Utilization of Marble Powder with Glass Fiber as Partial Replacement of Cement in Concrete

Ashish Patidar[1] Prof. Kishor Patil[2]
[1]M.Tech Student [2]Professor
[1,2]Department of Civil Engineering
[1,2]SDBCE, Indore, India

Abstract— Concrete is the most important component used in the construction industry. Due to urbanization, the uses of cement in the construction industry get increased rapidly. This necessitated adopting partial replacement of binder with supplementary cementious material viz., fly ash, slag, metakaolin, marble powder etc. In this research work, M20 grade mix of concrete (with water-binder ratio as 0.48) is adopted with marble powder as a partial replacement for cement. Marble waste is a solid waste material generated from the marble processing and can be used as a filler material in cement while preparing concrete. The amount of waste marble powder generated at the site every year is in the range of 250-400 tons. Glass fiber which is fine fiber of glass, light in weight, extremely strong and robust material is added in concrete to enhance the strength of concrete. The weight of the glass fiber added is 6% by the weight of the cement. The series of laboratory tests are to be conducted to study the effect of 5 to 20 % (in step of 5%) replacement of cement by marble powder with and without glass fiber and compared between marble powder with using glass fiber case and marble powder without using glass fiber by and workability, water absorption and compressive strength of concrete to ascertain the maximum percentage of replacement of marble powder with glass fiber.

Key words: Marble Powder, Glass Fiber, Concrete

I. INTRODUCTION

Concrete is the most versatile building material which is widely used all over the globe in the construction industry. Concrete used for construction has to be eco-friendly, economical and sustainable. Cement is one of the main ingredients used for the production of concrete. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas in to the atmosphere, a major contributor for greenhouse effect and the global warming. The production of ordinary Portland cement produces 7% approximately of the total greenhouse gas emitted to the atmosphere. The large scale production of cement is adding environmental problems in one hand and depleting the natural resources on the other. Hence it is inevitable either to search for another material or partly replace it by some other material.

A. Marble Powder

Marble is a metamorphic rock resulting from the transformation of pure lime stone.

B. Physical Origin

The most important materials used in buildings since ancient times, especially for decorative purposes. Marble powder is produced from processing plants sawing and polishing of marble blocks. Marble powder is one of the materials which severalty affects the environment and health problems. It is produced from sawing, shaping, and polishing process. Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased. We can reduce the environmental pollution by utilizing this marble powder. The use of waste marble powder (dust) was proposed in partial replacement of cement, for the production of Concrete Mix.

In particular, tests were conducted on the concrete mix cured for different times in order to determine their workability, flexural as well as compressive strength.

Fig. 1.1: Marble Powder

1) Common constituents of marble:

- Marble is one of the non-foliated changeable rocks which are made out recrystallized carbonate mineral that is most ordinarily calcite or dolomite.
- Marble as the transformed lime stone
- Marble is generally utilized as a part of model furthermore as building material.

2) Sculpture:

- Marble powder has been prized for its utilization in models.
- Delicate quality, relative isotropy and homogeneity.
- Relative imperviousness to shattering.

3) Quarrying:

- Explosive are restricted due to risk of shattering the stone.
- Machines include steel bars are used for quarrying.
- Application based dependency (area wise & availability).
- Extracting bock through different equipments.
- Creating space between blocks by air pressure bags.
- Loader and excavator lifting equipments are used for transporting.

C. Glass Fiber

Glass Fiber has been developed as an alternative to steel reinforcement for various structural concrete applications. Glass fiber is a widely used strengthening material for reinforced concrete members owing to its various advantages such as light weight, ease of application, high strength and stiffness. Due to their non-corrosive nature, they are particularly suited for harsh environments where steel reinforcement is prone to corrosion. The main reason to use the Glass fiber is to improve the strength & ductility of the concrete member. The main purpose is to prevent the concrete cover from damaged due to spilling or other chemical reaction. Due to the earthquake or other damage the building need to the strengthened to increase strength, stiffness and ductility. Glass is the oldest, and most familiar, performance fiber. Fibers' have been manufactured from glass since the 1930s.

1) Glass Fiber Classification:

As to the raw material glass used to make glass fibers or non-woven of glass fibers, the following classification is known:

1) A-glass: With regard to its composition, it is close to window glass. In the Federal Republic of Germany it is mainly used in the manufacture of process equipment.
2) C-glass: This kind of glass shows better resistance to chemical impact.
3) E-glass: This kind of glass combines the characteristics of C-glass with insulation to electricity

Fig. 1.2 Glass Fibers (12mm size)

4) AE-glass: Alkali resistant glass.

Generally, glass consists of quartz sand, soda, sodium sulphate, potash, feldspar and a number of refining and dying additives. The characteristics, with them the classification of the glass fibers to be made, are defined by the combination of raw materials and their proportions. Textile glass fibers mostly show a circular.

2) Advantages of Glass Fiber:

- Highly durable and safe
- Design freedom since GFRC is able to be molded into almost any shape and colour.
- Requires very low maintenance.
- Installation is quick and cost effective.
- Weather and fire resistance.
- Economical.
- Energy efficient.
- Light Weight and forming into Glass Fiber Reinforced Polymer (GFRP).

D. Objectives

1) To study the workability of M20 mix concrete of partial replacement of cement with marble powder in proportion 5%, 10%, 15%, and 20% by weight in concrete.
2) To study the workability of M20 mix concrete of partial replacement of cement with marble powder in proportion 5%, 10%, 15%, and 20% by weight with using glass fiber which is added 6% by weight of cement in concrete.
3) To compare the workability parameter (Slump value and Compacting Factor) between marble powders replaced mixed concrete without using glass fiber and the marble powder replaced mixed concrete with using glass fiber.
4) To study the Water Absorption of M20 mix concrete of partial replacement of cement with marble powder in proportion 5%, 10%, 15%, and 20% by weight in concrete.
5) To study the Water Absorption of M20 mix concrete of partial replacement of cement with marble powder in proportion 5%, 10%, 15%, and 20% by weight with using glass fiber which is added 6% by weight of cement in concrete.
6) To compare the of Water Absorption value between marble powder replaced mixed concrete without using glass fiber and the marble powder replaced mixed concrete with using glass fiber.
7) To study the influence of Compressive Strength of M20 mix concrete of partial replacement of cement with marble powder in proportion 5%, 10%, 15%, and 20% by weight in concrete.
8) To study the influence of Compressive Strength of M20 mix concrete of partial replacement of cement with marble powder in proportion 5%, 10%, 15%, and 20% by weight with using glass fiber which is added 6% by weight of cement in concrete.
9) To compare the Compressive Strength between marble powders replaced mixed concrete without using glass fiber and the marble powder replaced mixed concrete with using glass fiber.

- Deals with the References.
- Deals with the Report Publication.

E. Cement

OPC 53 grade cement conforming to IS 10262 – 2009 was used. The various properties of the used cement are tabulated below:

Sr. No	Properties of Cement	Results
1	Specific gravity	3.15
2	Standard consistency (%)	28%
3	Initial setting time	30 minutes
4	Final setting time	580 minutes

Table 4.1: Properties of Cement

F. Marble Powder

The constituents of used marble powder are tabulated below:

Sr. No	Constituents of Marble Powder	Results
1	Specific Gravity	2.50
2	Alumina (Al2O3)	0.70
3	Iron Oxide (Fe_2O_3)	0.33
4	Calcium oxide (CaO)	51.49
5	Magnesium oxide(Mow)	0.36
6	Sodium Oxide (Na_2O)	0.19
7	potassium Oxide (K_2O)	0.25
8	Sulphur trioxide (SO3)	0.10
9	Loss of ignition	44.60
10	Fineness % passing (sieve size)	90 µm

Table 4.2: Constituents of Marble Powder

G. Glass Fiber

The properties of used glass fiber are tabulated below:

Sr. No	Properties of Glass Fiber	Results
1	Length	12mm
2	Diameter	14 microns
3	Aspect ratio	857.14
4	Specific gravity	2.60
5	Failure strain	3.0%
6	Elasticity (GPa)	80
7	Tensile strength (GPa)	2.5

Table 4.3: Properties of Glass Fiber

H. Fine Aggregate (Sand)

The property of river sand used as fine aggregate in concrete is tabulated below:

Sr. No	Property of Sand	Results
1	Specific Gravity	2.60

Table 4.4: Property of Fine

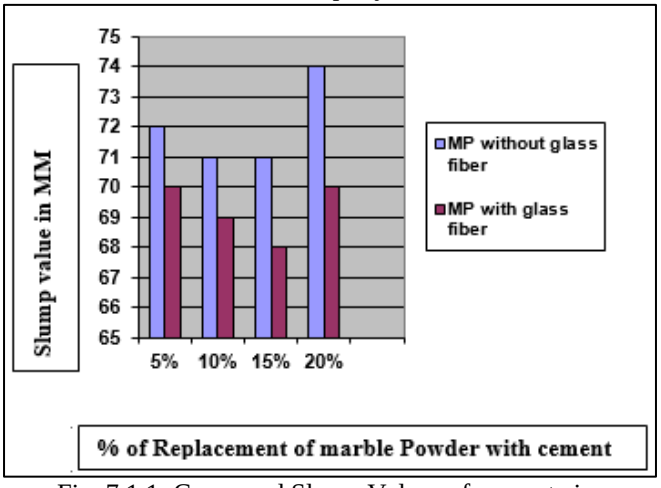

Fig. 7.1.1: Compared Slump Values of concrete in workability test for both case

Cement replacement detail	Compacting factor without using glass fiber	Compacting factor with using glass fiber	Increase in % of compacting factor Value
5%	0.96	0.97	1.04 %
10%	0.96	0.98	2.08 %
15%	0.95	0.97	2.10 %
20%	0.94	0.97	3.19%

Table 7.1.2: Compacting factor Values of concrete in workability test for without using glass fiber and with using glass fiber

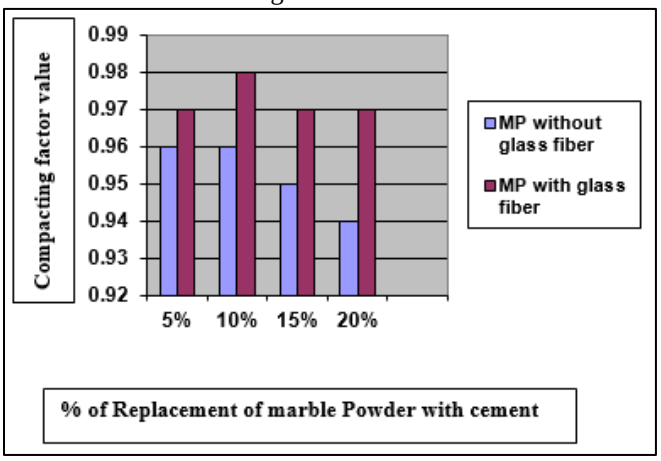

Fig. 7.1.2: Compared Compacting Factor Value between without using Glass fiber and with using Glass fiber

Cement replacement detail	Water Absorption Value without using glass fiber in %	Water Absorbtion Value with using glass fiber in %	Decrease in Water Absorption (%)
5%	2.62	2.32	12.93 %
10%	3.33	2.90	14.83 %
15%	2.94	2.46	19.52 %
20%	3.68	3.05	20.66%

Table 7.2: Result for water absorption test for both case

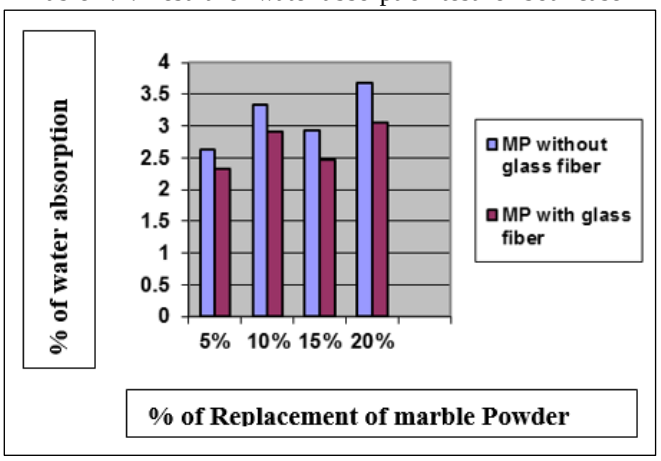

Fig. 7.2 Compared Result of water absorption test between without using glass Fiber and with using glass fiber

I. Compressive Strength Test Results

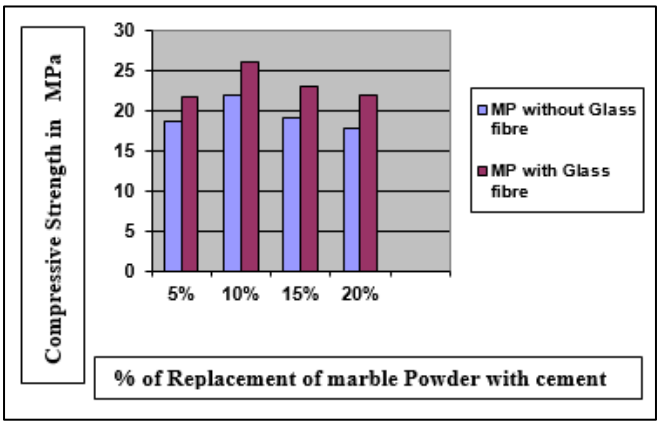

Fig. 7.3.1: Compressive Strength of cubes after 7 days curing.

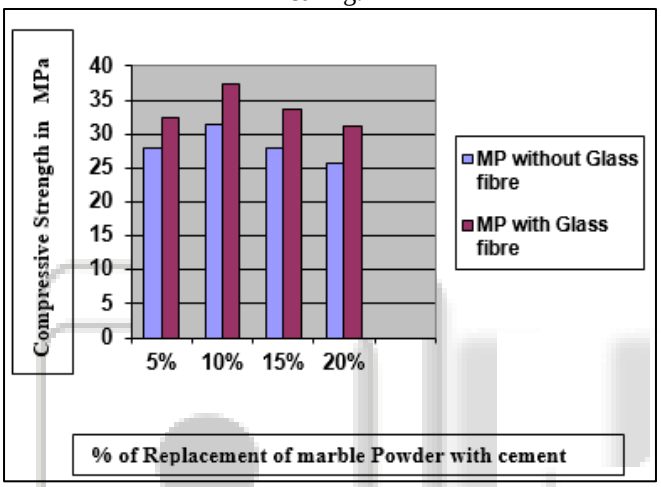

Fig. 7.3.2: Compressive Strength of cubes after 28 days curing

II. CONCLUSIONS

Within the scope of present work following conclusion are drawn:

- The minimum slump value is decreased by 2.85 % at 5% replacement of cement by marble powder with glass fiber.
- The maximum compacting factor value is increased by 3.19 % at 20% replacement of cement by marble powder with glass fiber.

III. SCOPE OF THE WORK

A. Scope of the Present Work

Concrete is the most widely used construction material in the world. Increase in investments of construction materials like cement, sand leads to an increase in the overall construction cost. At places where there is an abundant availability of alternative source of materials in replacement with cement or sand, replacement becomes economical.

- The scope of replacing the cement and sand involves the usage of waste materials like marble powder which are the by-products of respective industries. Their disposal also is an environmental challenge and proper utilization of these materials is necessary. Moreover, the change in properties of concrete like compressive strength with partial replacement of cement or sand with different percentages of these materials should be studied.
- The scope of replacing the cement with waste glass fiber with marble wastage in concrete gives safe disposal for both waste materials.

REFERENCES

[1] TalahA., Kharchi.F, Chaid.R. Influence of marble powder on high performance concrete behavior. Procedia Engineering 114(2015) 685-690(1st international conference on structural Integrity). .(1, Page no – 7)
[2] Ali Ergun. Effects of the usage of diatomite & waste marble powder as partial replacement of cement on the mechanical properties of concrete..(4, Page no – 9)
[3] HuseyinYilmazAruntas, Metin Guru, Mustafa Dayi, ilkerTekin. Utilization of waste marble dust as an additive in cement production. Materials and Design 31(2010) 4039-4042. .(6, Page no – 9)
[4] Valeria Corinaldesi, GiacomoMoriconi, Naik. Characterization of marble powder for its use in mortar and concrete. Construction and Building Materials 24 (2010) 113–117. .(8, Page no – 10)
[5] Bhupendra Singh Kalchuri Study on concrete using Marble powder Waste as partial replacement of sand. 2015 .(9, Page no – 11)
[6] Raman Kumar An Experimental study of marble powder on the performance of concrete.Volume 7 491-497 (2016)(IJCIET) .(11, Page no – 11)
[7] Ines Fayala, OualidLimam, Ioannis Stefanou. Experimental and numerical analysis of reinforced stone block masonry beams using GFRP reinforcement. Composite structures 152 (2016) 994-1006.(12, Page no – 12)
[8] XingyuGu, Bin Yu, Ming Wu. Experimental study of the bond performance and mechanical response of GFRP reinforced concrete. Construction and Building Materials 114(2016) 407-415. (13, Page no – 13)
[9] S.Y. Morshed Effect of waste glass on the properties of conventional concrete.
21-23 CUET 2016. (18, Page no – 15)
[10] Md.Abid Alam Experimental study on Properties of glass fiber reinforced concrete. Volume 24 June 2015. (19, Page no – 13)

