Experimental Investigation of Concrete in Partial Replacement of Cement by Dolomite and Fine Aggregate by Copper Slag

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Abstract – Concrete plays a vital role in the world of this paper is a part of experimental investigation to study the characteristic of concrete by using the combination of partial replacement of cement by dolomite powder and partial replacement of fine aggregate by copper slag. The dolomite is an anhydrous carbonate mineral made out of calcium magnesium carbonate and it is likewise used to portray as sedimentary carbonate shake. Dolomite is also known as dolomite. The dolomite powder is the crushed mineral from dolomite. Copper slag is a rough impacting coarseness made of granulated slag from metal refining procedures and it is likewise called as iron silicate. The replacement percentages of cement by dolomite powder is 10%, 20% & 30% and fine aggregate by copper slag is 25% by the weight of M25 grade concrete. The dolomite powder and copper slag is mixed with natural cement and fine aggregate in the grade of M25 with the mix proportion of 1:1:2. The concrete cubes were casted with varying content of dolomite powder and copper slag. The test specimens were cured and tested for compressive strength and split tensile strength in 7 days, 14 days & 28 days for concrete.

Index Terms – Cement, coarse aggregate, fine aggregate, dolomite, copper slag.

1. INTRODUCTION

Concrete is a versatile engineering material used in most of the Civil Engineering structures. It is basically composed of three components they are cement, water and aggregate. Its noticeably as a crucial building material being developed is a consequence of its economy, awesome durability, ease with which it can be created, the ability to frame it into any shape, size and its high compressive quality. The utilization of supplementary cementing materials natural pozzolans like Dolomite Powder, Rice Husk Ash, Fly Ask, Egg Shell Powder, Sugarcane Bagaesse Ash, Silica Fume, Metakaolin etc..in concrete production is one of the solutions to reduce the cement content as well as CO2. Because of this, prerequisites for more conservative and eco-accommodating establishing material have augmented enthusiasm for incomplete bond substitution materials.The Digging of the sand from riverbeds diminishes the water head, so less permeation of water in ground bringing about lower ground water level.Because of this, necessities for more conservative and ecoaccommodating waste material have augmented enthusiasm for incomplete substitution of fine total materials.

2. LITERATUREREVIEW

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. They reported that the shear strength of RC beams were better than that of the conventional SCC without dolomite powder.

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. For all levels of cement replacement, concrete achieved superior performance in the fresh and hardened states when compared with the reference mixture.

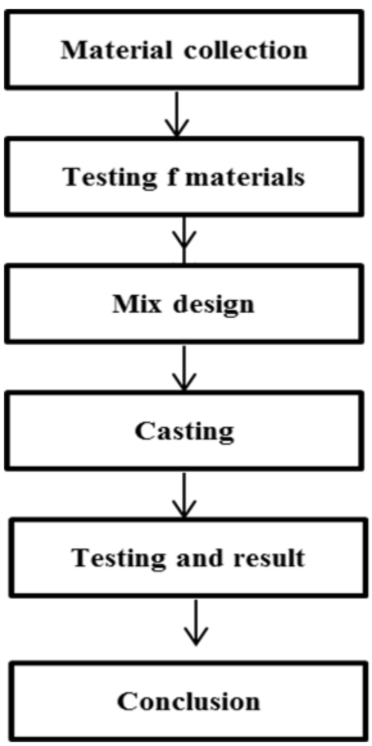
Bhavin K, (2013) presented the details of the investigation carried out on paver blocks made with cement, dolomite block and different percentages of polypropylene fibres.They reported that addition of 0.3% and 0.4% of polypropylene fibres improved the abrasion resistance and flexural strength of paver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

R R Chavan and D B Kulkarni(2013) has investigated the performance of high strength concrete (HSC) made with copper slag as a fine aggregate at constant workability and studied the effect conducted experimental investigations to study the effect of using copper slag as a replacement of fine aggregate on the strength properties and concluded that Maximum Compressive strength of concrete increased by 55% at 40% replacement of fine aggregate by copper slag and flexural strength increased by 14 % for 40 % replacement. Many researchers have investigated worldwide on the possible use of copper slag as a concrete aggregate

Jayapal Naganur and Chetan B.A.(2014) studied the compressive strength increased with increase in copper slag content up to a replacement level of 50%. The maximum increase in compressive strength was observed at a replacement level of 40%. Beyond the replacement level of 50% of sand with copper slag in concrete, a decrease in strength was observed. Hence, the properties of concrete were evaluated up to a replacement level of 60%The density of concrete increased with increase in percentage of copper slag.

3. METHODOLOGY



4. MATERIALS

The material used for this experimental work are cement, fine aggregate, coarse aggregate, water, sea shell and prosopis juliflora ash.

4.1 Cement:

Cement is a binder that sets and hardens and can bind other materials together. Ordinary Portland Cement (OPC) 53 grade is used. Cement is a binder that sets and hardens and can bind other materials together. A powdery substance made by claiming lime and clay, mixed with water to form mortar or mixed with sand, gravel and water to make concrete

.4.2 Fine aggregate:

Aggregate which passed through 4.75 mm IS sieve and retained on 75 micron IS sieve is termed as fine aggregate. The specific gravity of fine aggregate was 2.6.

4.3 Coarse aggregate:

Angular shape aggregate which passes through 20 mm sieve and retain on 10mm are used as coarse aggregate in this project work. The specific gravity of coarse aggregate was 2.64 and fineness modulus of 7 was found out12.5mm.

4.4 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 in 10% ,20%, 30% M25 grade of concrete.

Fig.4.1 Dolomite powder

4.5 Copper slag:

Fig4.2 Copper slag

Copper slag is a by-item made amid the copper purifying and refining process. As refineries coax metal out of copper mineral,they deliver a substantial volume of nonmetallic tidy, ash,andshake.Altogether, these materials make up slag, which can be utilized for an astonishing number of utilizations in building and modern fields. One of the essential focal points to copper slag is the generally safe it postures to wellbeing and the earth.

5. MATERIAL OF PROPERTIES

5.1 Properties of dolomite:

The chemicals present in dolomite are Carbonate, Calcium Carbonate, Magnesium Carbonate, Insoluble Acid and Silicon-dioxide.

Table 5.1 Chemical Composition

Chemical Analysis	**%**
Al_2O_3	0.04
Fe_2O_3	0.024
TiO_2	N.D
CaO	32.218
MgO	20.179
Insoluble	0.094
Loss	47.33
Total	99.885

Table 5.2 Physical properties

Color	Colorless, white, pink , green, gray, brown, black
Streak	White
Luster	Vitreous, pearly
Diaphaneity	Transparent to translucent
Cleavage	Perfect, rhombohedral, three directions
Mohs Hardness	3.5 to 4
Specific Gravity	2.8 to 2.9
Diagnostic Properties	Rhombohedral cleavage, powdered form effervesces weakly in dilute HCl, hardness
Chemical Composition	$CaMg(CO_3)_2$
Crystal System	Hexagonal

5.2 PROPERTIES OF COPPER SLAG :

The chemicals present in copper slag are Aluminum Oxide, Titanium-dioxide, Ferric Oxide, Silicon-dioxide, Calcium Oxide, Magnesium Oxide, Potassium Oxide, Sodium Oxide and Copper.

Table 5.3 PHYSICAL PROPERTIES

Particle shape	Irregular
Appearance	Black & glassy
Type	Air cooled
Specific gravity	3.91,3.68
Percentage of voids	43.20%
Bulk density	2.08 g/cc,1.70 to 1.90 g/cc
Fineness modulus of copper slag	3.47
Angle of internal friction	51° 20’
Particle size	0.075 mm to 4.75 mm
Hardness	Between 6and 7

6. TESTING OF MATERIALS

6.1GENERAL

The materials that are used such as cement, fine aggregate, coarse aggregate. This property of materials is very useful in calculating the mix ratio.

6.2 SPECIFIC GRAVITY OF COARSE AGGREGATE

The container is dried thoroughly and it’s weight W_1 grams. Take 200grams of the coarse aggregate and it’s weighed again with container W_2gams. The sufficient water is added to cover the coarse aggregate half full and is screwed on the top. It is shaking well and stirred thoroughly with the glass rod to remove to entrapped air.

After the air has been removed container is completely filled with water up to mark. The outside of the container is completely filled with up to mark is dried with a cloth and weighted W_3grams.The container is cleaned thoroughly. The container is completely filled with water up to top. The outside of the container is a dried with a clean cloth and it is weightedW_4grams.

6.4 SPECIFIC GRAVITY OF CEMENT

The Flask should be free from the liquid that means it should be fully dry. Weight the empty flask(W1).Fill the cement on the bottle up to half of the flask (about 50gm) and weight with its stopper (W2). Add Kerosene to the cement up to the top of the bottle. Mix well to remove the air bubbles in it.Weight the flask with cement and kerosene(W3). Empty the flask. Fill the bottle with kerosene up to the top and weigh the flask(W4).

6.5 WATER ABSORPTION TEST

This test is performed in order to determine the water absorption capacity of the aggregates used. Here about 300 grams of the various aggregates are taken separately and immersed in water for about 24 hours. These aggregates are then kept in oven at a temperature of 100 to 110 C° for a time period of 6 hours and then sample is weighted. The change in weight is noted. As per code the limiting value for the water absorption is 2%. The results of the aggregates tested are 1% for sand, 0.5% for 20mm aggregates and 0% for seashell.

Table 6.1 TESTING OF MATERIALS

TEST	**VALUES**
Specific gravity of coarse aggregate	**2.73**
Specific gravity of fine aggregate	**2.67**
Specific gravity of cement	**3.15**
Specific gravity of dolomite	**2.75**
Specific gravity of copper slag	**2.81**
Water absorption for coarse aggregate	**0.5%**
Water absorption for fine aggregate	**1%**

7. EXPERIMENTAL WORK

7.1 Mix design

The mix design methods being used in different countries are mostly based on empirical relationships, charts and graphs developed from extensive experimental investigations. A properly designed concrete mix should have minimum possible cement content without sacrificing quality in order to make in concrete mix. The ultimate aim of studying the various properties of the material of concrete, plastic concrete and hardened concrete, is to enable a concrete technologist is to design a concrete mix for a particular strength and durability.

7.2 Batching and Mixing

Weigh Batching was accomplished with the help of electronic weighing balance. Batching was done as for each the mix proportions. Mixing was done in tray. It was mixed for 2-3 minutes, later than addition of water. Placing and Compaction: Solid shapes and precious stone are cleaned and oiled to avoid the improvement of bond among concrete and iron molds. Put the fresh concrete in molds in 3 layers, pressing each layer with temper 25 times. The air which is ensnared in bond is emptied by table vibrator.

7.3 Demoulding

After placing fresh concrete in cubical moulds and prisms, it was allowed to set for 24 hours. It was marked with some permanent identification mark i.e. 1, 2, 3 etc. Cubes and prisms are now kept in curing tank for 7, 14 and 28 days. After 7, 14 and 28 days, concrete specimens were removed from curing tank to conduct tests on hardened concrete.

8. TEST RESULTS AND DISCUSSION

8.1 SLUMP CONE TEST:

Clean the internal surface of the mould and apply oil. Place the mould on a smooth horizontal non- porous base plate. Fill the mould with the prepared concrete mix in 4 approximately equal layers. Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer. Remove the excess concrete and level the surface with a trowel. Clean away the mortar or water leaked out between the mould and the base plate. Raise the mould from the concrete immediately and slowly in vertical direction. Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.

8.2 COMPRESSIVE STRENGTH OF CONCRETE CUBES

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M25 grade of concrete. Vibration was given to the moulds using table vibrator. The top surface of the specimen was levelled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 7, 14 and 28days

8.3 SPILT TENSILE STRENGTH OF CONCRETE CYLINDERS

For Split tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The split tensile strength of concrete is determined by casting cylinder of size 150mmx300mm.the cylinders were tested by placing them uniformly. Specimens were taken out form curing taken at age of 28 days of moist curing and tested after surface water dipped down form specimens. This test was performed on universal testing machine (UTM).

The magnitude of tensile stress (T) acting uniformly to the line of action of applied loading is given by formula.$T_{sp} = 2P/\Pi dl$

Table 1 Compression Strength Test

Test In Days	Normal Concrete	Copper slag 25%		
		Dolomite 10% N/mm²	Dolomite 20% N/mm²	Dolomite 30% N/mm²
7 days	17.14	19.70	20.29	22.22
14 days	20.04	23.32	24	26.58
28 days	24.10	28.55	30.31	32.12

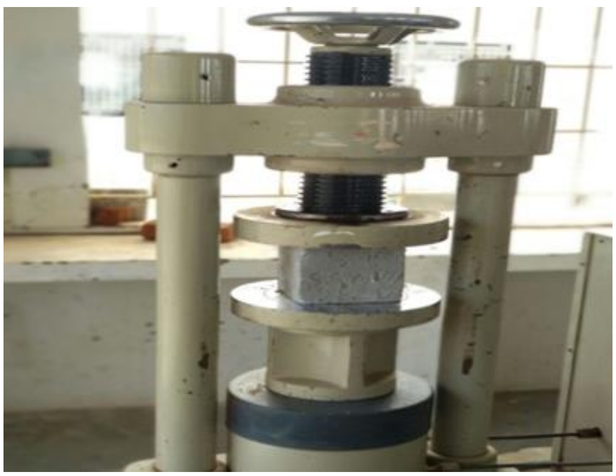
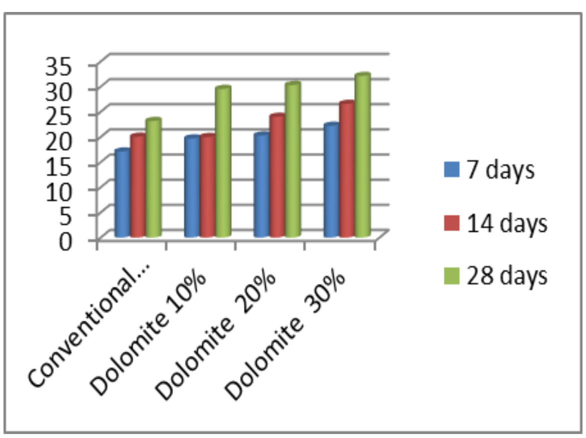
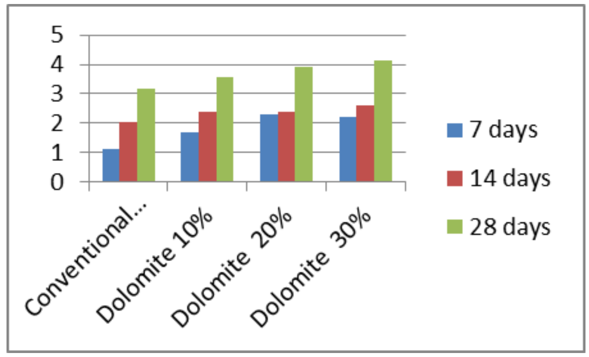


FIG 1. COMPRESSION TESTING FOR CUBE

GRAPH 1. COMPRESSION TEST



GRAPH 2. SPLIT TENSILE TEST



9. CONCLUSION

The use of dolomite powder and copper slag increased the compressive and tensile strength of concrete The compressive strength for M25 grade concrete is 27 and it is increased by replacement of 25% copper slag and dolomite 10%, 20% & 30%. Thus, the use of these eco-friendly materials has changed waste into wealth.

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