INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue3)
Available online at www.ijariit.com

Experimental Investigation of Mortar Cube with Pumice Powder and Ceramic Tile Powder

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***Abstract:** An experimental investigation was carried out to evaluate the properties of cement Mortar. In this project study, ordinary Portland cement is replaced partially with pumice powder and fine aggregate is replaced partially with ceramic tile powder. In this research is to study the utilization of ceramic waste as a partial replacement of fine aggregate in mortar. In this experimental investigation, prepare mortar cube of size 70.7mm x 70.7mm x 70.7mm with mix proportion 1: 3. The aim of this study is to determine the optimum % replacement of pumice powder in mortar cubes. .Cement mortar is made by replacing cement with pumice powder of different percentages like 5%, 10%, 15%, 20% & 25% with curing of 3, 7 & 28 days. The various combinations of pumice powder and ceramic waste powder were added to the mortar. Compressive strength test, splitting tensile strength test, water absorption test and the density test were performed and the results were analysed. Mortar cube shows light weight behaviour by replacing cement with pumice powder. Density of mortar is decreasing by adding pumice powder. Density of mortar cube is increasing by adding pumice powder and ceramic tile powder. Mortar cube shows almost similar strength compare to conventional mortar by adding pumice powder and ceramic tile powder.*

***Keywords:** Pumice Powder, Ceramic Tile Powder, Compressive Strength Test, Spilt Tensile Test, Density Test.*

I. INTRODUCTION

Mortar is a workable paste. It is used to bind construction blocks together and fill the gaps between them. It is also used for plastering works. Mortars are made with a mixture of sand, a binder such as cement, pozzolanic materials and water. Mortar becomes hard when it sets, and it resulting in a rigid structure. It provides protection against the penetration of air and water through the joints. Engineers have been looking for mortar which is ever stronger and durable against aggressive environment. Mortar bonds the non-masonry elements of an assembly such as joint reinforcement and ties. It also compensates for minor dimensional variations in the masonry. It provides coursing adjustment to meet required dimensions. Mortar joints give the architectural quality of the masonry assembly both through colour and shadow. Mortar mixes include ingredients that give it strength and that promote workability and good bond with the masonry units. A mortar that has high cement content will be stronger, but it may produce fewer bonds. Mortar with moderate cement content will not be as strong, but it will have better bond strength. The amount and fineness of pozzolanic are factors that affect the strength and durability of mortar.

The manufacture of ordinary Portland cement (OPC) releases large amount of carbon dioxide (CO2) to the atmosphere that contributes to greenhouse gas emissions. It is estimated that one ton carbon dioxide is released into the atmosphere for every ton of OPC produced. There is need to develop sustainable alternatives to conventional cement. Pumice powder is used as alternative for conventional cement. Pumice is a common rock of volcanic origin used as light weight aggregate, in many parts of the world. Pumice returns its useful properties only when it is young and unaltered. The low density is due to their cells with cavities being formed by gases expanding with release of pressure. Pumice is a colour less or light grey coloured coarse aggregate. It floats on water. The density of pumice is 0.25 g/cm^3. It is a natural raw material. It also possesses excellent mechanical strength and also acts as an excellent insulating material. Pumice is also fire resistant with a high melting point. It has low specific gravity. It also be employed in high sound regions as a good sound proofing material due to its excellent sound proofing properties.

In the ceramic industry 15%-30% waste material generated from the full production. It has been estimated about 30% of the daily production in the ceramic industry goes to waste. This waste is not recycled in any form at present. The ceramic waste is durable, hard and highly resistant to biological, chemical and physical degradation forces. The ceramic waste is piling up every day. So there is pressure on the ceramic industries to find a solution for its disposal. These wastes are not recycled in any course at

present owning a problem in present day world. It is a suitable form of management is required in society to attain sustainable growth.

II. . OBJECTIVES AND SCOPE OF THE PROJECT

A. Objectives of the Study

To determine the optimum % replacement of pumice powder in mortar cubes. To study the strength properties of mortar cube made with pumice powder and ceramic tile powder.

B. Scope of the Study

In this study use only one brand of 53 grade ordinary Portland cement. Replacement of cement is limited to 0-25% by adding pumice powder.10%, 20% and 30% of fine aggregate is replaced by ceramic tile powder in the pumice mortar.

III. MATERIAL PROPERTIES

A. Cement

Cement is a fine, grey powder. Cement is mixed with water and materials such as sand, Pozzolanic as to make mortar and concrete. The cement and water forms a paste that binds the other materials together in a mortar. In this work Portland cement has been used. It is tested for physical and chemical properties .The cement used is SANGHI Ordinary Portland Cement (OPC) of 53 grade, conforming to IS: 4031 - 1988, IS : 269 - 2015 and IS : 12269 - 1987.

B. Fine Aggregate

They are aggregate most of which passes 4.75mm IS sieve Commercially available M Sand is used as the fine aggregate. Sieve analysis is carried out and as per sieve analysis it comes under Zone-II this study use only one brand of 53 grade ordinary Portland cement. Replacement of cement is limited to 0-25% by adding pumice powder.10%, 20% and 30% of fine aggregate is replaced by ceramic tile powder in the pumice mortar.

C. Water

Water is an important ingredient of Mortar as it actually participates in the chemical reaction with cement. It helps to from the strength giving cement gel; the quantity and quality of water are required to be looked into very carefully.

D. Pumice powder

Pumice is formed during the volcanic eruption of viscous magma. It mostly siliceous and rich in dissolved volatile constituents. It is a natural raw material. It also possesses excellent mechanical strength. It is also acts as an excellent insulating material. Specific gravity of ceramic waste powder is 2.8.

Fig .1 pumice powder

E. Ceramic Tile Powder

The principal waste coming from the ceramic industry is the ceramic powder. It is specifically in the powder form. Ceramics are generated as a waste during the process of dressing and polishing. It is estimated that 15 to 30% wastes are produced of total raw material used and a portion of this waste may be utilized on-site such as for excavation pit refill. Ceramic waste can be used in mortar to improve the strength and other durability factors. Specific gravity of ceramic waste powder is 2.6.

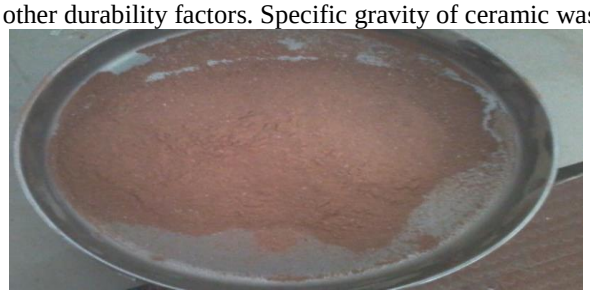

Fig .2 Ceramic tile powder

IV. MIX DESIGN

A cement mortar mix 1:3 was designed as per IS: 2250 methods and the same were used to prepare the test samples. Cement mortar was prepared by adding cement, water and fine aggregate. Cement mortar is made by replacing cement with pumice powder of different percentages like 5%, 10%, 15%, 20% & 25% with curing of 3, 7 & 28 days. The various combinations of pumice powder and ceramic waste powder were added to the mortar. Mortar mix 1:3 was selected for the study of mortars.

Moulds of size 70.7mm x 70.7mm x 70.7mm were used which gives cross sectional area of 5000mm2. Compressive strength and spilt tensile strength of mortars are obtained after 3days, 7days and 28days curing period.

TABLE 1
MIX DESIGN PROPORTIONS

Materials	Water	Cement	Fine aggregate
By Weight, [gms]	90	200	600

V. RESULT

In this project cement is replaced by pumice powder for 5%, 10%, 15%, 20% & 25% and also fine aggregate is replaced by ceramic tile powder 10% 20%, & 30% .The results for the compressive strength, split tensile strength and water absorption text are shown below.

A. Compressive Strength Test

TABLE 2

COMPRESSIVE STRENGTH BY USING PUMICE POWDER

Mix	3 days (N/mm^2)	7 days (N/mm^2)	28days (N/mm^2)
MC (0%P)	20.2	24.7	31.8
PM1 (5%P)	17.2	20.8	24.8
PM2 (10%P)	17.9	21.6	26.4
PM3 (15%P)	18.6	22.9	28.4
PM4 (20%P)	20.8	25.9	32.6
PM5 (25%P)	17.3	19.6	25.3

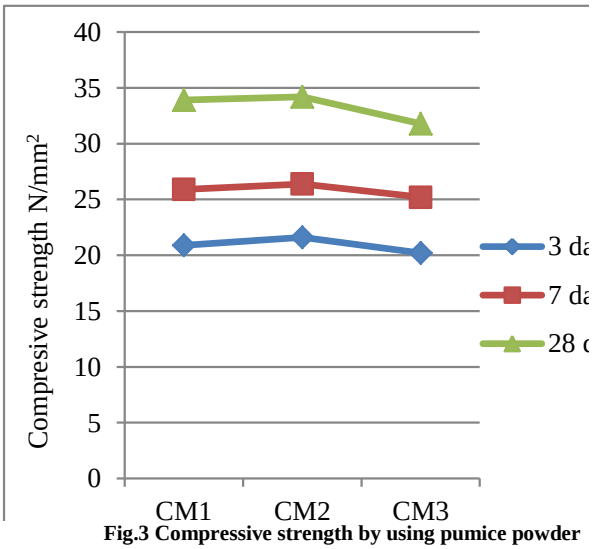

Fig.3 Compressive strength by using pumice powder

TABLE 3
COMPRESSIVE STRENGTH BY USING PUMICE POWDER & CERAMIC TILE POWDER

Mix	**3 days (N/mm^2)**	**7 days (N/mm^2)**	**28days (N/mm^2)**
CM1(20%P+10% C)	20.9	25.9	33.9
CM2(20%P+20% C)	21.6	26.4	34.2
CM3(20%P+30% C)	20.2	25.2	31.8

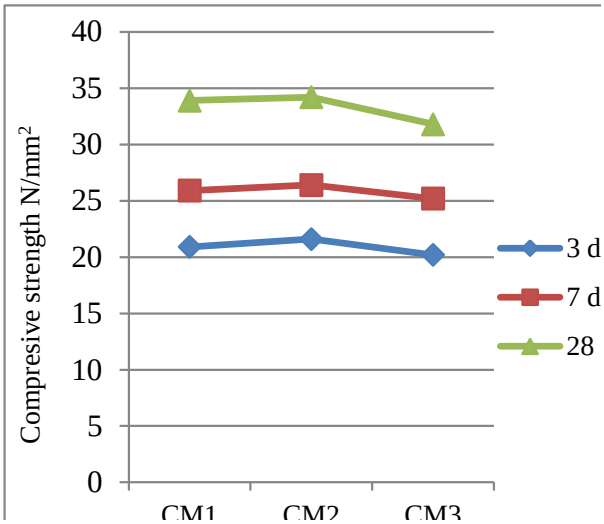

Fig 4 Compressive strength by using pumice powder & ceramic tile powder

Table 4
Spilt tensile strength by using pumice powder

Mix	3 days (N/mm^2)	7 days (N/mm^2)	28days (N/mm^2)
MC (0%)	2.85	3.3	4.28
PM1 (5%)	2.04	2.89	3.34
PM2 (10%)	2.10	2.91	3.56
PM3 (15%)	2.44	3.06	3.67
PM4 (20%)	2.98	3.85	4.98
PM5 (25%)	2.24	2.84	3.21

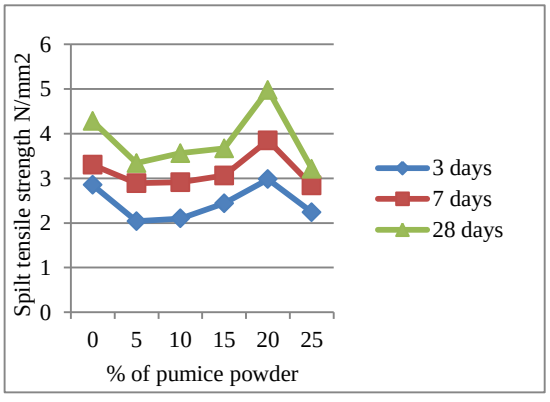

Fig 5 Spilt tensile strength by using pumice powder

TABLE 5
SPILT TENSILE STRENGTH BY USING PUMICE POWDER & CERAMIC TILE POWDER

Mix	3 days (N/mm^2)	7 days (N/mm^2)	28days (N/mm^2)
CM1(20%P+10%C)	3.1	3.4	4.29
CM2(20%P+20%C)	3.2	3.6	4.37
CM3(20%P+30%C)	2.82	3.2	4.1

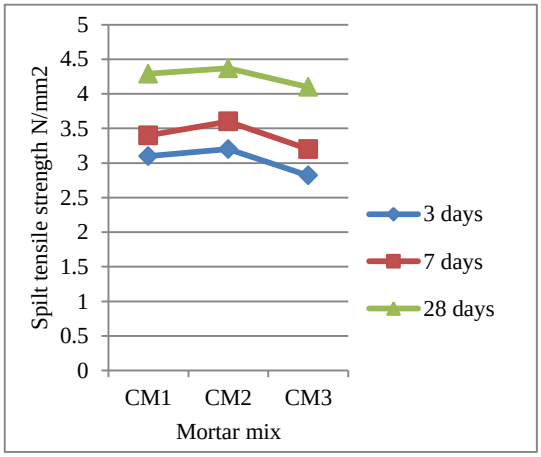

Fig .6 Spilt Tensile Strength by using pumice powder & ceramic tile powder

Table 6
Water absorption test by using pumice powder

MIX	28 DAYS
MC (0%)	3.45
PM1 (5%)	4.04
PM2 (10%)	4.6
PM3 (15%)	4.84
PM4 (20%)	5.2
PM5 (25%)	5.6

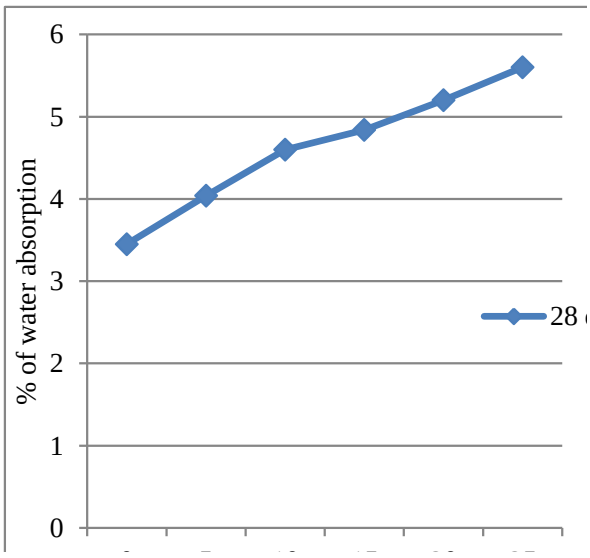

Fig 7 Water absorption test by using pumice powder

Table .7
Water absorption test by using pumice powder & ceramic tile powder

Mix	28days
CM1(20%P+10%C)	6.6
CM2(20%P+20%C)	8.4
CM3(20%P+30%C)	10.3

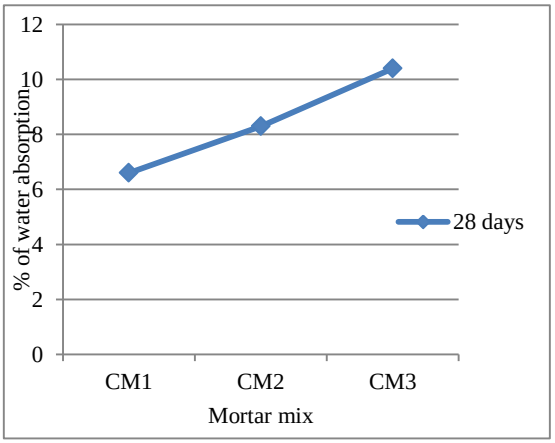

Fig. 8 Water absorption test by using pumice powder & ceramic tile powder

Table 8
Density test by using pumice powder

MIX	28 DAYS (Kg/m^3)
MC (0%)	2250
PM1 (5%)	1883
PM2 (10%)	1860
PM3 (15%)	1842
PM4 (20%)	1833
PM5 (25%)	1822

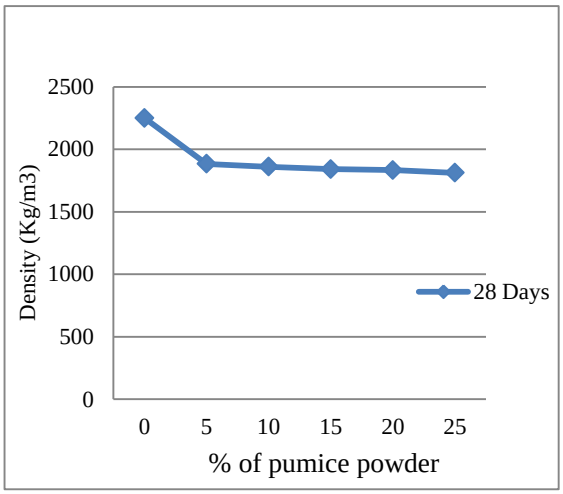

Fig 9 Density test by using pumice powder

Table 9
Density test by using pumice powder & ceramic tile powder

Mix	28 DAYS (Kg/m^3)
CM1(20%P+10%C)	1830
CM2(20%P+20%C)	1834
CM3(20%P+30%C)	1836

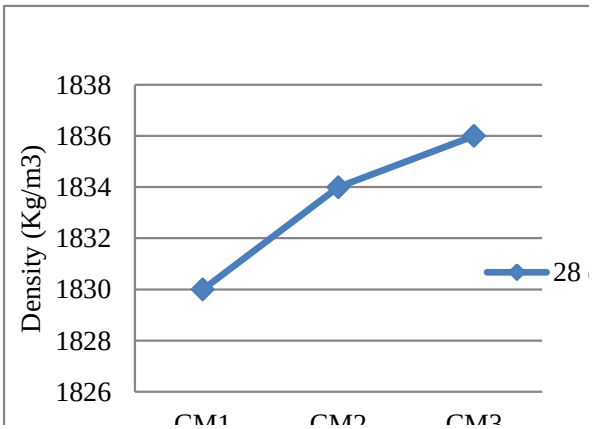

Figure 10 Density test by using pumice powder & ceramic tile powder

CONCLUSIONS

From this project I concluded that utilization of ceramic waste as a replacement material for fine aggregate is a possible alternative solution for the safe disposal of ceramic waste Compressive strength is high at 20% by replacing cement with pumice powder and by replacing fine aggregate with ceramic tile powder. Spilt tensile strength is high at 20% by replacing cement with pumice powder and by replacing fine aggregate with ceramic tile powder Mortar cube shows light weight behaviour by replacing cement with pumice powder. Density of mortar is decreasing by adding pumice powder. Density of mortar cube is increasing by adding pumice powder and ceramic tile powder. Mortar cube shows almost similar strength compare to conventional mortar by adding pumice powder and ceramic tile powder.

ACKNOWLEDGMENT

I would like to express my gratitude to God almighty who has given me the strength to complete this work. My project was possible only because of the encouragement I received from all quarters. I wish to express my sincere gratitude to Ms. MINU ANNA JOHNY, (Assistant Professor and Head of the Department of Civil Engineering) for her valuable encouragement to carry out this work. I express sincere thanks to project coordinator Ms. ANANYA JOHN, (Assistant Professor, Department of Civil Engineering) for her valuable guidance and motivation for preparation and presentation work. Also, I have been fortunate in having Mrs. TEENA JOY,(Assistant Professor, Department of Civil Engineering), as my guide, whose timely guidance, advices and inspiration helped me in the preparation and presentation of this work in time. I express my sincere gratitude for her invaluable guidance in spite of her almost overpowering schedule. Her views on many matters have inspired me a lot. I would like to extent my special thanks to my parents and friends.

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