Experimental Investigation on Compressive strength and Quality of Cement Mortar by Replacement of Cement by Silica Fume and Marble Powder

Authors

Abdullah Shabir	39-FET/BSCCET/F19
Bakhat Muneer	98-FET/BSCCET/F19
Noman Tariq	40-FET/BSCCET/F19
Aamir Khan	05-FET/BSCCET/F19
Muhammad Saleem	06-FET/BSCCET/F19

Supervisor

Engr. Mamoon Riaz

Lecturer in Department of Civil engineering

DEPARTMENT OF CIVIL ENGINEERING

INTERNATIONAL ISLAMIC UNIVERSITY, ISLAMABAD (IIUI), PAKISTAN

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Muhammad Saleem	06-FET/BSCCET/F19

A thesis submitted in fractional accomplishment of the obligation for the degree of

B.SC. CIVIL ENGINEERING TECHNOLOGY

Thesis supervisor

Mamoon Riaz

Lecturer in Department of civil engineering

Thesis supervisor signature……

DEPARTMENT OF CIVIL ENGINEERING

INRETNATIONAL ISLAMIC UNIVERSITY, ISLAMABAD (IIUI), PAKISTAN

ABSTRACT

In this project we are going to find the compressive strength of cement mortar by compression test and the quality of cement mortar by ultrasonic pulse velocity test.Prepared nine to twelve samples in the form of small cubes with the help of gang mould by replacement of cement by silica. First prepared the moulds in which 0% silica is replaced by cement and then prepared the moulds in which 5% amount of silica is replaced by cement.Similarly prepared the moulds in which 10% amount of silica is replaced by cement and then again prepared the moulds in which 15% amount of silica is replaced by cement. Now similarly prepared the twelve samples in the form of small cubes with of help of gang mould by replacement of cement by marble powder.First prepared the moulds in which 0% marble powder is replaced by cement. Now again prepared the moulds in 5% marble powder is replaced by marble powder and again prepared the moulds in 10% marble powder is replaced by marble powder and the last and final samples of moulds are prepared with the help of gang mould in which the 15% marble powder is replaced by cement. Now total 24 samples are prepared and after 24 hours demoulding would be done and place all the samples for curing in the curing tank. Now check the compressive srength and quality of the cement mortar cubes at 3days, 7days and 28days respectively with the help of compression test and ultrasonic pulse velocity test. There is minor differences are observed between the compressive strengths and the qualities of cement mortar cubes formed by the replacement of cement of by silica fume and marble powder.The marble powder would be economical and gives the good compressive strength and good quality against the silica fume.

DECLARATION

We proclaim that this proposal has formed exclusively by our self and that it has not been submitted in entire or partially in any past applications for degree. But where states in any case by reference or affirmation, the work present in the accompanying postulation is our own exertion.

Abdullah Shabir	39-FET/BSCCET/F19
Bakhat Muneer	38-FET/BSCCET/F19
Noman Tariq	40-FET/BSCCET/F19
Aamir Khan	05-FET/BSCCET/F19
Muhammad Saleem	06-FET/BSCCET/F19

DATE: _____

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We offer devout thanks to our beloved parents for their hold up support, tireless efforts and patience for this study and throughout every moment of our life. We would like to express our gratitude to the friends who supported us.

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CHAPTER: 1 INTRODUCTION

1.1 Background

Cement mortar is one of the most important building material used in construction it used for brick work, plastering work and for flooring etc. In history many researches done for the improvement of the compressive strength and the quality of the cement mortar.Many researchers use admixtures like silica fume, rice husk, nano silica, fly ash and performed compression test, tensile strength test, flexure strength test and ultrasonic pulse velocity tests. But they don't tell which admixture makes the project economical with respect to the other admixture and they don't use the marble powder in replacement of cement to see the compressive strength and quality of the cement mortar at 3days,7days and 28 days respectively till date. The comparison between the compressive strength and the quality of cement mortar cubes by the addition of admixture in replacement of cement and the addition of another admixture in replacement of cement in second part not done before and the properties of both the admixtures are different from each other. The reasearches donot explain why the use of silica fume increases the compressive strength and quality of cement mortar what happens to mixture of cement mortar when the silica fume is replaced by cement and they don't explain what happens to the mixture of cement mortar when the waste marble powder is replaced by cement due to which the compressive strength and quality of cement mortar increases and decreases.

1.2 Introduction

Cement mortar is used as building materials for plastering work as well as masonry work. The compressive strength and quality of cement mortar increases by the addition of silica fume in replacement of cement at a percentage 0%, 5%, 10% and 15% and above the 15% the compressive strength and the quality of cement mortar decreases. Only 12 samples were prepared with the help of gang moulds the first three samples 0% silica fume is replaced by cement and the remaining nine samples 5% silica fume is replaced by for three samples and the 10% silica fume is replaced by cement for next three samples and for the last three samples 15% silica fume is replaced by cement and check the compressive strengths and quality of the cement mortar cubes in which the replacement of cement by silica fume at 3days, 7days and 28days respectively by compression test and ultrasonic pulse velocity test.Similarly prepared next 12 samples of cement mortar

cubes from gang mould in which the replacement of cement by waste marble powder.Similarly the first three samples the 0% waste marble powder is replaced by cement and for the remaining nine samples 5% waste marble powder is replaced by cement for three samples and 10% waste marble powder is replaced by cement for next three samples and for the last three samples 15% waste marble powder is replaced by cement and check the compressive strengths and the quality of cement mortar cubes in which the repalcement of cement by waste marble powder at 3days, 7days and 28days respectively by compression test and ultrasonic pulse velocity test.

1.1 Problem Statement

The problem is that many reasearchers study on the compressive strength and quality of cement mortar by the replacement of cement by silica fume or they study on the compressive strength and the quality of cement mortars by partial replacement of cement by silica fume as the use of silicafume is uneconomical so they don't tell which admixture gives the greater strength or equal strength and it would also be economical with respect to the silica fume. So we would solve the problem and in the cement mortar we would use the replacement of cement by waste marble powder which would be economical with respect to silica and fume and it would also gives the good quality and good compressive strength of the cement mortar with respect to silica fume.

1.2 Objectives

- To investigate the compressive strength and quality of cement mortar when the replacement of cement by waste marble powder.
- To investigate the compressive strength and quality of cement mortar when the replacement of cement by silica fume.
- To make the project economical in future.

1.3 Scope

i. Compressive strength and quality will be find of the cement mortar cubes at 3days, 7days, and 28 days respectively in which the cement is replaced by waste marble powder at a percentage of 0%, 5%, 10% and 15% respectively.

ii. Compressive strength and quality will be find of the cement mortar cubes at 3days, 7days, and 28 days respectively in which the cement is replaced by silica fume at a percentage of 0%, 5%, 10% and 15% respectively.

iii. The rate of silica fume of 20kg bag is 2000Rs and the rate of waste marble powder of 20kg bag is 600Rs.

iv. The study of our research of finding the compressive strength and the quality of the cement mortar by the replacement of cement mortar by silica fume and by waste marble powder is just on plastering work(1:3) and for the brick work(1:4) respectively.

1.4 Overview of Thesis

Cement mortar is one of the most important building materials used in construction used for brick work, plaster work and flooring etc. Historically many studies have been conducted to improve the compression strength and quality of cement mortar. velocity. But they do not tell them which compound is the most economical in terms of other compounds and do not use marble powder instead of cement to determine the compressive strength and quality of cement mortar for 3, 7 and 28 days respectively. to date. The comparison between the compressive strength and quality of cement cement cubes by mixing the cement instead and adding another cement mixture to the second part has never been done before and the properties of both mixtures differ from each other. . Recent research does not explain why the use of silica fume increases the compressive strength and quality of cement mortar that occurs in cement mortar when silica smoke is replaced with cement and does not explain what happens with cement mortar when marble powder is replaced by cement due to its compressive strength and quality of mud. of cement rising and falling.The compressive strength and great of cement mortar will increase via the addition of silica fume in substitute of cement at a percentage 0%, 5%, 10% and 15% and above the 15% the compressive electricity and the first-class of cement mortar decreases. best 12 samples were prepared with the assist of gang moulds the primary 3 samples zero% silica fume is replaced by means of cement and the remaining nine samples 5% silica fume is changed via for 3 samples and the ten% silica fume is replaced by using cement for next 3 samples and for the remaining 3 samples 15% silica fume is changed by means of cement and take a look at the compressive strengths and best of the cement mortar cubes in which the replacement of cement by silica fume at 3days, 7days and 28days respectively via compression test and ultrasonic pulse velocity test.further organized subsequent 12 samples of cement mortar

cubes from gang mold in which the alternative of cement by way of waste marble powder.in addition the primary three samples the zero% waste marble powder is changed via cement and for the last 9 samples 5% waste marble powder is changed by cement for 3 samples and 10% waste marble powder is replaced by means of cement for subsequent three samples and for the remaining three samples 15% waste marble powder is replaced by using cement and test the compressive strengths and the exceptional of cement mortar cubes wherein the repalcement of cement through waste marble powder at 3days, 7days and 28days respectively by means of compression check and ultrasonic pulse speed test.The problem is that many reasearchers take a look at at the compressive energy and pleasant of cement mortar by way of the alternative of cement by means of silica fume or they have a look at on the compressive electricity and the exceptional of cement mortars via partial substitute of cement via silica fume as the usage of silica fume is uneconomical in order that they don't tell which admixture offers the more energy or equal energy and it'd also be cost-effective with appreciate to the silica fume. So we would clear up the hassle and inside the cement mortar we would use the alternative of cement with the aid of waste marble powder which might be reasonably priced with admire to silica and fume and it would also gives the good excellent and good compressive power of the cement mortar with admire to silica fume. Compressive electricity and best may be discover of the cement mortar cubes at 3days, 7days, and 28 days respectively wherein the cement is replaced by using waste marble powder at a percentage of 0%, five%, 10% and 15% respectively. Compressive power and fine might be locate of the cement mortar cubes at 3days, 7days, and 28 days respectively wherein the cement is replaced via silica fume at a percentage of zero%, 5%, 10% and 15% respectively. The price of silica fume of 20kg bag is 2000Rs and the charge of waste marble powder of 20kg bag is 600Rs.The take a look at of our studies of locating the compressive electricity and the pleasant of the cement mortar by way of the alternative of cement mortar through silica fume and with the aid of waste marble powder is simply on plastering work(1:3) and for the brick work(1:4) respectively.

CHAPTER: 2 LITERATURE REVIEW

Bekir Topcu et . al (2009) reasearch on waste marble powder he used waste marble powder as filler material in self compacting concrete the properties of self compaction concrete at 200 kg/m^3 but when the amount of waste marble powder increases above 200 kg/m^3 then the mechanical properties of the self compactin concrete have decreased.

Bahar Demirel (2010) research on the waste marble powder he prepared four mixes of concrete in which the amount of waste marble powder is 0%, 25%, 50% and 100% respectively by weight and when he tested the specimens he observed that the compressive strength is improving when the waste marble powder is used in place of sand.

Baboo rai et . al (2012) research on the waste marble powder he concluded that if the replacement of cement by waste marble powder in varying percentage the work ability and the compressive strength increases.

Manju Pawar et . al (2014) research on the waste marble powder. He concluded that the replacement of sand by a waste marble powder in a percentage 25%, 50% and 75% respectively due to the experimental results he concluded that the slump of the concrete increases.

Omar.M.Omar (2016) research on the silica fume and waste marble powder he experimentally concluded that the compressive strength of the concrete at 7days, 14days and 28days respectively increases at percentage of 15% of silica fume and at the percentage of 15% of waste marble powder respectively.

Ammudhavalii and Mathew (2012) research on the effect of silica fume on concrete. They used M35 grade concrete in partial replacement of cement by silica fume at a percentages of 0%, 10%, 15%, 20% and 25% respectively. The results after 7days,

14days, and 28days shows that the compressive strength of the concrete will be increased by the use of silica fume and its durability is also increases.

Kumar and Dhaka (2016) research on the effect of silica fume on concrete. They used M35 grade concrete and the replacement of cement by silica fume in a percentages 0%, 5%, 9%, 12%, 15% respectively. They detailed study on compressive strength, tensile strength after 7days and 28days they find that the strength and durability increases by the use of silica fume with respect to normal concrete.

Ghutke and Bhandari (2014) research on silica fume that what happens on the workability and compressive strength of concrete. The replacement of cement by silica fume at percentages 10% and 15%. They obesrve that it is the optimum percentages at these percentages the strength of concrete would be good but on further increasing the strength of concrete decreases.

Henry and Smith (2012) research on the silica fume. They use M20 grade concrete the partial replacement of cement by silica fume with a percentage of 10% and 15% respectively. They concluded that at 7days and 28days the compressive strength and durability properties of M20 increases at 10% and 15% replacement of cement by silica fume. So this is the optimum percentage of the replacement of cement by 10% and 15% silica fume.

Roy and Sill (2015) study the effect of silica fume on hardened concrete. They form six levels of mixes in which the replacement of cement by silica fume at a percentages 0%, 5%, 10%, 15%, 20% and 25% respectively. They concluded that the compressive strength of the SF concrete is 19.6% and 16.82% than those of the normal concrete for cube and cylinder. The tensile strength and flexure strength increase about to 38.58% and 21.13% than those of the normal concrete when 10% of cement is replaced by silica fume. **Ajileye (2012)** study on replacement of cement by silica fume then he concluded that when 10% of cement is replaced by silica fume then the compressive strength of M30

grade concrete increases about 16.15% to 29.24% at 7days and 28days. From 15% there respectively.

2.1 Properties of Silica Fume

a) Physical Properties

b) Chemical Properties

A. Physical Properties

Silica fume physical property depends on the type of producing and it also depends on the manufacturing process. It is in spherical shape and its diameter is less 100 times than ordinary portland cement (OPC). It is in three forms condensed, slurry, undensified. Its colour is light to grey and it depends on the manufacturing process which includes wood chip to coal used,exhaust temperature, furnace temperature and type of metal produced. Such type of silica fume whose bulk density is low and it is in the rang of 200-300kg/m^3 then this type of silica fume will be used for mortar, grouts protective coatings etc but this type of silica fume doesnot used in concrete production. Such type of silica fume whose bulk density is in range of 500-600kg/m^3 it is densified silica fume and it can be used in concrete roof tile works, precast work and ready mix concrete plants with wetting units.

Physical Characteristics	Typical Values
Appearance	Grey Powder
Specific Gravity	2.2
Average Particle Size	0.1 micron
Bulk Density	240kg/m^3
Particle Size	0.1u - 0.5u
Specific Surface Area	20,000kg/m^2

B. Chemical Properties

Silica fume produced during high temperature and reduction of quartz in electric arc furnace the main product is silica and ferrosilicon. These processes will be held in the areas where the production of electricity is high for e.g U.S.A, South Africa, Austrailia etc.When the concrete hardens, the pozzolonic active reaction occurs and silica start the physical affects. The calcium hydroxide reacts with silica and forms calcium silicates and aluminates hydrates. The calcium silicates and aluminium hydrates increases the strength and decreases the permeability of the conctete mix. Silica fume which has higher surface area and high silicon dioxide is much more reactive than fpa or ggbs, The increase of this reactivity the rate of hydration C_3S fraction of the cement for the first instance increases.

Constituents	Percentage %
Silicon Dioxide (SO_2)	90-96
Aluminium Oxide (Al_2O_3)	0.5 - 0.8
Ferric Oxide (Fe_2O_3)	0.2 - 0.8
Magnesium Oxide (MgO)	0.5 - 1.5
Calcium Oxide (CaO)	0.1 - 0.5
Sodium Oxide (Na_2O)	0.2 - 0.7
Potassium Oxide (K_2O)	0.4 - 1

2.2 Properties of Waste Marble Powder

There are two types of properties

a) Physical Properties

b) Chemical Properties

A. Physical Properties

Waste marble powder is in finey powdery form, similar to that of crused stone. Since waste marble powder dust is slight shimmer to it because of the crystallized particles and it can also be discoloured wity brown, grey, yellow, pink or even greenish particle due to the impurities in the original marble.

Properties	Observations
Colour	White
Form	Powder
Specific Gravity	2.66
Blaine Fineness	1500m^2/kg

B. Chemical Properties

Waste marble powder comes from the crused marble, which formed by the crystallization of limestone or dolostone. The crystals appear as a calcite material through different atmospheric and temperature changes. The pressure present in the formation of marble destroys any other objects in the rock creating a dense, smooth rock. Coloured marble is produced when different amounts of silt, clay and other objects are mixed with the limestone.

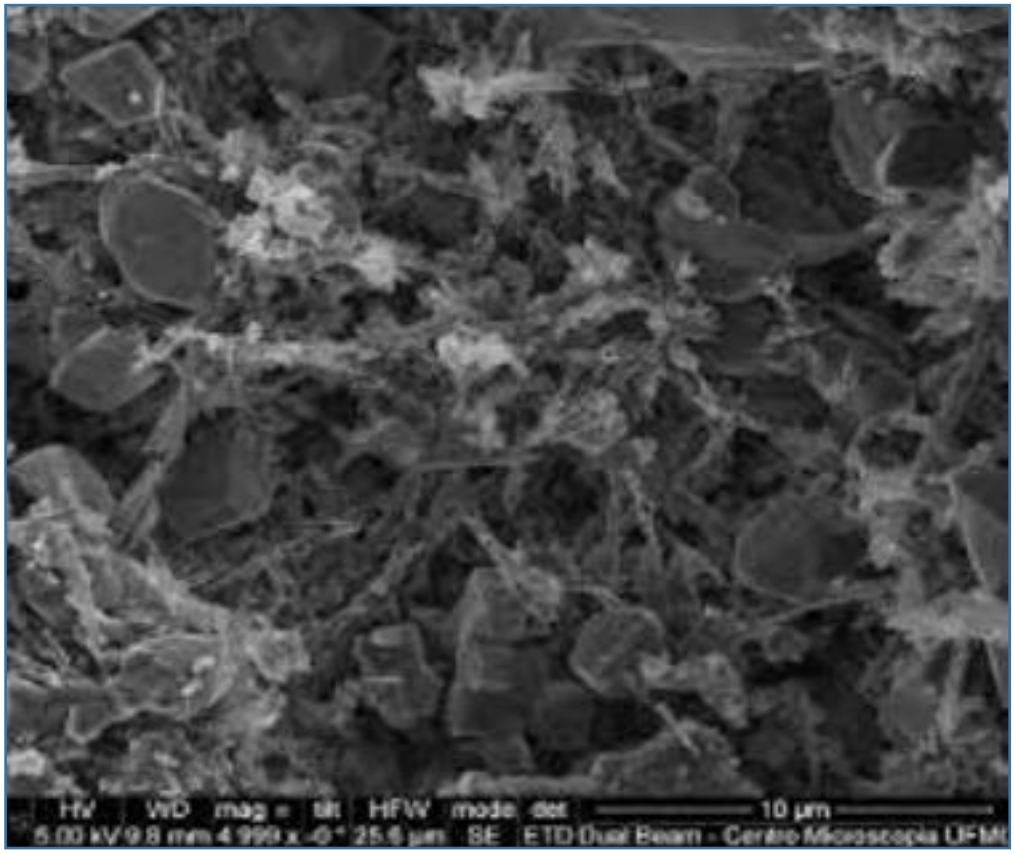
Constituents	Percentage %
Silicon Dioxide (SO_2)	0.42
Aluminium Oxide (Al_2O_3)	0.13
Ferric Oxide (Fe_2O_3)	0.06
Magnesium Oxide (MgO)	0.12
Calcium Oxide (CaO)	56.01
Sodium Oxide (Na_2O)	0.43
Potassium Oxide (K_2O)	0.01

2.3 Mixes and Compressive strengths of Cement Mortar

A number of studies was carried out on the cement mortar paste in the recent years. I.M AHO and E. E. NDUBUBA study on the compressive strength of the cement mortar they prepared the mix of cement mortar of ratios 1:1 and 1:2. They used the raffia palm fruit peel fibre the replacement of cement by raffia palm fruit peel fibre at a percentages of 2%, 4%, 6% and 8% respectively. The compressive strength of the cement mortar cubes will be tested by compression test at 3days, 7days and 28days respectively. They obeserved that the compressive strength increases when the 8% amount of raffia palm fruit peel fibre is replaced by cement above the 8% the compressive strength of the cement mortar cubes will be decreased. The compressive strength of the cement mortar cubes at a ratio of 1:1 is 10.67N/m^2 when the 8% amount of raffia palm fruit peel fibre is replaced by cement and similarly the compressive strength of the cement mortar cubes at a ratio of 1:2 is 10.01N/m^2 when the same amount of 8% of raffia palm fruit peel fibre is replaced by cement. Saravanan and Balamuralikrishnan R they study on the compressive strength of the cement mortar they prepared the mix of cement mortar of ratio 1:3. They used the Alccofine which is made up of glass wastes and it is partially replaced by cement in the reasearch. They used the alccofine in the cement mortar in which the replacement of cement by alccofine at a percentages of 5%, 10%, 15% and 20% respectively. They concluded that the compressive strength of the cement mortar cubes increases upto 10% alccofine at 3days, 7days and 28 respectively when it is replaced by cement and above the amount of 10% the compressive strength of the cement mortar cubes will be decreased.Ibrar Ahmad and Fayaz Ahmad study on the compressive stength of the cement mortar they prepared the mix of cement mortar of ratio 1:3. They used the cocunut fibre in the cement mortar in which the replacement of cement by cocunut fibre at a percentages of 2%, 4% and 6% respectively. They concluded that when the 4% amount of cocunut fibre is replaced by cement then the compressive strength of the cement mortar is higher at 3days and when the 6% amount of cocunut fibre is replaced by cement in the cement mortar the compressive strength of the cement mortar is increases at 28days respectively.

2.4 Morphological Structure and Micro Structure analysis of Cement Mortar by SEM

The morphological structure and micro structure analysis of cement mortar cubes can be done by (SEM) in this the cement mortar cube sample is placed in the vaccum chamber then the electrons are generated on it from the gun from the electron source and scrolling the image of the cement mortar cube sample with the help of mouse because the computer is also attached to the (SEM). The magnification can be increased from 20X to 30000X to analysed the element clearly and to see the chemical reaction when the admixutre is added into the cement mortar cubes and the spatial resolution of the (SEM) to see the nano particles will be from 50nm to 100nm and we can see the sample in 2D view and 3D view in (SEM).



CHAPTER: 3 METHODOLOGY

3.1 Materials Selection

3.1.1 Collection of Silica Fume:

Silica fume was collected from (PAGEL production chemical compounds) at G-nine Islamabad. Silica fume may be very pleasant no crystalline silica manufactured by way of electric powered arc furnaces as a of the manufacturing of metal silicon or ferro silicon alloys. The uncooked substances are coal, quartz, and wood chips. The smoke that created from furnace operation is stored and offered as silica fume instead of land filled. because the silica fume powder debris are hundred instances finer than the ordinary portland cement there might be issues stand makeup while offers with silica fume, such as dispersing consideration, transportation, and garage that have to be taken into acount. to conquer a number of those difficulties the cloth is commercially is split into diverse paperwork. The distinction between these bureaucracy is the dimensions of the particle which donot drastically have an effect on the chemical or reaction of material. This difference has impact on the unique purposes of use. thus cautious attention is needed while deciding on the kind of silica fume for unique application.

3.1.2 Collection of Waste marble powder:

Waste marble powder was amassed from the (MARBLE street DHOKE HASU RWP). Waste marble powder comes from overwhelmed marble stone, that's shaped by the crystallization of limestone or dolostone. The crystals seem as a calcite cloth via exceptional atmospheric and temperature modifications. The pressure present inside the formation of marble destroys some other gadgets within the rock creating a dense,easy rock. colored marble is produced while specific amounts of silt, clay, and different gadgets are blended with the limestone.Waste marble powder is in finey powdery form, just like that of crused stone. on account that waste marble powder dirt is slight shimmer to it because of the crystallized debris and it may also be discoloured wity brown, grey, yellow, pink or maybe greenish particle due to the impurities in the authentic marble.

3.1.3 Cement

For this study we used Ordinary Portland® Cement (OPC) conforming to ASTM C150 type I. The fineness of cement was determined by Blaine air permeability test according to ASTM C 204-94a.

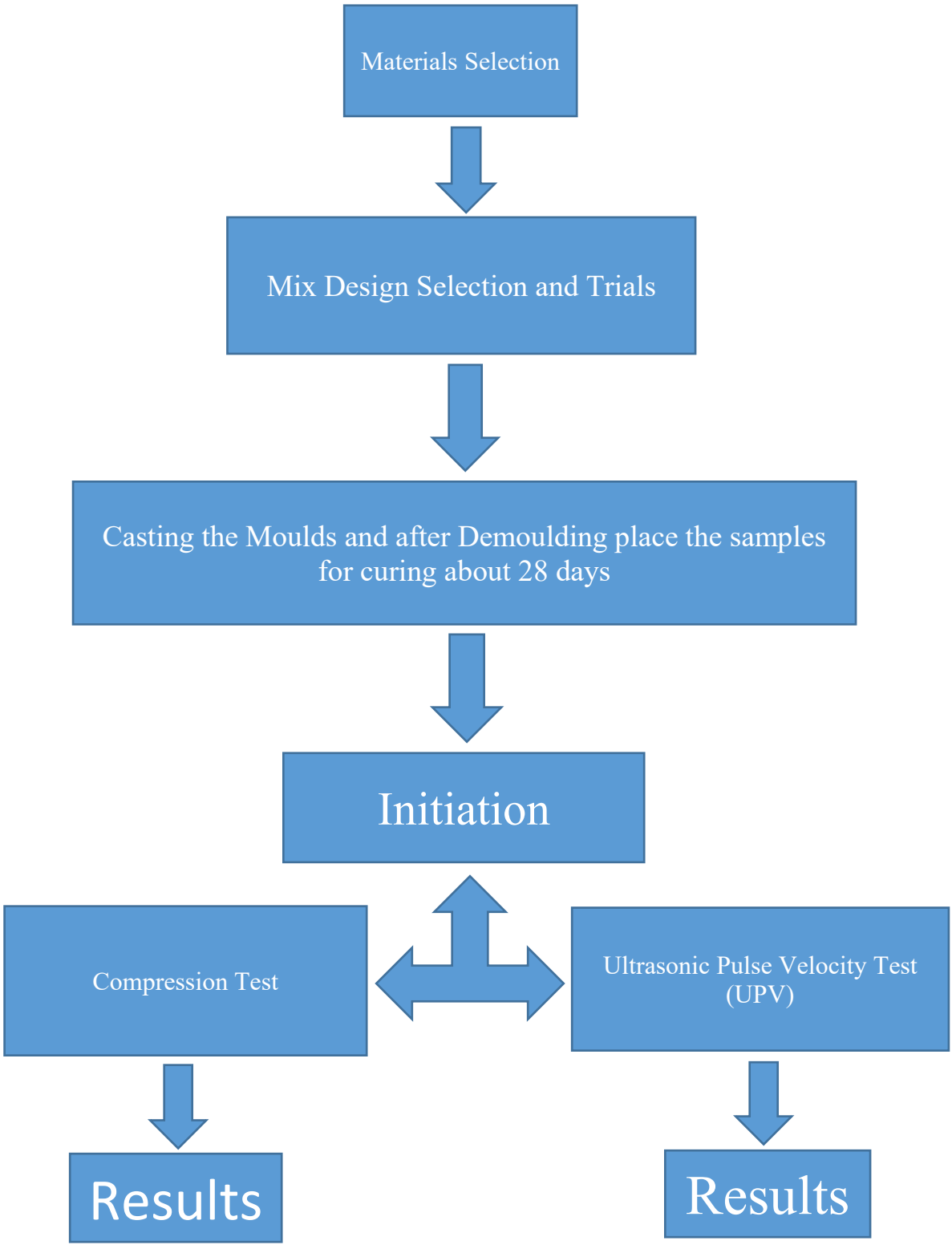
3.1.4 Fine Aggregate

The fine aggregate used changed into mining sand passing through 4.75 mm sieve. The specific gravity as well as absorption tests for fine aggregate had been accomplished as specified in ASTM C128-97, respectively. The sieve analysis became accomplished in compliance with BS 882:1992.

3.1.5 Curing time and Conditions

Prepared the cement mortar cubes with the help of gang moulds then after 24 hours demoulding should be and the cement mortar cubes should be place in the curing tank for curing according to specifications at a period of (3days, 7days and 28days respectively) the temperature of the water should be 25 degree celsius to 29 degree celsius. The compressive strength and quality of the cement mortar cubes should be checked at 3days, 7days and 28days respectively with the help of compression testing machine and ultrasonic pulse velocity test.

Design Methodology:



CHAPTER: 4 EXPERIMENTAL INVESTIGATIONS

4.1 Materials

In this section cement mortar cubes are prepared with the help of gang moulds in specific procedure and the replacement of cement by silica fume will be done at specicfic percentages (0%, 5%, 10% and 15% respectively) and form the cement mortar cubes samples and similarly the replacement of cement by waste marble powder will be done at specific percentages (0%, 5%, 10% and 15% respectively).

4.1.1 Cement

For this study we used Ordinary Portland® Cement (OPC) conforming to ASTM C150 type I. The fineness of cement was determined by Blaine air permeability test according to ASTM C 204-94a.

4.1.2 Silica fume

The replacement of cement by silica fume will be done at specific percentages (0%, 5%, 10% and 15% respectively and then form the cubes of cement mortar and check the compressive strength and quality of cement mortar cubes by compression test and ultrasonic pulse velocity test.

4.1.3 Waste Marble Powder

Similarly the replacement of cement by waste marble powder will be done at specific percentages (0%, 5%, 10% and 15% respectively and then form the cubes of cement mortar and check the compressive strength and quality of cement mortar cubes by compression test and ultrasonic pulse velocity test.

4.1.4 Fine Aggregate

The fine aggregate used changed into mining sand passing through 4.75 mm sieve. The specific gravity as well as absorption tests for fine aggregate had been accomplished as specified in ASTM C128-97, respectively. The sieve analysis became accomplished in compliance with BS 882:1992.

4.1.5 Material Preparations

In this stage the mix is prepared of two ratio 1:3(For Plastering Work) and 1:4(For Brick Work). The replacement of cement by silica fume is done for both the ratios of mix 1:3 and 1:4 at a percentages of 0%, 5%, 10% and 15% respectively. Similarly the

replacement of cement by waste marble is done for both the ratios of mix 1:3 and 1:4 at a percentages of 0%, 5%, 10% and 15% respectively.

4.1.5 Testing Program

When the cement mortar cubes of ratios 1:3 and 1:4 are formed by the replacement of cement by silica fume at a percentages of 0%, 5%, 10% and 15% respectively and similarly when the cement mortar cubes of ratios 1:3 and 1:4 are formed by the replacement of cement by waste marble powder at a percentages of 0%, 5%, 10% and 15% respectively. Then after 24 hours demoulding the moulds and place the cement mortar cubes for curing and the temperature of water should be 25 to 29 degree celsius in which the cement mortar cubes are placed for curing. Then test the compressive strength and qualtiy of the cement mortar cubes at (3days, 7days and 28days) with the help of compression test and ultrasonic pulse velocity test.

4.1.6 Mix Design of Cement Mortar by Weight

Mix design is used to know the amount of constituents (cement, sand, silica fume) of the cement mortar cubes when the cement is replaced by silica fume at a percentages of 0%, 5%, 10% and 15% respectively. Similarly it is used to know the amount of constituents (cement, sand, waste marble powder) of the cement mortar cubes when the cement is replaced by waste marble powder at a percentages of 0%, 5%, 10% and 15% respectively. The w/c ratio would be fixed which is 0.5.

Data:

The replacement of cement by silica fume in cement mortar.

For Plastering Work (1:3)

When 0% replacement of cement by silica fume in cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*1 = 175g

Sand = 700/4*3 = 525g

Water = 0.5 * 175 = 87.5g

When 5% replacement of cement by silica fume in cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*0.95 = 166.25g

Sand = 700/4*3 = 525g

Silica fume = 700/4*0.05 = 8.75g

Water = 0.5 * 166.25 = 83.12

When 10% replacement of cement by silica fume in cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*0.9 = 157.5g

Sand = 700/4*3 = 525g

Silica fume = 700/4*0.1 = 17.5g

Water = 0.5 * 157.5 = 78.75

When 15% replacement of cement by silica fume in cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*0.85 = 148.75g

Sand = 700/4*3 = 525g

Silica fume = 700/4*0.15 = 26.25g

Water = 0.5 * 148.75 = 74.375

When 20% replacement of cement by silica fume cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*0.8 = 140g

Sand = 700/4*3 = 525g

Silica fume = 700/4*0.2 = 35g

Water = 0.5 * 140 = 70g

Now for brick work (1:4)

When 0% replacement of cement by silica fume in cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*1 = 140g

Sand = 700/5*4 = 560g

Water = 0.5 * 140 = 70g

When 5% replacement of cement by silica fume in cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*0.95 = 133g

Sand = 700/5*4 = 560g

Silica fume = 700/5*0.05 = 7g

Water = 0.5 * 133 = 66.5

When 10% replacement of cement by silica fume cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*0.9 = 126g

Sand = 700/5*4 = 560g

Silica fume = 700/5*0.1 = 14g

Water = 0.5 * 126 = 63g

When 15% replacement of cement by silica fume cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*0.85 = 119g

Sand = 700/5*4 = 560g

Silica fume = 700/5*0.15 = 21g

Water = 0.5 * 119 = 59.5

When 20% replacement of cement by silica fume cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*0.8 = 112g

Sand = 700/5*4 = 560g

Silica fume = 700/5*0.2 = 28g

Water = 0.5 * 112 = 56g

Now the replacement of cement by waste marble powder in cement mortar**For Plastering Work (1:3)**

When 0% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*1 = 175g

Sand = 700/4*3 = 525g

Water = 0.5 * 175 = 87.5g

When 5% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*0.95 = 166.25g

Sand = 700/4*3 = 525g

Silica fume = 700/4*0.05 = 8.75g

Water = 0.5 * 166.25 = 83.12

When 10% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*0.9 = 157.5g

Sand = 700/4*3 = 525g

Silica fume = 700/4*0.1 = 17.5g

Water = 0.5 * 157.5 = 78.75

When 15% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*0.85 = 148.75g

Sand = 700/4*3 = 525g

Silica fume = 700/4*0.15 = 26.25g

Water = 0.5 * 148.75 = 74.375

When 20% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:3 = 1+3 = 4

Cement = 700/4*0.8 = 140g

Sand = 700/4*3 = 525g

Silica fume = 700/4*0.2 = 35g

Water = 0.5 * 140 = 70g

Now for brick work (1:4)

When 0% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*1 = 140g

Sand = 700/5*4 = 560g

Water = 0.5 * 140 = 70g

When 5% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*0.95 = 133g

Sand = 700/5*4 = 560g

Silica fume = 700/5*0.05 = 7g

Water = 0.5 * 133 = 66.5

When 10% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*0.9 = 126g

Sand = 700/5*4 = 560g

Silica fume = 700/5*0.1 = 14g

Water = 0.5 * 126 = 63g

When 15% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*0.85 = 119g

Sand = 700/5*4 = 560g

Silica fume = 700/5*0.15 = 21g

Water = 0.5 * 119 = 59.5

When 20% replacement of cement by waste marble powder in cement mortar

Mix = 700g

Mix ratio 1:4 = 1+4 = 5

Cement = 700/5*0.8 = 112g

Sand = 700/5*4 = 560g

Silica fume = 700/5*0.2 = 28g

Water = 0.5 * 112 = 56g

4.1.7 Formation of Control Mixes

When the replacement of cement by silica fume in cement mortars at a percentages of (0%, 5%, 10%, 15% and 20% respectively) will be done then the formation of control mixes would be done i.e SF0, SF5, SF10, SF15, and SF20 respectively. Similarly when the replacement of cement by waste marble powder in cement mortars at a percentages of (0%, 5%, 10%, 15% and 20% respectively) will be done then the formation of control mixes would be done i.e M.P0, M.P5, M.P10, M.P15, M.P20 respectively.For Mix 1:3 and 1:4 the replacement of cement by silica fume the control mix should be prepared. Similarly for the mix 1:3 and 1:4 the replacement of cement by waste marble powder the control mix should be prepared.

Control Mix (C.M)	Cement
SF_0	0%
SF_5	5%
SF_{10}	10%
SF_{15}	15%
SF_{20}	20%

Control Mix (C.M)	Cement
WMP_0	0%
WMP_5	5%
WMP_{10}	10%
WMP_{15}	15%
WMP_{20}	20%

CHAPTER: 5 DISCUSSIONS AND RESULTS

5.1 Compression Test on Cement Mortar Cubes

5.1.1 Purpose of Compression Test

The purpose of compression test is to check the compressive strengths of the cement mortars when the cement is replaced by silica fume and when the cement is replaced by waste marble powder.

5.1.2 Importance of Compression Test

The importance of compression is that due to the compression test we know the compressive strength of cement mortars due to which are able to justify that if that type of mortar is used in brick work it would bear the load of the wall when it used to joined the bricks together in the wall. It is very helpful for the cement mortars which are going to be used in plastering work because due to the compression test we are able to know that if that type of mortar is used in plastering work will it strengthen the wall due to its own strength and this can be done only due to compression test because it tells the compressive strength of the cement mortar which is going to be used in plastering work.

5.1.3 Apparatus Needed To Perform Compression Test

- Gang Moulds
- Tamping Rod
- Curing Tank
- Oven
- Weighing Balance
- Compression Testing Machine

5.1.4 Compression Test Procedure

1) First of all prepared the mix ratio of 1:3 and then start oiling the moulds

2) Now fill the gang mould with cement mortar in two layers and each layer should be tamped 32 times.

3) Now level the surface and after 24 hours demoulding should be done and place the samples of the cement mortar cubes into the curing tank for curing till the day when it was tested.

4) Now check the compressive strength of cement mortar cubes at 3days, 7days and 28 days respectively with the help of compression testing machine.

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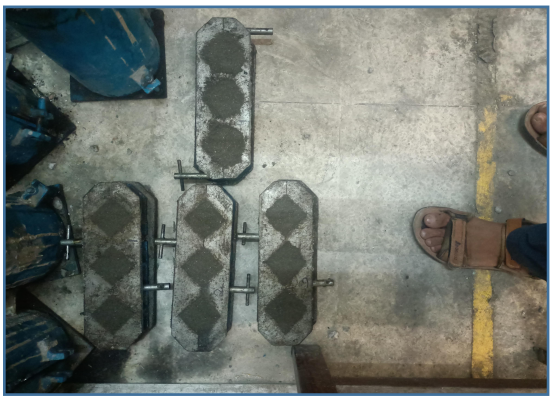


5.1.5 Observations and Calculations

The compressive strength of the cement mortar cubes are determined with the help of compression testing machine. The cement mortar cubes in which the replacement of cement by silica fume would be done and their compressive strength should be checked at 3days, 7days and 28days respectively. Similarly the cement mortar cubes in which the replacement of cement by waste marble powder would be done and their compressive strength should be checked at 3days, 7days and 28days respectively.

- **Compressive strength when the cement is replaced by silica in cement mortar.**

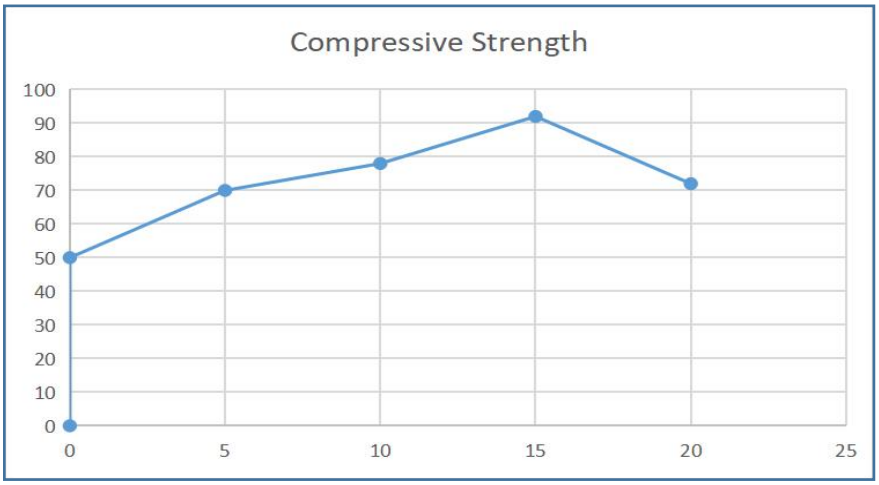
Control Mix (C.M)	**Percentage**	**3days**	**7days**	**28days**
SF_0	0%	11.50N/mm^2	17.50N/mm^2	50N/mm^2
SF_5	5%	27N/mm^2	55N/mm^2	70N/mm^2
SF_{10}	10%	48N/mm^2	56N/mm^2	78N/mm^2
SF_{15}	15%	53N/mm^2	69N/mm^2	92N/mm^2
SF_{20}	20%	35N/mm^2	51N/mm^2	72N/mm^2

- **Compressive strength when the cement is replaced by waste marble powder in cement mortar.**

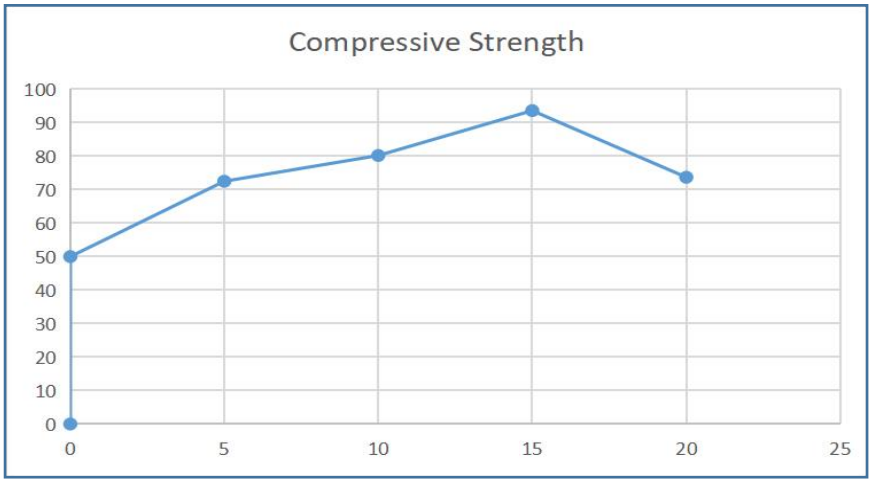
Control Mix (C.M)	Percentage	3days	7days	28days
WMP_0	0%	11.50N/mm^2	17.50N/mm^2	50N/mm^2
WMP_5	5%	28.5N/mm^2	57.4N/mm^2	72.5N/mm^2
WMP_{10}	10%	49.3N/mm^2	57.5N/mm^2	80.2N/mm^2
WMP_{15}	15%	54.7N/mm^2	71.3N/mm^2	93.6N/mm^2
WMP_{20}	20%	36.8N/mm^2	52.1N/mm^2	73.7N/mm^2

5.1.6 Graphical representations of the compressive strength

- The graphical representation of the compressive strength of the cement mortar after 28 days in which the replacement of cement by silica fume respectively.



- The graphical representation of the compressive strength of the cement mortar after 28 days in which the replacement of cement by waste marble powder.



5.2 Ultrasonic Pulse Velocity Test on Cement Mortar Cubes

5.2.1 Purpose of Ultrasonic Pulse Velocity Test

The purpose of ultrasonic pulse velocity is that we know the quality of cement mortar and we are able to observe that there is presence of voids, cracks and deterioration in the cement mortar cubes.

5.2.2 Importance of Ultrasonic Pulse Velocity Test

The purpose of ultrasonic pulse velocity is that when the presence of voids, cracks and deterioration is detected then we are able to say that this type of cement mortar is unsuitable for brick work, plastering work because if this type of cement mortar is used in the brick work or plastering work the wall will fail and the rain penetration occurs from the plaster work due to which there is cause of dampness will be possible.

5.2.3 Procedure of Ultrasonic Pulse Velocity Test Procedure

1. First of all prepared the mix ratio of 1:3 and then start oiling the moulds
2. Now fill the gang mould with cement mortar in two layers and each layer should be tamped 32 times.
3. Now level the surface and after 24 hours demoulding should be done and place the samples of the cement mortar cubes into the curing tank for curing till the day when it was tested.
4. Now test the cement mortar cubes with the help of ultrasonic pulse velocity machine at 3days, 7days and 28days respectively.
5. Vaseline will be installed on the sides of the cement mortar cube and the transducer is one side and on the other side the reciever will be present which receives the waves and the time of passing waves it will be in microseconds and at the end calculate the velocity.

5.2.4 Observations and Calculations

The quality of the cement mortar cubes are determined with the help of ultrasonic pulse velocity test. The cement mortar cubes in which the replacement of cement by silica fume would be done and their quality should be checked at 3days, 7days and 28days respectively. Similarly the cement mortar cubes in which the replacement of cement by waste marble powder would be done and their quality should be checked at 3days, 7days and 28days respectively.

- **Ultrasonic Pulse Velocity Test when the cement is replaced by silica in cement mortar.**

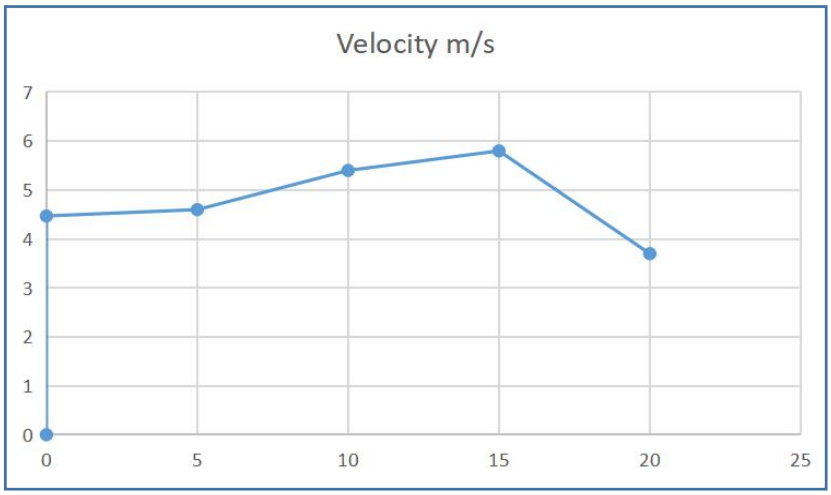
Control Mix (C.M)	**Percentage**	**3days**	**7days**	**28days**
SF_0	0%	3.29m/s	4m/s	4.40m/s
SF_5	5%	3.48m/s	4.28m/s	4.57m/s
SF_{10}	10%	3.55m/s	4.55m/s	5m/s
SF_{15}	15%	3.69m/s	4.63m/s.	5.6m/s
SF_{20}	25%	2.75m/s	3.1m/s	3.4m/s

- **Ultrasonic Pulse Velocity Test when the cement is replaced by waste marble powder in cement mortar.**

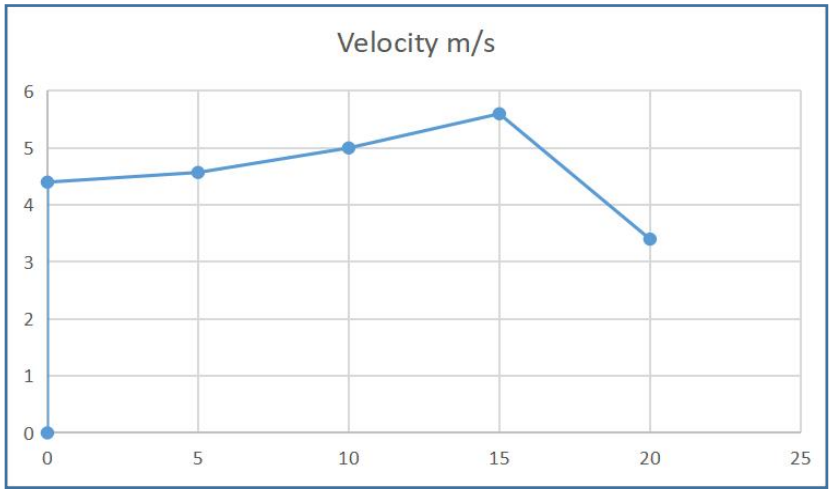
Control Mix (C.M)	Percentage	3days	7days	28days
WMP_0	0%	3.3m/s	4.1m/s	4.47m/s
WMP_5	5%	3.5m/s	4.34m/s	4.6m/s
WMP_{10}	10%	3.6m/s	4.6m/s	5.4m/s
WMP_{15}	15%	3.75m/s	4.7m/s.	5.8m/s
WMP_{20}	20%	2.8m/s	3.2m/s	3.7m/s

5.2.5 Graphical Representation of the Velocity

- The graphical representation of the velocity of the waves passing from the cement mortar after 28 days in which the replacement of cement by silica fume respectively.



- The graphical representation of the velocity of the waves passing from the cement mortar after 28 days in which the replacement of cement by waste marble powder respectively.



CHAPTER: 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions:

- It is concluded that the use of waste marble powder instead of silica fume for the compressive strength and for the quality of the cement mortar is economical.
- On further investigation we observe that the strength of the cement mortar cubes we obtain from the replacement of cement mortar by waste marble powder is at the level of strength which we obtain when the cement is replaced by the silica fume in the cement mortar cubes.
- The main point to noted is that when the replacement of cement by waste marble powder and silica is greater than 15% then the compressive strength of the cement mortar cubes will decreases as well as it would also affects the quality of the cement mortar cubes.
- The water cement ratio (W/C = 0.5) should be fixed for both the mixes 1:3 and 1:4 respectively due to which the strength and quality of the cement mortar cubes would not be affected.
- We concluded that if the ingredients would not weight correctly according to the mix design the strength and quality would not be achieved which we want.
- We observe that if the replacement of cement by waste marble powder and silica at a time directly means we use both admixtures at a time in replace of cement and form the cubes of cement mortar but their strength and quality would not be achieved which we want.
- If we want that the quantity of water would not absorb by the bowl so first we wet the bowl due which it does not absorb the water which is used for the ingredients mixing.
- The physical and chemical properties of the silica fume and waste marble powder has the significant effect on the bonding between the sand and cement respectively.
- Some experiments were further conducted to see the effect of properties of silica fume and waste marble powder on the cement mortar.

6.2 Recommendations:

- In order to see which admixture would be more economical than waste marble powder and it would gave the results to an equal level of waste marble powder further research needs to be done.
- The use of cement mortar in which the replacement of cement by waste powder is suitable for the brick masonry (1:4) and for plaster work (1:3) and if we wants to use the replacement of cement by waste marble powder for the flooring work (1:2) further analysis needs to be done on the compressive strength and quality of the cement mortar
- The results are more satisfactory if the replacement of sand by silica fume and waste marble powder respectively.