Utilization of Dolomite Powder as Partial Replacement to the Cement

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ABSTRACT :-

In this generation, we observe the rapid urbanization and industrialization which was leading to the increase in the construction of the projects. Several attempts have been therefore made in the building material industry to put to use natural materials to control the total cost of the project. Concrete is the prime material used in any RCC structure. So, in the construction of any structure concrete is main material to be used in completion of structure. Concrete is a mixture of several ingredients but the main ingredients are cement and coarse aggregate. The natural material can also be replaced with cement and coarse aggregate in the concrete i.e. dolomite. Dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate, ideally $CaMg(CO_3)_2$. Lime mud is present plentifully in dolomite stone. Dolomite sedimentary carbonate rock which has properties like binding and bearing the loads. In this present study it is investigated to find the strength parameters of M30 grade concrete when the concrete materials are replaced with other natural rock materials. In this study the cement and coarse aggregate which are replaced by using natural material i.e., dolomite at various percentages. The specimens are casted by replacing cement with dolomite powder and coarse aggregate with dolomite crushed stone at 0%, 10%, 15%, 20%, 25%, 30%, 35% and 40%. The cubes and cylinders are casted and cured and tested at the age of 7, 14 and 28 days to know the strength characteristics like compressive strength and split tensile strength. The obtained values are compared with M30 grade concrete of conventional mix.

KEY WORDS: Dolomite powder, Urbanization, Industrialization, Anhydrous carbonate mineral, Calcium magnesium carbonate($CaMg(CO_3)_2$),Sedimentary carbonate rock, Compressive strength.

1.INTRODUTION:-

1.1 GENERAL:

In now a day construction, concrete is one of the major building materials used. The reason behind its use in large quantities is due to its excellent structural performance and durability. It is used for numerous purposes

in construction such as construction of buildings, dams, foundations, highways, parking structures, pipes, and poles. Also, the use of concrete offshore drilling platforms and oil storage tanks is already on the increase. Concrete is a composite material composed mainly of water, aggregate, and cement. Water is an important ingredient of concrete as it actively participates in chemical reaction with cement. Curing of concrete stands for procedures devoted to promote cement hydration, consisting of control of time and humidity conditions immediately after the placement of concrete mixture in to formwork.

1.2 AGGREGATES:

Aggregates are the inert materials that are mixed in fixed proportions with a binding material to produce concrete these act as fillers or volume increasing components on the hand are responsible for strength, hardness, durability of the concrete on other hand.

1.2.1 COARSE AGGREGATES:

When the aggregates are sieved through 4.75mm sieve, the aggregate retained on the sieve is called coarse aggregates. It is well recognized that coarse aggregates plays an important role in concrete.

1.3 FINE AGGREGATES:

When the aggregates are sieved through 4.75mm sieve, the aggregates passed through the sieve, it is called as fine aggregates. Natural sand is generally used as fine aggregates, silt and clay are also comes under this category.

1.3CEMENT:

Cement, in general is the binding material used in building and civil engineering works. Cements are finely grounded powders that when mixed with water set to hard mass. Concrete is a mixture of paste and aggregates. The paste composed of cement and water, coats the surface of coarse and fine aggregates.

1.4 DOLOMITE:

Dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate, ideally $CaMg(CO_3)_2$. The term is also used for a sedimentary carbonate rock composed mostly of the mineral dolomite. An alternative name sometimes used for the dolomitic rock type is dolostone. Dolomite has some properties like cement and coarse aggregates

1.5 NECESSITY OF PROJECT:

As per the literature available it is said that in near future there will be shortage of cement and coarse aggregates itself. Cement and coarse aggregate will not be available for concreting purpose. So, in order to full fill the requirement, this study is necessary to test that the dolomite can also be used as a replacement offline aggregate which helps in usage of natural rock materials.

1.6 OBJECTIVES OF THE WORK:

The objective of the present investigation is to investigate

1.6.1 To know the basic properties of cement, fine aggregate, coarse aggregate.

1.6.2 To know the basic properties of dolomite stone, dolomite powder.

1.6.3 To know the strength characteristics of compressive strength, split test for dolomite concrete mix of M30 grade by replacing cement with dolomite powder, coarse aggregate with dolomite crushed stone at various percentages like 0%, 10%, 15%, 20%, 25%, 30%,35% and 40%.

1.7 SCOPE OF THE WORK:

In the present study, an attempt has been made to investigate the strength parameters of concrete made with partial replacement of cement is replaced with dolomite powder

In this research work, the concrete specimens are casted, and the specimens are cured to know the strength characteristics by performing destructive tests.

The dolomite powder is replacing the cement, and coarse aggregate also replaced with dolomite powder at various percentages like 0%, 10%, 15%, 20%, 25%, 30%, 35% and 40%. The specimens are cured and tested at the age of 7, 14 and 28 days.

2.LITERATURE REVIEW:-

2.0 GENERAL:

A review of previous research works were done to accomplish the objectives of this project. Many researchers have studied the properties and reaction of the cementitious materials and also the other ingredients.

2.1 REVIEW OF LITERATURE:

Preethi (2008) et al. Done experiment on possibility of using dolomite powder as a partial replacement material to cement. The some replacement percentages in experiment was 0%, 5%, 10%, 15%, & 20% by weight of cement. The compressive, split tensile and flexural strengths of M25 concrete.

Shanu Sharma (2012) et al. Studied use of cement and production of cement creates much more issues of environment

and also costlier process. Hence, dolomite crushed Powder can used as a developing binding material which will allow the concrete industry to optimize material use, produce financial profit and construct of structures will be strong, durable.

Arulraj (2015) et al. studied the effect of replacement of cement with dolomite powder on the mechanical properties of concrete.M20 mix concrete with dolomite powder as a partial replacement material to cement. The replacement percentages tried were 0%, 5%, 10%, 15%, 20% and 25% by weight of cement. Replacement of cement with dolomite powder is found to improve the strength of concrete.

Pranay P. Rathod (2018). He was studied investigation on dolostone is replaced with a coarse aggregate for concrete mix The coarse aggregate is the huge component of concrete. It is chemically a steady material. Existence of coarse aggregate reduces the drying shrinkage by replacing the dolomite stone the wettability and flexibility strengths are increases.

Jobin Johnson (2019). Study on the Strength and Durability of Concrete with Partial Replacement of Cement by Dolomite Powder and Coarse Aggregates Extensive use of concrete leads to the scarcity of natural coarse aggregates. The obtained results are compared with M30 grade conventional concrete. Durability properties like alkali resistance and sulphate resistance are determined.

Kaushal Prajapati (2019) et al. We found out the optimum percentage of replacement of dolomite powder with cement is 10% cement for cubes, cylinders and beam. At this replacement level, the maximum increase in the 28th day compression, flexural strength and were found to be 5.30%, 2.83% and 4.76% respectively.

John keeling (2021). He studied on the Structure and resources efficiency of dolomite stone Dolomite can form as a major mineral component of marlstones and limestones and is an important sink for magnesium in the marine environment.

Mustaqim Abdul Rahim (2015) et al. He studied on physical properties of dolomite fines as partially replacement of cement, Based on results obtained, the finest of dolomite fines is almost identical to the cement, the workability of the concrete is increased with the replacement of cement with dolomite fines.

Syed Afzal Basha (2016). The purpose of this work is to describe the effect of quarry dust and dolomite on the compr essive strength of concrete. The present examinations indicate that dolomite may be used as partial replacement of cement in concrete and quarry dust may be suitably replaced with fine aggregate in concrete to some extent. The results are found to be satisfactory with the individual replacements but the combination of both quarry dust and dolomite did not yield the positive results with respect to compressive strength of concrete.

Amal Abdulameer Maher (2017). He was investigated utilizing workability test, (compressive, splitting, flexural) strength test. Test results uncovered that the incorporation of using Samawah dolomite aggregate in high strength concrete blends enhances obviously the hardened properties of high quality concrete. The quality of concrete is controlled by the property of the cement mortar, coarse total, and the boundary for a similar quality cement.

Ghalib Mohsin Habeeb (2017). He studied of Using samawah dolomite rock to produce high strength for concrete They are a part of many of the most important composite materials such as concrete. The aggregates are accountable for the weight of the unit, the elastic coefficient, the strength and the dimensional stability of the concrete because these properties depend on the physical properties (strength and mass density) of the aggregate. The principal goal of this study is to investigate the production of high strength mortar and concrete by using Samawah dolomite stone aggregate.

Prof. Dr. Ghalib Mohsin Habeeb (2019) et al. studied about using samawah dolomite rock to produce high strength concrete. Samawah dolomite rock used as replacement of coarse aggregate in various percentages (0%, 50%, 100%). Compressive strength, splitting tensile and flexural strength of HSC mixes containing samawah dolomite aggregate gives higher values than high strength conventional concrete mixes.

METHODOLOGY :-

3.1MATERIALS AND THEIR PROPERTIES:

The raw materials that are used in the production of concrete are mentioned below.

Raw Materials:

- Aggregates
- Coarse aggregates
- Fine aggregates
- Cement
- Dolomite powder

3.1.1 COARSE AGGREGATES:

The material whose particles are of size are retained on IS sieve of size 4.75mm is termed as coarse aggregate and containing only so much finer material as is permitted for the various types described in IS:383-1970 is considered

as coarse aggregate. Aggregates are the major ingredients of concrete. They constitute 70-80% of the total volume, provide a rigid skeleton structure for concrete, and act as economical space filters. Because at least three-quarters of the volume of the concrete is occupied by aggregate, it is not surprising that its quality is of considerable importance. The properties of aggregate greatly affect the durability and structural performance of concrete.

3.1.2Fine aggregate:

The size of the fine aggregate is below 4.75mm. fine aggregate can be natural or manufactured. The grade must be throughout the work. The moisture content or absorption characteristics must be closely monitored. The fine aggregate as shown in figure 3.2 used is natural sand obtained from the river Godavari conforming to grading zone-II of table 3 of IS: 10262-2009. The results of various tests on fine aggregate are given in table 3.2. the fine aggregate shall consist of natural sand or subject to approval, other inter materials with similar characteristics, or combinations having hard, strong, durable particles. The use of concrete is being constrained by urbanization, zoning regulations, increased cost and environmental concern.

3.1.3 ORDINARY PORTLAND CEMENT:

Ordinary Portland cement is used for general constructions. The raw materials required for manufacture of Portland cement are calcareous materials, such as limestone or chalk and argillaceous materials such as shale or clay. The manufacture of cement consists of grinding the raw materials, mixing them intimately in certain proportions depending upon their purity and composition and burning them in a kiln at a temperature of about 13000C to 15000C at which temperature, the material sinters and partially fuses to form nodular shaped clinker. The clinker is cooled and ground to a fine powder with addition of about 2 to 3% of gypsum. The product formed by using the procedure is a "Portland Cement". In the present experimental work KCP 53 grade ordinary Portland cement was used.

3.1.4 DOLOMITE:

Dolomite stone is a sedimentary rock that contains a high percentage of the mineral dolomite. It's often used as a decorative stone in landscaping and building projects due to its pleasing appearance. Additionally, it's utilized in the production of concrete and asphalt for construction purposes. The distinctive feature of dolomite stone is its composition of both calcium and magnesium carbonates. Dolomite commonly used in construction for building materials, as a decorative stone in landscaping, and in the production of concrete and asphalt.

Dolomite has mohr's hardness 3.5 to 4, specific gravity 2.70, and the thickness of the dolomite stone is 20 mm-70 mm. The stability of dolomite at maximum static pressure of 28 GPA.

Advantages of dolomite Powder:

- Dolomite makes up 2 percent of the earth's crust. There is a dolomite mountain range, comprised of massive deposits of this stone.
- Dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate, ideally $CaMg(CO_3)_2$. The term is also used for a sedimentary carbonate rock composed mostly of the mineral dolomite
- Dolomite stone has bearing strength than coarse aggregate which was a combination of calcium carbonate $CaMg(CO_3)_2$.

Disadvantages of dolomite Powder:

- Dolomite is more susceptible to etching compared to other countertop materials.
- Unlike some other natural stones, dolomite offers a relatively limited range of colors and pattern.
- Maintenance Requirements Dolomite countertops require regular sealing to maintain their appearance and protect against staining.
- Due to heavy heat the dolomite will absorbs the heat reduction pursues strength minimizing.

4. MIX DESIGN :-

4.1 INTRODUCTION:

In this chapter concrete mix design calculations for M20 and M30 grade concrete in detail were presented.

4.2 REQUIREMENTS OF CONCRETE MIX DESIGN:

The requirements which form the basis of selection and proportioning of mix ingredients are:

- The minimum compressive strength required from structural consideration
- The adequate workability necessary for full compaction with the compacting equipment available.
- Maximum water-cement ratio to give adequate durability for the particular site conditions.

- Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

4.3 FACTORS TO BE CONSIDERED FOR MIX DESIGN:

- The grade designation, (the characteristic strength requirement of concrete).
- The type of cement influences the rate of development of compressive strength of concrete.
- Maximum nominal size of aggregates to be used in concrete may be as large as possible within the limits prescribed by IS: 456-2000
- The cement content is to be limited from shrinkage, cracking and creep.
- The workability of concrete for satisfactory placing and compaction is related to the size, shape, quantity and spacing of reinforcement and technique used for transportation, placing and compaction.
- Proportion of Volume of Coarse Aggregate and Fine Aggregate Content

From Table 3 of IS: 10262-2009 volume of coarse aggregate corresponding to 20 mm size aggregate & fine aggregate (Zone-II) For water-cement ratio of 0.50 = 0.62

But our water content is 0.44 Therefore water cement ratio lowers by 0.06, the proportion of Volume of coarse aggregate is increased by 0.02

(@ of -/+ 0.01 for every 0.05change in w/c ratio)

Corrected volume of coarse aggregate for the water-cement ratio 0.44 = 0.632 Volume of fine aggregate = 1-0.632 = 0.368

5.EXPERIMENTAL WORK :-

5.1 INTRODUCTION:

In this chapter, concepts of experimental work are presented. Objective of testing, i.e. ordinary Portland cement, fine aggregate, coarse aggregate, potable water, dolomite crushed stone and dolomite powder in process of manufacturing of concrete, workability of fresh concrete and testing of hardened concrete procedures are explained in details.

5.2 OBJECTIVE OF TESTING:

- It was proposed to investigate the properties of concrete, cast with partial replacement of cement with dolomite powder and coarse aggregate with dolomite powder in the ratio of 10%, 15%, 20%, 25%, 30%, 35% and 40%.
- In this experimental work, Physical properties of materials used in the experimental work were determined. Grade of concrete M30 were mixed and cured by using two methods. The specimens were cured for 7 and 28 days and tested for Compressive strength, spilt tensile strength.

5.3 PROCESS OF MANUFACTURING OF CONCRETE:

5.3.1 Aggregates

The coarse aggregate was kept completely immersed in clean water for 24 hours for water absorption. After 24 hours, the aggregate was gently surface dried. It was then spread out and exposed to the atmosphere until it appears to be completely surface dry. For fine aggregate, considering the huge time to be taken to become surface dry from wet condition.

5.3.2 Batching:

Batching means measuring the quantities of constituents of concrete required for the preparation of concrete mix. Weight batch method is adopted to measure the quantities. The quantities of cement, fine aggregate, coarse aggregate, water for each batch were measured by a weighing balance according to the mix proportions.

5.3.3 Mixing:

The object of mixing is to coat the surface of all aggregate particles with Cement paste and to blend all the ingredients of concrete into a uniform mass. Though mixing of the material is essential for the production of uniform concrete. The mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency.

5.3.4 Slump cone test:

A slump cone test measures the consistency of fresh concrete by determining how easily it flows. The test is used to ensure that concrete batches have the same quality and strength.
The slump cone test value for M30 concrete is usually between 100–150 millimeters (mm). This measurement indicates the concrete's

5.3.5 Casting of Concrete cubes and cylinders:

The test moulds were kept ready before preparing the mix. Moulds were cleaned and oiled on all contacts surfaces then fixed on vibrating table firmly. The concrete is filled into moulds in three layers and then vibrated. The top surface of concrete is struck off to level with a trowel.

5.4 STRENGTH PROPERTIES OF CONCRETE:

5.4.1Compressive Strength Test

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection.

Concrete compressive strength for general construction varies from 15 MPa (2200 psi) to 30 MPa (4400 psi) and higher in commercial and industrial structures.

Compression test was conducted on 150mm×150mm×150mm cubes as shown in Figure. Concrete specimens were removed from curing tank and cleaned. In the testing machine, the cube is placed with the cast faces at right angles to that of compressive faces, then load is applied at a constant rate of 1.4 kg/cm³/minute up to failure and the ultimate load is noted. The load is increased until the specimen fails and the maximum load is recorded. The compression tests were carried out at 7, 14 & 28 days. For strength computation, the average load of three specimens is considered for each mix.

The average of three specimens was reported as the cube compressive of strength. applied at a constant rate of 1.4 kg/cm³/minute up to failure.The compression tests were carried out at 7, 14 & 28 days and days. For strength computation, the average load of three specimens is considered for each mix. The average of three specimens was reported as the cube compressive of strength.

Cube compressive strength =

Load/Area of cross section.

6.OBSERVATION:-

6.1 INTRODUCTION:-

In this chapter, the experimental observations are presented. The test results such as compressive strength, split tensile strength of hardened concrete of M30 grade replacement of coarse aggregate and cement with dolomite at various proportions and cured by using portable water curing and ring method at the ages of 7 days,14 days & 28 days are detailed both exposure conditions.

6.11 COMPRESSIVE STRENGTH :

The compressive strength of the concrete was done on 150 x 150 x 150 mm cubes. Testing of the specimens was done at 7 days, 14days and 28 days at the rate of three cubes for each mix on that particular day. The average value of the 3 specimens is reported as the strength at that particular age. The compressive strength test was conducted for all the mixes.

Table 6.1.1 Compressive strength test results of M30 grade dolomite concrete mix with dolomite powder at the age of 7days

S.NO	Mix grade	Mix proportion of dolomite powder added	Compressive strength (N/mm2)
1	M30	0%	19.62
2		10%	19.78
3		15%	20.11
4		20%	20.43
5		25%	20.83
6		30%	21.19
7		35%	21.87
8		40%	20.23

Fig 6.1.1 Compressive strength test result of specimen with a replacement of cement with dolomite powder by curing at the age of 7 days

From the above graph, the compressive strength values obtained by testing standard cubes made with various percentage of dolomite powder and cured by using portable water. It was observed that the Compressive Strength values of cured concrete by using portable water at the age of 7 days is 19.62 N/mm².

Table 6.1.2 Compressive strength test results of M30 grade dolomite concrete mix with dolomite powder at the age of 14days

S.NO	Mix grade	Mix proportion of dolomite powder added	Compressive strength (N/mm2)
1	M30	0%	23.79
2		10%	24.05
3		15%	24.41
4		20%	24.9
5		25%	25.27
6		30%	25.84
7		35%	25.31
8		40%	24.72

Fig.6.1.2 Compressive strength test result of specimen with a replacement of coarse aggregate with dolomite powder by curing at the age of 14 days

From the above graph, the compressive strength values obtained by testing standard cubes made with various percentage of dolomite stone and cured by using portable water. It was observed that the Compressive Strength values of cured concrete by using portable water at the age of 14 days is 23.79N/mm².

Table 6.1.3 Compressive strength test results of M30 grade dolomite concrete mix with dolomite powder at the age of 28 days

S.NO	Mix grade	Mix proportion of dolomite powder added	Compressive strength(N/mm2)
1	M30	0%	32.14
2		10%	32.59
3		15%	33.02
4		20%	33.85
5		25%	34.15
6		30%	35.15
7		35%	34.23
8		40%	33.72

Fig.6.1.3 Compressive strength test result of specimen with a replacement of cement with dolomite powder by curing at the age of 28 days

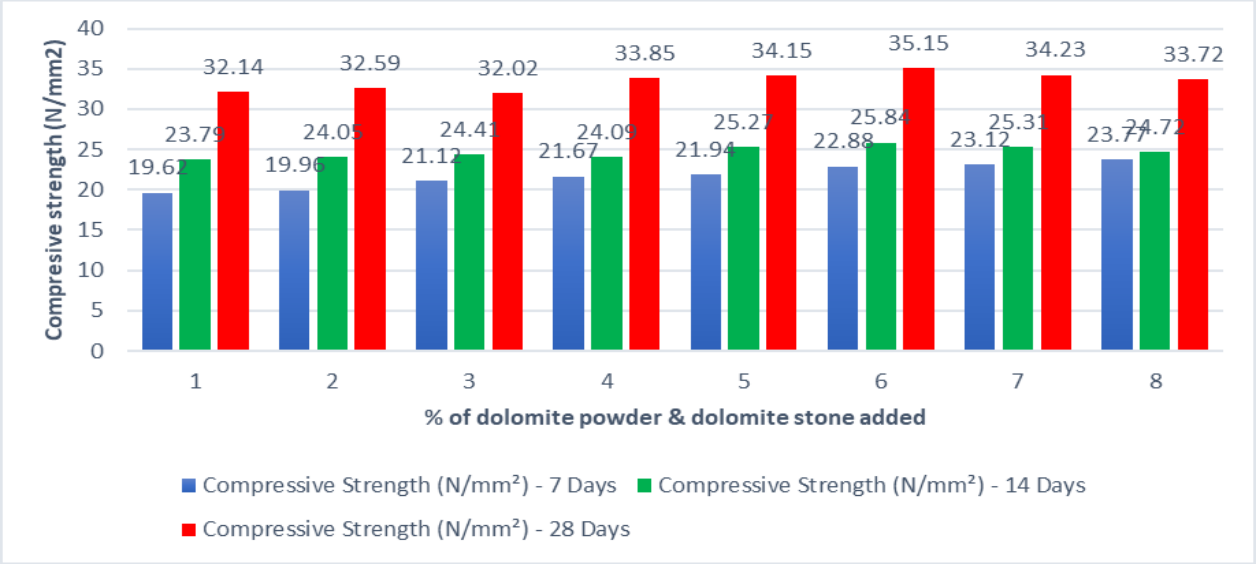
From the above graph, the compressive strength values obtained by testing standard cubes made with various percentage of dolomite powder and cured by using portable water. It was observed that the Compressive Strength values of cured concrete by using portable water at the age of 28 days is 32.14 N/mm².

Table 6.1.4 Compressive strength test results of M30 grade dolomite concrete mix at the age of 7, 14 and 28 days

		Mix proportion of dolomite	Compressive strength

S.NO	Mix grade	powder added	(N/mm2)		
			7 days	14 days	28 days
1	M30	0%	19.62	23.79	32.14
2		10%	19.96	24.05	32.59
3		15%	21.12	24.41	33.02
4		20%	21.67	24.09	33.85
5		25%	21.94	25.27	34.15
6		30%	22.88	25.84	35.15
7		35%	23.12	25.31	34.23
8		40%	23.77	24.72	33.72

Fig 6.1.4 Compressive strength test results of M30 grade dolomite concrete mix at the age of 7, 14 and 28 days



From the above graph, the compressive strength between two values obtained by testing standard cubes made with various percentage of dolomite powder and stone by curing with portable water at the age of 7 days 14 days and 28 days cured by using portable water. It was observed that the compressive Strength values of cured concrete by using portable water at the age of 7 days 14 days and 28 days is 19.62, 23.79 and 32.14N/mm². By using dolomite stone and powder, it was observed that the compressive Strength obtained at every percentage is more than the nominal mix. The maximum value attained at the 40% replacement of coarse aggregate with dolomite powder and cement with dolomite powder. by increasing the dolomite powder the compressive strength is increases.

CONCLUSION :-

In this study series of the experiments have been conducted on concrete with the addition of dolomite powder and dolomite stone as partial replacement of OPC and coarse aggregate. The dolomite powder was used as partial replacement of OPC at various percentages like 0%, 10%, 15%, 20%, 25%, 30%, 35% and 40% The experiments were conducted on M30 grade of concrete as per relevant IS-code practice based on the test results obtained from this study the following conclusion can be drawn.

From the compressive strength test results, the concrete grade is M30, it is found that with the replacement of dolomite powder the strength characteristics are increased than the strength characteristics of conventional concrete mix.

- The maximum strength characteristics obtained for M30 grade of concrete is at 30% replacement of cement with dolomite powder.
- The maximum strength characteristics obtained for M30 grade of concrete is at 40% replacement of coarse aggregate with dolomite powder.

7.1 Scope of the further study:

The experimental study can be carried out for higher strength concrete grade like M40, M50 and above. This work was carried out on replacement of cement, coarse aggregate in concrete with dolomite powder, dolomite stone and other natural materials like basalt, crushed tile, tiles powder etc. So, that by using of dolomite as a replacement material we can reduce the usage of cement and cost of the project.

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