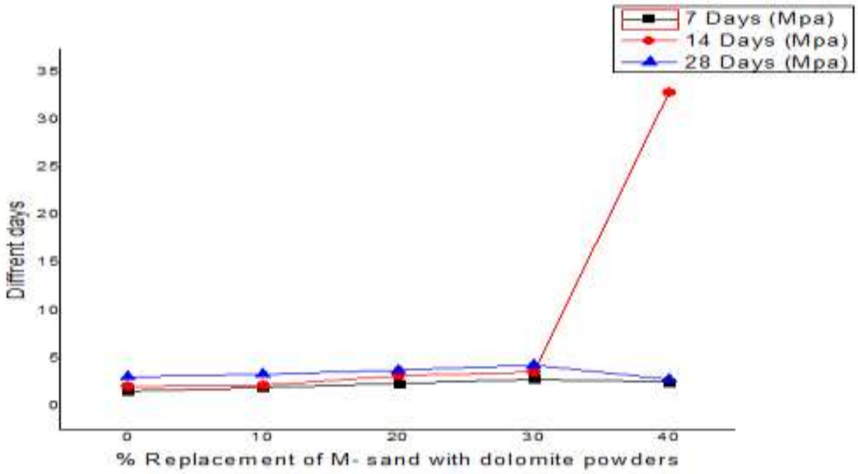
% Replacement of **M- sand** with dolomite powders	7 Days (Mpa)	14 Days (Mpa)	28 Days (Mpa)
0	16.15	18.02	28.30
10	17.56	18.54	29.56
20	18.14	19.02	31.24
30	17.96	22.01	25.72
40	15.56	22.05	23.07



Graph for Compressive Strength of M40 Concrete at 7th & 28th Days

Table: Spilt Strength of M40 Concrete at 7th & 28th Days

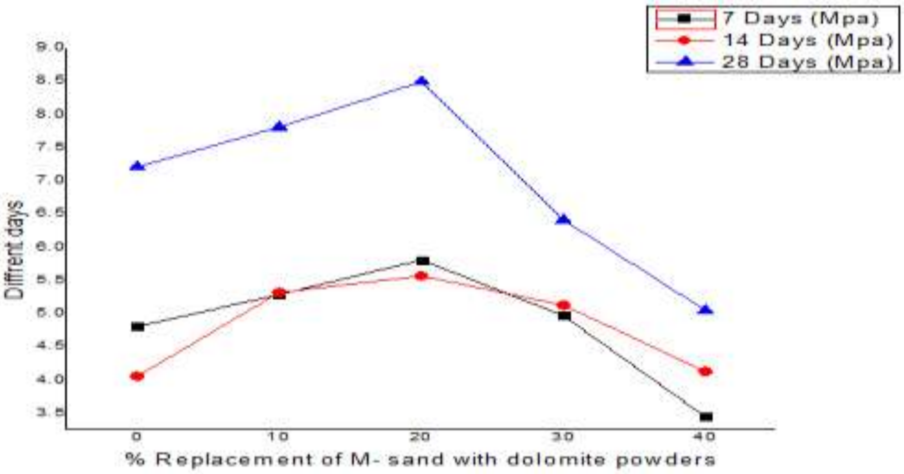
% Replacement of M- sand with dolomite powders	7 Days (Mpa)	14 Days (Mpa)	28 Days (Mpa)
0	1.53	2.05	3.0 4
10	1.91	2.14	3.29
20	2.33	3.14	3.72
30	2.76	3.54	4.25
40	2.48	32.79	2.76



Graph for Spilt Strength of M40 Concrete at 7th & 28th Days

Table: Flexural Strength of M40 Concrete at 7th & 28th Days

% Replacement of M- sand with dolomite powders	7 Days (Mpa)	14 Days (Mpa)	28 Days (Mpa)
0	4.80	4.05	7.20
10	5.28	5.31	7.80
20	5.80	5.56	8.48
30	4.96	5.12	6.40
40	3.44	4.12	5.04



Graph for Flexural Strength of M40 Concrete at 7th & 28th Days

From the tables and figures, it can be seen that dolomite powder improves the compressive strength, the split tensile strength and the flexural strength of concrete up to certain replacement percentage. As the percentage replacement of M-sand with dolomite powder increases, the compressive, the split tensile and the flexural strengths increase, reach a maximum value and then decrease.

V. CONCLUSION:

The fractional replacement of M-sand with Dolomite-silica sand is found to enhance the strength and consistency of mortar in view of the investigation of the obtained results. 50:50 and 70:30 mix proportions have similar compression strength to the conventional mortar. The drying shrinkage values are straight and have less strain values in 50:50 and 70:30 blend extents. This meets the sustainability conditions and spares the common assets. The bond strength of 70:30 extent additionally demonstrates more strength than conventional and all blend extents. So it is construed to utilize 70% of M-sand and 30% of Dolomite-silica sand rather than conventional or M-sand mortar. It additionally demonstrates that utilization of50% of M-sand and Dolomite-silica sand likewise indicates great strength conditions than conventional however it fails in durability and further increase in Dolomite-silica sand content diminishes the strength. Additionally, work is required to locate the correct mix proportions of M-sand and Dolomite-silica sand to meet the conventional prerequisites.

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