Examination of The Strength Characteristics of Concrete by Partial Replacement of Cement With Limestone Powder And Marble Dust

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I. INTRODUCTION

1.1 INTRODUCTION

The mixture of coarse aggregate, fine aggregate and binding material with water in proper ratio is called concrete. The key factor that adds importance to concrete is that it can be designed to survive harshest environmental condition significantly. In the current period of time environmental dame have become visible harms in the recent years. It is very serious issue for viewed of zero emission society required change over from the mass waste, mass consumption, mass production to a less and zero waste mass product. In this series lime and marble by product (Marble Stone Dust) & lime stone powder does not harm the environment because it does not produced by product. It is little bit harmful for human as well as animal. In the term of non biodegradable matter it is less friendly to environment. In the developing countries are required new technologies and less pollution products. The by product of lime (Lime Stone Dust) & Marble (Marble Stone Dust) have different chemical properties like Calcium Carbonates ($CaCO_3$), Silica (SiO_2), Alumina (Al_2O_3), Iron Oxide (Fe_2O_3), Calcium Oxide (CaO) & Magnesia etc. For that type of properties lime stone powder & marble dust used as pozzolanic material in the civil engineering work. The marble dust & lime stone powder is useful for increasing content of alkali in the cement.

1.1 Lime stone powder:-

In the research found the supplement addition in the cement has focused on particle size of cement is same. If lime stone powder have surface area 0.952 m^2/g and added to cement upto 15% the 7 days strength (Compressive Strength) 22% higher then the controlled mixture. Other researcher also find that when decrease the size of supplement it is helpful to increase compressive strength but when we compared to content mixture with different ages and different percentages of mixture its strength increase or decrease **(Cyr, M., Lawrence, P., and Ringot, E., 2006)**.

Figure- 1.1 Typical image of lime stone dust (Bouasker, M., et al., 2008)

also research that in first 24 hours the degree of hydration as well as chemical shrinkage is increase.

1.1.1 Permissible limit of use of lime stone powder in concrete: -

Lime Stone dust with particular size, compare with cement it improve the water retention capacity and workability of mortar. Its components nearly same as fine sand is used in the mortar and concrete mixed as a partially replacement of fine aggregate. In the other hand we can also say that lime stone either as a replacement of cement & sand increase flow ability and consistency of the mortar. The one of the most property of lime, it has self compacting capacity in concrete mixed. **(Diamantonis, N., et al., 2009)**.

Lime stone is also improve concrete consistency and reduced water demand. In concrete mixed design required low water-to-cement (W/C) ratio. The high replacement of lime stone dust produced same result as ordinary Portland cement mixed. **(Damtoft, J.S., et al., 2008)**.

Table-1.1 Maximum permissible limit on use of limestone powder in concrete

Standard	Maximum permissible limit	Recommendation
American Society for Testing and Materials (ASTM)	15 Percent	ASTM has approved 15 Percent limestone in 2013
CEN	35 Percent	For CEM II/B-L "portland limestone cement"
CSA	15 Percent	CSA has approved Percent % in 2009

In Oras Blended Hydraulic Cement has been permitted by various organizations that lime stone dust is a component in OPC cement. The maximum percentage of addition of lime stone dust is vary according to the industry standard and country. In the above table 1.1 show the maximum permissible limit of the addition of lime stone dust and the range is 15% to 35% on the basis of standard. According to ASTM C150 for a Portland cement the maximum 5% lime stone dust is used but according to the ASTM C595 for Blended Hydraulic Cement allows up to 15% lime stone dust.

Lime stone dust also introduced in two ways: -

(a) Before grinding of clinker.
(b) At the time of additive or replacement to cement.

Lime stone dust add at the time of grinding or during batching process of concrete. The addition of limestone micro-particle are added to cement at the time of before grinding process in the Blended Cement it enhanced the rate of hydration and strength at early stages of hydration process. At the time of grinding process of clinker lime stone crushed to a very fine powder so we observed that it is more soft as compare with cement. **(Hawkins, P., Tennis, P., 2005)**. In my research work to study the effect of addition of lime stone micro particle as a bulk additive to cement and studied the effect of lime stone micro particle on short & long term properties of cement.

1.2 Marble dust:-

Figure- 1.2 Typical image of marble dust

Figure- 1.3 Image of marble dust

Marble is a type of metamorphic rock. At the high temperature and pressure metamorphosed lime stone structures of calcite dolomite on the combination of both mineral. Lime stone and marble is a sedimentation rock the main mineral in this type of rock is calcium carbonate. In the stone market the term commercial marble used due to it referred both metamorphic marble and sedimentary lime stone. Therefore the presentation of calcareous in stone we take it my work.

The importance of marble industries gained last 2 decades. The developed and developing countries like US, China, India, France, Belgium and many more country reserved marble. In the processing of marble stone destroyed by scrap 30% due to being smaller in size and irregular shaped. In the process of extraction million of tons marble powder are processed every year in out ATM in the world. Due to this environment damages the industries which produced marble dust it is harmful for skin allergies and many more diseases. It is the most disadvantage of marble but it have different several application. It is used as a supplement, filler and additive in different industries.

In the world specially Asian countries waste management is most critical issue. To enhance the world economy Asian country play important role in past decades.

Asian country is carry third large global economy in the world. The Varity and the living standards is varied large in Asian country. In Asian country there are different industrialization with respect to rural area is more. All these parameters say the production of waste. According to the analytical classification the low income countries (Bangladesh, Cambodia, Republic of Korea) and developing country like (India , Pakistan, Srilanka and Vietnam and most China include in this region to produced waste.

These countries about 60% of industries and hazardous waste is produced or other 10% waste dumped in Ocean every year. Remaining either goes to incineration processor or treated as higher expenses. Over waste management. To overcome this issue many researchers tried to resolve this problem.

Including solution of the waste management some suggestions are given blow: -

1. In the cycle of waste management waste prevention, reuse, material recycle, compositing, recovery and final disposal.
2. For the case of stone waste increase awareness and industries should not produced plan waste.

1.3 Objectives of our proposed research work:-

The main objective of this research work is to understand the effect of the replacement of cement with adding up the lime stone dust and marble dust successfully and check their properties.

The objectives can be classified into the following three main categories.

1. To understand the effect of using various percentages of lime stone powder and marble dust in concrete and their significant effect on their properties at fresh state like workability, consistency, setting time and degree of hydration.
2. To understand the effect of these prepared mix on the physical properties of concrete like compressive strength and flexural strength.
3. To compare the effects of adding lime stone powder and marble dust in concrete separately.

II. LITERATURE REVIEW

As useful recycled materials, lime stone powder and marble dust are mainly used in fields related to civil engineering, for example, in cement, as pozzolanic material (supplementary cementitious materials), and coarse aggregate. Their recycling ratio is close to 100%, and it is also used in cement concrete without adverse effects in concrete durability. Therefore, it is considered ideal for recycling. Recently, lime stone powder and marble dust has been used as a construction material to decrease environmental issues. The addition of limestone reduces the initial and final setting time of cement, as well as porosity, whereas free lime and combined water increase with increasing limestone content **(Heikal, M., et. al, 2000)**. The qualities of the limestone filler affect the performance of the cement in concrete and the water demand of the cement **(Livesy, P., 1991)**.

Dr. M. Vijaya Sekhar Reddy, K. Ashalatha, M. Madhuri, P. Sumalatha, 2015 presented the research paper on the use of Marble has been extensively used in structures since ancient times. Most of the monuments and the ancient sculptures were made with the help of marbles. At the present time, marbles are used for the decoration purpose, which increases its demand in the current market. With the increase in manufacturing of marbles it increases the waste that obtained from it. As marble powder is the waste product obtained during the process of sawing and shaping of the marble by parent marble rock, it contains heavy metals which makes the water unfit for use. Marble powder generates environmental problems. Due to the environmental problems, it has a great impact on the human health as well as on environment. To manage its effects we have to use this waste in the production of concrete. This study was aimed at utilizing waste marble dust (WMD) in the construction industry itself as fine aggregate in concrete, replacing the natural sand. The replacement is done partially and fully in the various proportions like 0%, 25%, 50%, 75% and 100% and its effect on properties of concrete were investigated. The study showed that waste marble dust can effectively be used as fine aggregate replacement (up to 50%) without substantial change in strength.

These days, concrete made with Portland cement is possibly the most widely used man made material in all around the world. In spite of this fact, concrete production is one of the most important concerns worldwide that impact the environment with major impact being global warming due to Carbon di oxide emission during the manufacturing of cement. Otherwise, when industrial wastes are recycled or reused, Carbon di oxide (CO_2) emissions are reduced and less material is dumped as landfill and more natural resources are saved by this. Hence an attempt is made to replace the cement by granite dust powder in cement concrete. In this study, the possibility of using granite dust powder in the cement concrete production was examined by considering the effects of blending of granite dust powder with cement on the

performance of fresh and hardened concrete. In this experimental program, granite dust powder was used in the concrete as a cementitious material as partial replacement of cement. Replacement of cement was made by level of 5%, 10%, 15% and 20% by weight of cement. For each replacement the workability, compaction factor and strength test was conducted. Compressive strength after 7 and 28 days curing was obtained. From the test results it was found that concrete at the level of 15% partial replacement of cement with granite dust powder has better workability and high compressive strength of 7 days and 28 days curing. The granite dust powder is free of cost. Hence it seems to be economical **(Dr. G. Elangovan, 2015).**

III. MATERIALS AND THEIR PROPERTIES

3.1 General:-

This chapter deals with different types of materials.

3.2 Materials:-

The material which id used in my research works are as following :-

S. No.	Specific Work	Material	Used as
1	Binding	Cement	Binding Purpose
2	Supplementary Binding Material	Lime Stone Dust % Marble Dust	Filler Material
3	Filler material	Fine aggregate (Sand)	Filler Material
4	Strengthening material	Aggregates	Filler Material
5	Mixed	Water	Filler Material

3.2.1 Binding material (cement):-

Cement is a binding material which is formed by crushing, burning and then grinding of the stones clinkers these clinkers are formed by siliceous, argillaceous and calcareous stones. Cement provides binding property by the process of heat of hydration with the help of water, now a day's cement is widely used material on the earth. The various uses of cement are bonding of bricks, plastering of the walls, preparation of the base for the foundation, flooring work, grouting work and final finishing. Cement is classified into three grades those are as follows: -

I. 33 grades
II. 43 grade and
III. 53 grades.

These grades are categorized upon their compressive strength at 28 days. PPC 43 grade of JAYPEE CEMENT was used in this thesis work as shown in Figure-3.1.

Figure-3.1 Photograph of cement used in our work

In our thesis work we use PPC (Portland Pozzolana cement) of grade 43 and the properties we found are presented in the table-3.1 below after performing the laboratory test.

Table-3.1 Properties of PPC 43 grade

S. No.	Particulars	Result values after test	Requirements of IS:1489-1991 (Part-1)	
1.	Normal Consistency (%)	32	33	
2.	Setting Time (minutes)			
	a. Initial Setting Time	145-155 Minutes	30 Minutes	Minimum
	b. Final Setting Time	200-275 Minutes	600 Minutes	Maximum

By these test results we can say that our cement is fit for construction use.

3.2.2 Supplementary binding material:-

Supplementary binding materials (SBM) or we can say supplementary cementations materials react with the cement hydration products in the presence of lime and water

to form supplementary calcium silicate hydrates (C-S-H), To increasing the durability & strength of concrete (C-S-H) helped in the ordinary concrete. **(Gutteridge, W.A., 1990 and Bijen, J., 1996).**Many researcher and scientist in the laboratory as well as in the field the use of SBM in the concrete.

There are two different SBM materials used in our this work which is given in the below:-

1. Lime Stone Powder.
2. Marble Dust

3.2.2.1 Lime stone powder (LSP): -

The ground lime stone powder finally used in my thesis work. Many chemical properties include in the L.S.P like $CaCO_3$, $MgCO_3$, SiO_2, Al_2O_3, Fe_2O_3, SO_3, P_2O_5 & in major quantity $CaCO_3$ & $MgCO_3$ used. **(Harris, P. M., 1982)**. The main form of lime stone (CaCO3) is broadly used in the cement production. In the manufacturing of cement the main mixture is calcining (75%) lime stone and calcium silicate clay (25%) used and the little quantity of Gypsum also used in cement manufacturing. **(Abebe Dinku, 1991)**.In the manufacturing of cement $CaCO_3$ play a great role say IS (Indian Standard) because it fulfil the following requirement which is given below:-

1) In 100% of cement mass 75% mass fulfill by $CaCO_3$.
2) The organic content shall be < 0.21% of volume of cement.

The main chemical composition of lime stone powder is in table 3.2

3.2.2.2 Chemical composition of lime stone powder:-

Table-3.2 Chemical composition of lime stone powder

S. No.	Chemical name	Test result of lime stone powder (%)
1	Calcium Carbonate, $CacO_3$	93.75%
2	Silicate, SiO_2	2.58%
3	Iron Oxide, Fe_2O_3	0.12%
4	Alumina, Al_2O_3	1.03%
5	Calcium Oxide CaO	5.31%
6	Magnesium Oxide MgO	0.4%

According to the following test result of lime stone (Calcium Carbonate) as a supplement is above 93% and clay 1.15% which is satisfying IS requirement other hand it also fulfill the requirement of scientist and researcher. Lime stone and Marble dust encouraging utilization as additive in PCC cement. And other parameter like $CaCO_3$ > 90%, Al_2O_3 < 2%, MgO < 5% and SO_3 < 0.5% also fulfill IS requirements.

3.2.2.1.2Effect on consistency and setting times after addition of lime stone powder in PPC:-

3.2.2.1.2.1 Effect of lime stone powder on consistency:-

Normal consistency tests were conducted to observe the changes in water requirements of the pastes due to the addition of limestone powder. The test result shows that the consistency of the cement pastes slightly decreases with the increase in proportion of limestone powder content in the cement (Table-3.3). This decrease in consistency is due to the addition of limestone which increases the plasticity of cement paste. This may be recognized to the effect of limestone powder as an active component in the hydration of cement, i.e. the rate of hydration increases and the amount of the hydration products also enhances. The limestone supplements act as a nucleating agent which increases the hydration rate of cement paste and also the limestone forms mono-carbon aluminates hydrate that requires less water than that of other component of the cement.

Table-3.3 Effect of lime stone powder on standard consistency

S. No.	% of lime stone powder added	% of PPC (Pozolona Portland Cement)	Cement Consistency (Standard Consistency)
1	0	100	32
2	5	95	30
3	10	90	29
4	15	85	28

The above table show the result of water demand in the mixed. The addition of lime stone powder reduced % of water demand.

3.2.2.1.2.2 Effect of lime stone powder on initial setting time:-

According tothe Indian standards the limit of initial setting times for composite portland cement should not to be less than 45 minutes. Europian standards also specify the initial and final setting time for Portland Pozzolana cement to be 45 minutes and 600 minutes, respectively. After comparing the obtained testresults of our research investigation indicated in the Table-3.4 and Table-3.5, every limestone powder added

cement sample produced, satisfy the requirements specified by both the Indian and European standards.

Table-3.4 Effect of lime stone powder on initial setting time

S. No.	% of lime stone powder added	% of PPC (Pozolona Portland Cement)	Initial setting time
1	0	100	145
2	5	95	155
3	10	90	160
4	15	85	165

The test result of initial setting time for mixed proportion with cement and lime stone powder increases the initial setting time.

3.2.2.1.2.3 Effect of lime stone powder on final setting time:-

Table-3.5 Effect of lime stone powder on final setting time

S. No.	% of lime stone powder added	% of PPC (Pozolona Portland Cement)	Final setting time
1	0	100	210
2	5	95	220
3	10	90	230
4	15	85	235

The test result of final setting time for mixed proportion with cement and lime stone powder increases the final setting time.

3.2.2.2 Marble dust:-

The marble dust buying from local market of Bhopal M.P.. At the time of mixing process on concrete we sieving it with IS 90 micron.

Various test are performed to find out properties of waste marble dust. The following test performed which is given in table 3.6

Table-3.6 Test result of chemical composition of Marble dust

S. No.	Chemical Composition	Marble Dust Result In (%)
1	Calcium Oxide	34.98
2	Magnesium Oxide	18.96
3	Silica	2.76
4	Alumina	0.98
5	Iron Oxide	0.4
6	LOI	41.92

In the above table show the following test result of marble dust 35% of $CaCO_3$, 18.96% of $MgCO_3$, 2.75% of SiO_2 which is fulfill IS requirements as well as scientist and researchers for finding chemical composition of marble dust and utilization as addition in Portlant Pozzolona Cement (PPC).

3.2.2.2.1 Effect on consistency and setting times after addition of Marble dust in PPC:-

3.2.2.2.1.1 Effect on consistency of addition Marble dust in PPC:-

The standard consistency tests were perform in the laboratory according to Indian standards with the partial replacement of cement in variable percentage like 5%, 10%, 15%. The test results are presented in the table-3.7 below.

Table-3.7 Effect of Marble dust on standard consistency

S. No.	% of marble dust added	% of PPC (Pozolona Portland Cement)	Standard consistency
1	0	100	32
2	5	95	31
3	10	90	30
4	15	85	29

By these test results we can say that standard consistency reduces with increase in the percentage content of marble dust in PPC.

3.2.2.2.1.2 Effect of Marble dust on initial setting time:-

Table-3.8 Effect of Marble dust on initial setting time

S. No.	% of marble dust added	% of PPC (Pozolona Portland Cement)	Initial setting time
1	0	100	145
2	5	95	170
3	10	90	180
4	15	85	185

The test result of initial setting time for mixed proportion with cement and marble dust increases the initial setting time.

3.2.2.2.1.3 Effect of Marble dust on final setting time:-

Table-3.9 Effect of Marble dust on final setting time

S. No.	% of marble dust added	% of PPC (Pozolona Portland Cement)	Final setting time
1	0	100	210
2	5	95	225
3	10	90	240
4	15	85	245

The test result of final setting time for mixed proportion with cement and Marble dust increases the final setting time.

IV. MIX DESIGNING AND SAMPLE PREPARATION

4.1 Mix Calculations:-

The mix calculations per unit volume of concrete according to IS code shall be as follows:

1- Volume of concrete = 1 m^3 eq. **1**

2- Volume of cement = $\frac{\text{Mass of cement}}{\text{Specific gravity of cement}} \text{ X } \frac{1}{1000}$

$= \frac{372}{3.15} x \frac{1}{1000} = 0.118\ m^3$ eq. **2**

3- Volume of water = $\frac{186}{1} x \frac{1}{1000} = 0.186\ m^3$ eq. **3**

4- Volume of all aggregate = [eq. 1 – ({eq. 2 + eq. 3})]

$= 0.696\ m^3$ eq. **4**

5- Mass of coarse aggregate = (eq. 4) x Volume of coarse aggregate x Specific gravity of coarse aggregate x 1000

= 0.696 x 0.62 x 2.65 x1000

= 1143.528 kg

Mass of fine aggregate= (eq. 4) x Volume of fine aggregatex Specific gravity of fine aggregate x 1000

= 0.696 x 0.38 x 2.72 x1000

= 719.39 kg

Table-4.1 Proportion of Different Materials In Our Mix

Cement	Fine aggregate	Coarse aggregate	Water
372	719.39kg	1143.528 kg	186litre
1	1.93	3.074	0.50

4.1.1 Preparation of Trial Mixes:-

On the basis of IS,4no trial mixed were prepared. In which two were prepared with 0.50 W/C ratio and remaining two with 0.55 W/C ratio. In Each mixed we prepare 6 sample (Cubes) and tested after 7 & 28 days. The following reading of proportion given in the table 4.6

Table-4.2 Quantities Per Cubic Meter for Trial Mixes (M-25)

Mix No.	W/C	Slump (mm)	Water (l/m³)	Cement Kg/m3	Sand Kg/m³	Coarse Aggregate Kg/m³	Average cube strength at 7 days (MPa)	Average cube strength at 28 days (MPa)
Mix-A	**0.50**	**50**	**186**	**372**	**719.39**	**1143.52**	**21.31**	**31.8**
Mix-B	0.50	100	208	416	633.18	1162.58	19.93	30.2
Mix-C	0.55	50	186	338.18	724.32	1126.62	20.53	31.1
Mix-D	0.55	100	208	378.18	712.33	1139.52	20.95	30.8

The Mix-A was selected as the design mix because its average cube strength is very close to the target mean strength of the concrete with appropriate content of cement among all the trial mixes.

4.2 Prepared Mixes For Testing of The Compressive Strength:-

Various mixes of concrete were prepared to find out compressive strength with various % of replacement with cement by lime stone dust and marble dust and the range of the stone powder & marble dust is 5% to 15%

Table-4.3 Prepared mixes of concrete for Testing (Compressive Strength of Concrete)

Mix No.	W/C ratio	Slump	Lime stone powder %	Water (l/m³)	Cement Kg/m³	Sand Kg/m³	Coarse Aggregate Kg/m³
Mix-I	0.50	50 mm	0	186.00	372.00	719.391	1143.522
Mix-II	0.50	50 mm	5	186.00	353.41	719.391	1143.522
Mix-III	0.50	50 mm	10	186.00	334.52	719.391	1143.522
Mix-IV	0.50	50 mm	15	186.00	316.21	719.391	1143.522

V. ANALYSIS OF RESULTS

5.1 General:-

Series of the tests were carried out on the samples prepared with various mixes i.e. variable percentage of supplementary cementations materials in partial replacement of cement (5%, 10% and 15%). The tests conducted were compressive strength, split tensile strength and flexural strength of concrete mixes. The test results for compressive strength given in the table 5.1

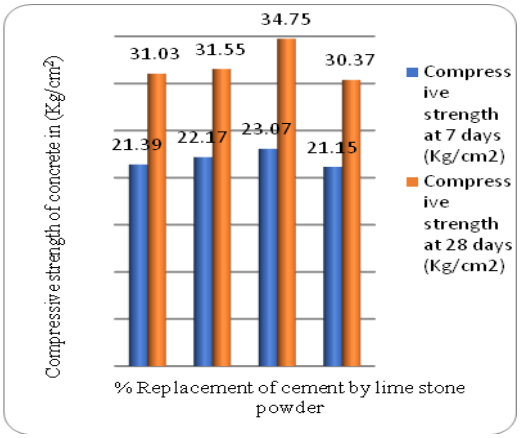
5.2 Compressive Strength Test Results:-

After comparing all these test results we prepare a combine table showing the average compressive strength of the prepared samples after 7 days and 28 days.

Table-5.1 Test Results of Compressive Strength of All The Mixes (Prepared With Lime Stone Powder)

S. No.	Lime stone powder (%)	Cement Content (%)	Compressive strength at 7 days (Kg/cm²)	Compressive strength at 28 days (Kg/cm²)
1	0	100	21.39	31.03
2	5	95	22.17	31.55
3	10	90	23.07	34.75
4	15	85	21.15	30.37

Graph-5.1 Test Results of Compressive Strength of All The Mixes (Prepared With Lime Stone Powder)



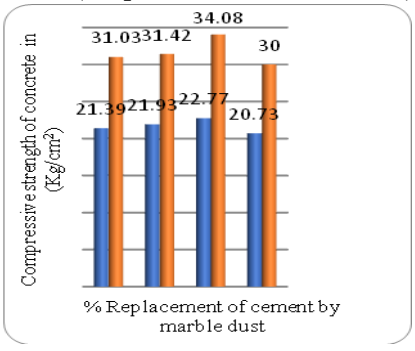
After comparing all these test results we found that when we replace 10 % cement by lime stone powder the results of compressive strength at 7 days shows approximately 8 % increment in compressive strength and at 28 days shows 12 % increment in compressive strength.

After comparing all these test results we prepare a combine table showing the average compressive strength of the prepared samples after 7 days and 28 days.

Table-5.2 Compressive strength result with different % of marble dust and lime stone powder at 7 &28 days curing

S. No.	Marble dust (%)	Cement Content (%)	Compressive strength at 7 days (Kg/cm²)	Compressive strength at 28 days (Kg/cm²)
1	0	100	21.39	31.03
2	5	95	21.93	31.42
3	10	90	22.77	34.08
4	15	85	20.73	30.00

Graph-5.2 Test Results of Compressive Strength of All The Mixes (Prepared With Marble Dust)



After comparing all these test results we found that when we replace 10 % cement by Marble dust the results of compressive strength at 7 days shows approximately 6.5 % increment in compressive strength and at 28 days shows approximately 10 % increment in compressive strength.

5.3 Split Tensile Strength Test Results:-

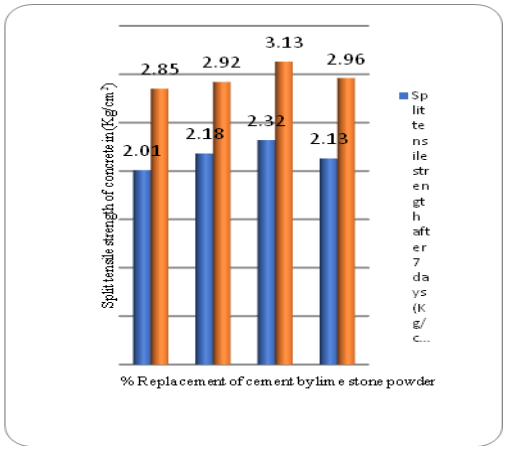
The laboratory test results are presented below in the tabular form for different mixes with variable percentage of lime stone powder and marble dust.

For the comparative study of these test results we prepare a combine table i.e. showing results of all the mixes.

Table-5.3 Test Results of Split Tensile Strength of All The Mixes Prepared With Lime Stone Powder

S. No.	Lime stone powder (%)	Cement Content (%)	Split tensile strength after 7 days (Kg/cm²)	Split tensile strength after 28 days (Kg/cm²)
1	0	100	2.01	2.85
2	5	95	2.18	2.92
3	10	90	2.32	3.13
4	15	85	2.13	2.96

Graph-5.3 Test Results of Split Tensile Strength of All The Mixes Prepared With Lime Stone Powder



After comparing all these results we can say that lime stone powder increase the compressive strength of a concrete mix up to 15.4 % at 7 days curing and approximately 10 % at 28 days curing a certain limit but after that range it starts reducing its strength.

For the comparative study of these test results we prepare a combine table i.e. showing results of all the mixes.

5.4 Flexural Strength Test Results:-

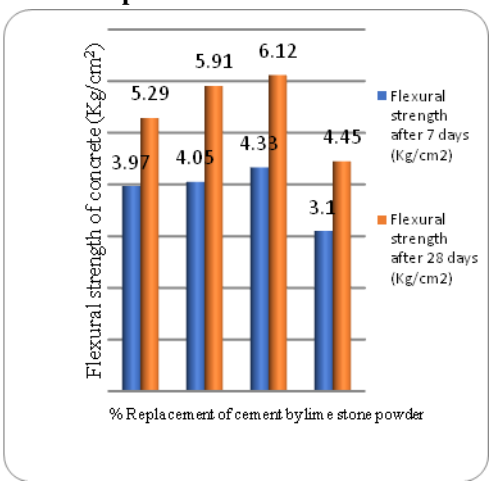
The laboratory test results are presented below in the tabular form for different mixes with variable percentage of lime stone powder and marble dust.

For the comparative study of these test results we prepare a combine table i.e. showing results of all the mixes.

Table-5.4 Test Results of Flexural Strength of All The Mixes Prepared With Lime Stone Powder

S. No.	Lime stone powder (%)	Cement Content (%)	Flexural strength after 7 days (Kg/cm²)	Flexural strength after 28 days (Kg/cm²)
1	0	100	3.97	5.29
2	5	95	4.05	5.91
3	10	90	4.33	6.12
4	15	85	3.10	4.45

Graph-5.4 Test Results of Flexural Strength of All The Mixes Prepared With Lime Stone Powder



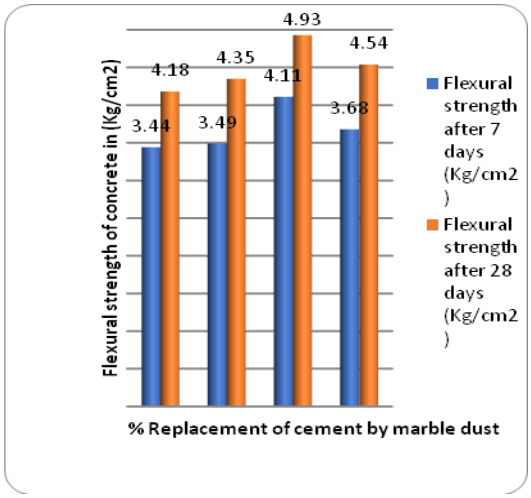
After comparing all these results we can say that lime stone powder increase the compressive strength of a concrete mix up to 9.06 % at 7 days and 15.68 % 28 days respectively till certain limit but after that range it starts reducing its strength.

For the comparative study of these test results we prepare a combine table i.e. showing results of all the mixes.

Table-5.5 Flexural strength result with different % of marble dust and lime stone powder at 7 &28 days curing

S. No.	Marble dust (%)	Cement Content (%)	Flexural strength after 7 days (Kg/cm^2)	Flexural strength after 28 days (Kg/cm^2)
1	0	100	3.44	4.18
2	5	95	3.49	4.35
3	10	90	4.11	4.93
4	15	85	3.68	4.54

Graph-5.6 Test Results of Flexural Strength of All The Mixes Prepared With Marble Dust



After comparing all these results we can say that marble dust increase the compressive strength of a concrete mix up to 19.48 % at 7 days and 17.94 % at 28 days till certain limit but after that range it starts reducing its strength.

VI. CONCLUSION AND RECOMMENDATION FOR FUTURE RESEARCH

6.1 Conclusion:-

The objectives of the study were to study the effect of partial replacement of Lime Stone Powder and Marble Dust with cement used as additive in concrete. The concrete specimens were prepared by partial replacement of cement with lime stone powder & marble stone dust from 5%, 10% and 15%. After having trial of mixes, the water-cement ratio selected was 0.50 and it was kept constant for all the mixes. In fresh concrete workability check after preparing the concrete whereas the compressive strength, splitting tensile strength and flexural strength of concrete was tested after 7 and 28 days of curing. The main conclusion are listed below:-

1. Lime stone powder & marble dust addition improves the compressive, split tensile & flexural strength of concrete.
2. After studying of compressive strength it increased 8% at 7 days and 12% at 28 days curing when we partially replace cement with lime stone powder.
3. The compressive strength it increased 6.5% at 7 days and 10% at 28 days curing when we partially replace cement with marble dust.
4. The split tensile strength it increased 15% at 7 days and 10% at 28 days curing when we partially replace cement with 10% of lime stone powder.
5. The split tensile strength, it increased 15% at 7 days and 10% at 28 days curing when we partially replace cement with 10% marble dust.
6. The flexural strength it increased 16.23% at 7 days and 16.86% at 28 days curing when we partially replace cement with lime stone powder.
7. The split tensile strength, it increased 19.78% at 7 days and 17.94% at 28 days curing when we partially replace cement with marble dust.

On the basis of this research work we can say that the lime stone & marble dust is useful material for civil engineering construction that's why we refer this as a useful by product in the civil engineering.

6.2 Recommendation for Future Research:-

Theses are some recommendation for future work in this field.

1. Further studies need to be conducted by using materials like glass powder, granite dust and other stone's powder with these materials could be tested for all types of strength.
2. Further studies need to be conducted for the test of durability, soundness, thermal insulation, and water absorption of the concrete.
3. In our thesis work we did not add any admixture, in this area we also studied in future.
4. To find out detailed properties of these material we can studied in live structure and higher rise buildings in future.

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