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STUDY ON STRENGTH PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY MARBLE POWDER FOR USAGE IN RIGID PAVEMENT

S.Dhatri Aishwarya[1] ,P.V.Kartheek[2] ,P.Avinash[3] ,T.P.V.V.Sudheer[4] ,M.Lalitha Pallavi[5]

[1234]Under Graduate Students, Department of Civil Engineering, Seshadri Rao Gudlavalleru Engineering College, Gudlavalleru, India.

[5]Assistant Professor, Dept. of Civil Engineering, Seshadri Rao Gudlavalleru Engineering College, Gudlavalleru, India.

Abstract : Recently, the high demand for marble stones has progressed in the construction industry, ultimately resulting in waste marble powder. Thus, environmental degradation is unavoidable because of waste generated from quarry drilling, cutting, and blasting methods.

Marble waste is produced in an enormous amount in the form of odd blocks and unwanted rock fragments. Absence of a systematic way to dispose of these marble waste massive mounds results in environmental pollution and landfills.

To reduce this risk, an effort has been made for the incorporation of waste marble powder into concrete for sustainable construction. In this research work, an attempt has been made to understand the behavior of concrete with partial replacement of cement with added percentage values of marble powder and attain required strength. Partial replacement of marble powder in cement accordingly in the range of 0%, 5%, 10%, 15%, 20%, 25%, by weight for M30 grade of concrete. It analyzed the research work the compressive strength, flexural strength, split tensile strength values at 7 ,28 day.

Keywords – Marble powder, Compressive Strength, Split Tensile Strength, Flexural Strength

I. INTRODUCTION

Concrete is the important material in construction other than steel and timber and its main constituents are cement, sand, fine and coarse aggregates, and water. But, one of the greatest environmental concerns in construction industry are the production of cement which emits large amount of CO_2 to the atmosphere. It is estimated that production of one ton of clinker/cement releases equally one ton of CO_2. Therefore, the past two decades of research is diverted primarily in making concrete without cement or at least partially in low or high volumes, replacing cement by suitable alternatives like fly ash, silica fume, ground granulated blast furnace slag, rice husk ash. China, India, united states of America is the order of countries having largest cement consumption.

Concrete is a widely used vital material in the construction world. Producing cementin huge amount in factories directly influences the greenhouse gases emission. Reductions in getting good quality limestone directly affect the production of good quality cement. Higher cement content of High Strength Concrete significantly affects the quality at the hardened state due to shrinkage and greater evaluation of heat of hydration. The cost of construction also gets escalated and leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized.

In building industry, Marble has been commonly used for various purposes like flooring, cladding etc., as a building material since the ancient times. The industry's disposal of the marble dust material, consisting of very fine powder, today constitutes one of the environmental problems around the world. In India, marble dust is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health and the marble processing is one of the most thriving industry the effects. Therefore, the scientific and industrial community must commit towards more sustainable practices. Marble dust is not only the economical material but also improves the properties of the concrete so by varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated.

II.MATERIAL

Marble powder

One of the major wastes produced in the stone industry during cutting, shaping, and polishing of marbles is the MDP. During this process, about 20- 25% of the process marble is turn into the powder form. India being the third (about 10%) top most exporter of marble in the world, every year million tons of marble waste form processing plants are released. Due to the availability of large quantity of waste produced in the marble factory, this project has been planned and preceded. It has been calculated that huge tons of Marble Dust Powder are being produced in the process of quarrying worldwide. Disposal of this waste has become an environmental issue therefore it utilization of marble powder in concrete for improved harden properties. Marble is a metamorphic rock. It is composed of 100% $CaCO_3$.Marble is used in construction and has a good durability and aesthetic appearance. Chemically, marbles are composed mostly of calcite, dolomite or serpentine minerals. Marble dust powder is produced during the marble cutting process, which is 20% of the total marble quarried. The limited availability of natural minerals in the production of cement pushes us to find alternatives for replacing cement, thereby reducing emission of carbon dioxide production which is harmful for the environment.

In INDIA, the marble and granite stone processing is one of the most thriving industry the effects if varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been

investigated. The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment. Marble powder of 90Micron passing is used. This waste marble Waste powder is replaced in increasing percentage from 0% to 30%. Advantages of using marble powder are as follows:

- It acts as a filler and reduces voids.
- Increases the strength of concrete.
- Low Cost.
- Good binding.

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III.MIX PROPORTION:

The mix proportion of M30 grade concrete is CEMENT: F.A: C.A: 1: 1.42: 2.56

Table 1. Mix proportion Ratios for M30 Grade

Cement Kg/m^3	**Fine aggregate Kg/m^3**	**Coarse aggregate Kg/m^3**	**Water l/m^3**
437	622.2	1122	197
1	1.42	2.56	0.46

IV.METHODOLOGY :

Workability: Slump cone method consist a cone of 300mm height, 200mm bottom diameter and 100mm top diameter. For doing slump test concrete is poured into the cone in 3 layers and tamped at 24 times for each layer with a tamping bar. After total compaction the cone will removed and height of cone will measure. The difference between actual height and formed cone height will give slump value.

Compressive strength: Compressive strength or crushing strength is the main property observed in testingthe cubes. Cubes are tested to calculate Compressive strength by applying gradual loading in Compression Testing Machine. The reading of the failure load is occurred on the top of the machine in the indicator.

The Compressive strength has been calculated by the formula Compressive strength = applied load/cross sectional area

= P/A

= load/area N/mm^2

Split Tensile Test: Split tensile strength is the most important property of concrete. Concrete generally weak in tension. So, to improve tensile behavior of concrete, split tensile strength is important.It is also important in reducing formation of cracks in concrete. Cylinders are casted for calculating split tensile strength. The cylindrical specimens are also tested in compression testing machine. The cylinders are placed in axial direction by facing cylindrical face to the loading surface.

Here the cylinder split into the two parts and reading observed on the top of the machine. The split tensile strength has been calculated by the formula

Split tensile strength = $2P / \pi ld$

P = failure load (applied load)

L = height of the cylinder specimenD
= diameter of mold

Flexural Strength: Most of the beam failures are occurred due to their failure in flexural strength. It is important that prediction of flexural strength by calculating modulus of rupture for reducing failure problems in beams. The calculation of modulus of Rupture in terms of Flexural strength is the main aim in casting beam specimens. In this modulus of rupture is calculated by testing specimens in the universal testing machine. In this line of facture is the main important propertyin formulating the modulus of rupture.

The modulus of rupture is denoted by "fcr ".

The 'f' value is mainly based on the shortest distance of line fracture 'a'

If 110mm < a < 133mm, $f_{cr} = 2PL/bd^2$

If a > 133mm, $f_{cr} = PL/bd^2$

If a < 110mm, the test shall be discarded.

V..RESULTS

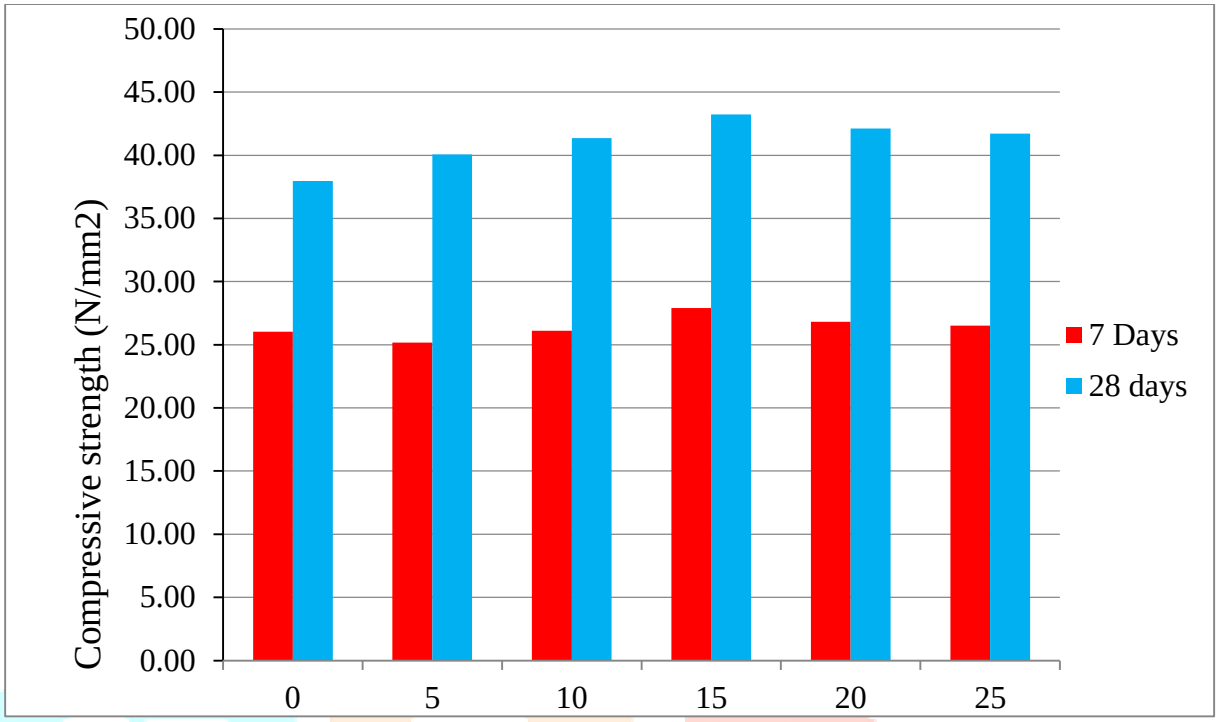
A.COMPRESSIVE STRENGTH TEST

Compressive strength is obtained by applying crushing load on the cube surface. So, it is also called as crushing strength. Compressive strength of concrete is calculated by casting 150mm x 150mm x 150mm cubes. The test results are presented here for the Compressive strength of 7 days and 28 days of testing.

Table 2 Compressive strength results of 7 days, 28 days

Mix	**Compressive strength(N\mm^2)**	
	7 days	**28 days**
Conventional	26.02	37.96
MP 5%	25.18	40.07
MP 10%	26.12	41.35
MP 15%	27.91	43.24
MP 20%	26.82	42.11
MP 25%	26.52	41.72

Fig1. Compressive strength results for 7 days & 28 days



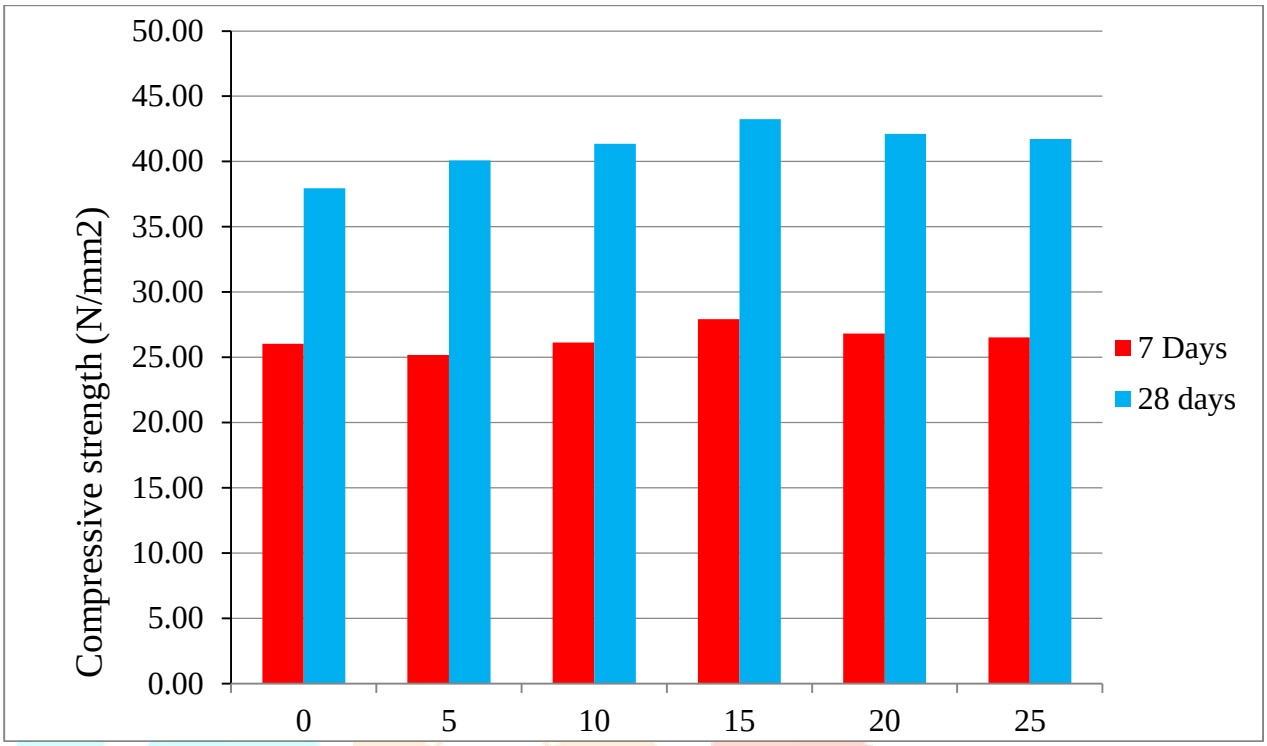
B.SPLIT TENSILE TEST

Out of all the properties of concrete, tensile strength is very important one. The tensile strength is calculated by testing cylindrical specimens of size 300mm height and 150mmdiameter. Here each set of specimens are tested for 7 & 28 days of curing. The details of test results are summarized below.

Table3. Split tensile strength results for 7 days & 28 days

Mix	**Split tensile strength(N\mm^2)**	
	7 days	**28 days**
Conventional	3.12	4.21
MP 5%	3.54	4.49
MP 10%	3.91	4.92
MP 15%	4.23	5.24
MP 20%	3.88	4.81
MP 25%	3.67	4.56

Fig 2. Split tensile strength results for 7 days & 28 days



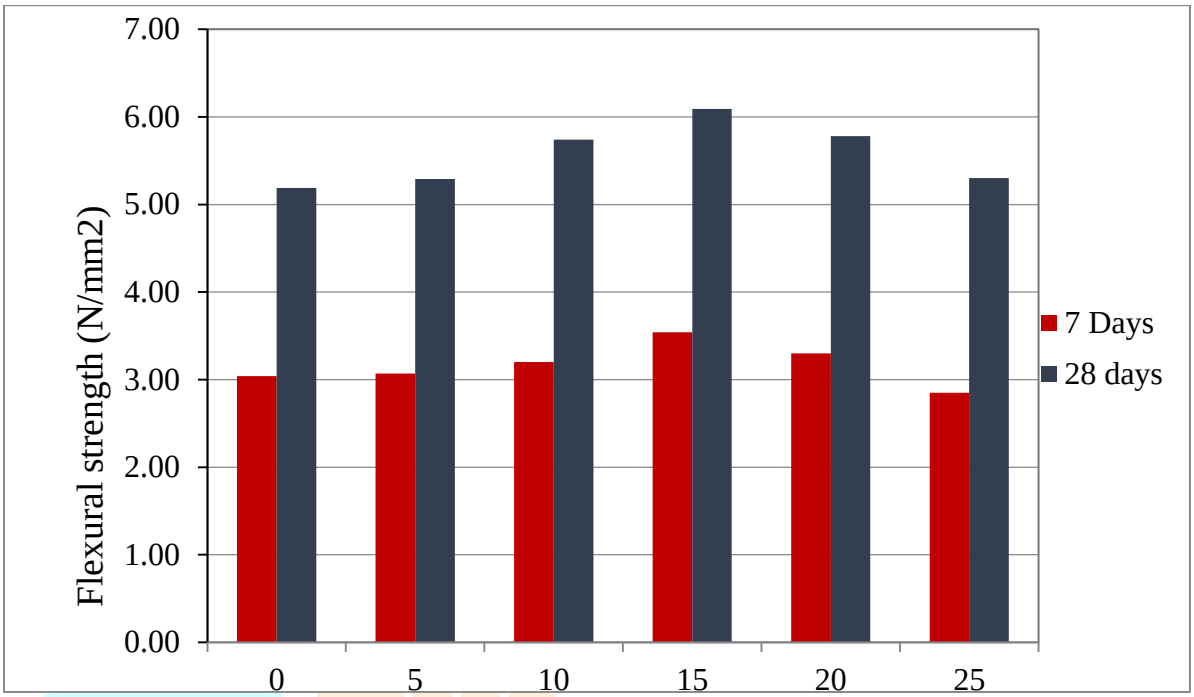
C.FLEXURAL STRENGTH

The modulus of rupture is the main property for the flexural members. To improve the flexural strength of concrete is one main task in present construction activities. Flexural strength for concrete is determined by casting beam specimens. The beam dimensions are of 500mm x 100mm x 100mm. Here each set of specimens are tested for 7 & 28 days of curing. The modulus of rupture values for both grades are described as follows.

Table 7.3 Flexural strength results of 28 day

Replacement %	**7 Days**	**28 days**
0	3.04	5.19
5	3.07	5.29
10	3.20	5.74
15	3.54	6.09
20	3.30	5.78
25	2.85	5.30

Fig 7.3 Flexural strength results for 7 days & 28 days



CONCLUSION

After the analysis of the result of the experimental programme the following conclusions were arrived.

- The workability and mechanical properties of concrete are increased with partial replacement of waste marble powder in place cement and quarry dust in place of fine aggregate.
- The test results shows that waste marble powder can improve hardened concrete performance up to 15% replacement.
- The compressive strength, split tensile strength and flexural strength of concrete is increased with addition of marble powder up to 15% by weight in place of cement
- The mechanical properties of 15% marble powder is close proximity of conventional concrete. Hence 15% replacement of marble powder given optimum value.
- Hence, we concluded that the partial replacement of cement with marble powder and fine aggregate with quarry dust increases the mechanical properties of concrete up to certain point of replacement.

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