DESIGN OF CONCRETE BLOCK BY PARTIAL REPLACEMENT OF CEMENT WITH EGGSHELL AND SILICA FUME

In partial fulfillment for the award of degree of

MASTER OF TECHNOLOGY

IN

CIVIL ENGINEERING

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UNDER THE GUIDANCE OF:

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DECLARATION

I hereby declare that the project work entitled "**DESIGN OF CONCRETE BLOCK BY PARTIAL REPLACEMENT OF CEMENT WITH EGGSHELL AND MICROSILICA**" is an authentic record of our own work carried out as requirements of Project for the award of degree of Master of Technology in Civil Engineering from Lovely Professional University, Phagwara, under the guidance of **Mr. Paramveer Singh** , during January to May, 2017. This matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any degree.

Signature

Mrinal Kanti Sen (41400013)

CERTIFICATE

Certified that this project report entitled "Design of concrete block by partial replacement of cement with eggshell and silica fume" submitted by Mrinal kanti sen (41400013) student of Civil Engineering Department of LOVELY PROFESSIONAL UNIVERSITY, Phagwara, Punjab who carried out the project work under my supervision.

This report has not been submitted to any other university or institution for award of any degree.

Signature

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For getting success in any field of life one only needs guidance and inspiration both being very important as they help at each and every step in achieving the goal. "It's felt that words to be very insufficient, less and outplace to some extent in context of expressing sincere feeling to the people who helped to completion of this project is not more than a mere ritual". So, I thank all our teachers, our friends who have helped me in completion of this project.

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ABSTRACT

Concrete is the one of the most widely used construction material throughout the world. Hence it has been labelled as the backbone to the infrastructure development of nation. To fulfill the requirement of industries I have to replace fully or partially the constituent materials of concrete by using waste material. It was carried out to evaluate the properties of concrete by replacing the cement by eggshell powder and silica fume by varying the percentage of eggshell. A comparison of partially replaced concrete with conventional concrete was also include into the study. Comparison of weights of natural concrete with partially replaced concrete after 7, 14 and 28 days of curing was included. The mix design arrived for an M30 mix.

As I know the carbon dioxide produced by cement industry causes environmental pollution and global warming. In 1000Kg of cement manufacturing process approximately 900Kg of carbon dioxide is emitted. In order to reduce the cement production into atmosphere waste by products are used admixture in study so that environmental pollution and natural resources consumption is reduced. In India, eggshell powder which in calcium and silica fume is thrown away as waste. In the present study, I use eggshell and silica fume as a partial replacement of cement and various properties like workability, compressive strength was determined. Keep silica fume as constant and varying eggshell percentage I find strength of blocks.

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LIST OF ABBREVIATIONS

S. No.	Abbreviations	Description
1.	F_t	Target strength
2.	F_{ck}	Characteristic strength
3.	CTM	Compression testing machine
4.	M30	M-Mix ,30-strength of concrete after 28 days
5.	S_c	Specific gravity of cement
6.	S_{fa}	Specific gravity of saturated dry fine aggregate
7.	S_{ca}	Specific gravity of saturated dry coarse aggregate
8.	F.M.	Fineness Modulus
9	OPC	Ordinary Portland cement

CHAPTER 1

1.1. INTRODUCTION

Cement is the costliest and energy intensive component of concrete. The unit cost of concrete can be reduced by partial replacement of cement with Eggshell Powder and partial replacement of cement with micro silica fume. Eggshell increases the solid waste which is a major issue for environment. The utilization of eggshell and silica fume instead of throwing it as a waste material can be partly used on economic grounds with partial replacement of cement.

It has been used particularly in mass concrete applications and large volume placement to control expansion due to heat and also helps in reducing cracking at early ages. Silica fume is byproduct of producing silicon metal or ferrosilicon alloys. One of most beneficial use of silica fume in concrete because its chemical and physical properties. Concrete containing silica fume can have high strength and can durable.

It is the action of human being that determines the worth of any materials having potentials for gainful utilization remain in the category of waste until its potential is understood and put to right use. Eggshell and silica fume is one such example, which has been treated as a waste material in India.

This project comprises of replacing of cement (OPC, 43 grades) for different percentage of Eggshell Powder and Silica fume and then testing them for their compressive strength.

1.2. SCOPE OF THE STUDY

The scope of the project work is as under:

- Preliminary laboratory test of fine aggregates, coarse aggregate for mix design.
- Mix design and Proportioning for ingredients Modification and correction in mix proportioning during concrete production to meet workability requirement.
- Water to binder ratio was kept 0.45 throughout for M30 grade concrete.
- 150*150*150mm size cubes, 700*100*100mm size beams and cylinder diameter 100mm and height 200mm were casted, and cured in a water tank for different mix proportions.

- The replacement of cement by Eggshell Powder 10%, 20%, 30% and replacement of sand by Silica fume.
- The workability test was conducted for every mix proportion to determine the slump.
- Test result interpretation for optimum selection of suitable part replacement of Eggshell powder as cementations material.
- Every test, including the mixing of cement and eggshell Powder was done in the lab itself under proper conditions.
- Mechanical properties of concretes at 7, 14, 28 days from the date of casting of the test specimen.

1.3. OBJECTIVES AND HYPOTHESIS OF STUDY:

- In this project work, objective is to develop engineering database on the mechanical properties and to determine the necessary level of fluidity, generally termed as workability (as control of workability is one of the main objectives of mix proportioning) of Eggshell concrete and silica fume concrete.
- Also, only one grade (M30) of concrete is targeted to select optimum percentage of cement replacement Eggshell powder as cement material, for obtaining maximum possible 28 days compressive strength.
- The main objective of using Eggshell and silica fume in most of the cement concrete applications is to get durable concrete at reduced cost, which can be achieved by adopting one the following method:
- Using Eggshell and silica fume as an ingredient in cement
- Product and does not require any additional quality check for eggshell powder during production of concrete. In this method, the proportion of eggshell powder and cement is however fixed and limits the proportioning of eggshell powder in concrete mixes.
- The addition of eggshell as additional ingredients at concrete mixing stage as part replacement of OPC and fine aggregates is more flexible method. It allows for maximum utilization of the quality eggshell and silica fume as an important component of concrete.
- In this Project, I have used the method. The simple replacement method of cement and sand.
- In this process, the early strength of concrete is lower and higher strength is developed after 28 days.

CHAPTER 2

2.1 CONCRETE MIX DESIGN

Introduction

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability and workability as possible as economically is termed the concrete mix design. The ingredient proportioning of concrete is given by the required performance of concrete in 2 states, namely plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The Property of workability, therefor, becomes of vital importance. The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; Placing, compaction and curing. From technical point of view the rich mixes may lead to high shrinkage and cracking in the structural concrete, and to evolution of high heat of hydration in mass concrete which may cause cracking.

Requirements of concrete mix design

The requirement which form the basis of selection and proportioning of mix ingredients are:

- The minimum compressive strength required from structural consideration.
- The adequate workability necessary for full compaction with the compacting equipment available.
- The strength and durability of concrete depends on the quality control during construction operation at site
- Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.
- Each construction material should have been tested laboratory before it is considered for mix design calculation.

2.2 TYPE OF MIXING

Nominal Mix

In the past, the specifications for concrete prescribed the proportions of cement, fine and coarse aggregates. These mixes of fixed cement aggregate ratio which ensures adequate strength are termed nominal mixes. These mixes provide a marginal strength, however, due to the variability of mix ingredients the nominal concrete for a given workability varies widely in strength.

Standard Mix

The nominal mixes of fixed cement aggregate ratio vary widely in strength and may result in varied mixes. For this reason, the minimum compressive strength has been included in many specifications. These mixes are termed standard mixes.

IS 456-2000 has designated the concrete mixes into a number of grade as M10, M15, M20, M20, M25, M30 and M40. In this designation, the letter M refers to the mix and the number to the specified 28-day cube strength of mix in N/mm^2. The mixes of grades M10, M15, M20 and M25 correspond approximately to the mix proportions (1:3:6), (1:2:4), (1:1.5:3) and (1:1:2) respectively.

Designed Mix

In these mixes, the performance of the concrete is specified by the designer but the mix proportions are determined by the producer of concrete, except that the minimum cement content can be laid down. This is most rational approach to the selection of mix proportions with specific materials in mind possessing more or less unique characteristics. The approach results in the production of concrete with the appropriate properties most economically. However, the designed mix proportions for the prescribed performance.

It is a performance based mix where choice of ingredient and proportioning are left to the designer to be decided. The user has to specify only the requirement of concretes. The requirement in fresh concrete are workability and finishing characteristics, whereas in hardened concrete these are mainly the compressive strength and durability.

2.3. FACTOR AFFECTING THE CHOICE OF MIX PROPORTIONS

The various factors affecting the mix design are:

Compressive strength

It is one of the most important properties of concrete and influences many other describable properties of the hardened concrete. The mean compressive strength required at a specific age, usually 28 days, determines the nominal water cement ration of the mix. The other factor affecting the strength of concrete at a given age is the degree of compaction this is cured at a prescribed temperature. As we know according to Abraham's law the strength of fully compacted concrete is inversely proportional to the water cement ratio.

Workability

The degree of workability required depends on three factors. These are the size of section to be concreted, the amount of reinforcement, and the method of compaction to be used. For the narrow and complicated section with numerous corners or inaccessible parts, the concrete must have a high workability so that full compaction can be achieved with a reasonable amount of effort. This also applies to the embedded steel sections. The desired workability depends on the compacting equipment available at the site.

Durability

The durability of concrete depends upon the aggressive environmental conditions. High strength concrete is generally more durable than low strength concrete. In the situations when the high strength is not necessary but the conditions of exposure are such that high durability requirement will determine the water cement ratio to be used.

Maximum nominal size of aggregate

The workability of concrete increase with increase in maximum size of the aggregate. In general, larger the size of aggregate smaller is the cement requirement. However, the compressive strength tends to increase with the decrease in size of aggregate.

Grading and type of aggregate

The grading of aggregate influences the mix proportions for a specific workability and water cement ratio. Coarser the grading leaner will be mix which can be used. Very lean mix is not desirable since it does not contain enough finer material to make the concrete cohesive.

The type of aggregate influences strongly the aggregate cement ratio for the desired workability and stipulated water cement ratio. An important feature of a satisfactory aggregate is the uniformity of the grading which can be achieved by mixing different size fractions.

Quality Control

Quality control can be estimated statistically by the variations in test results. The variation in strength results from the variations in the properties of the mix ingredients and lack of control of accuracy in batching, mixing, placing, curing and testing. The lower the difference between the mean and minimum strengths of the mix lower will be the cement content required. The factor controlling this difference is termed as quality control.

2.4 MIX PROPORTION DESIGNATIONS

To express the proportions of ingredients of a concrete mix is in the term of parts of ratios of cement, fine and coarse aggregate. E.g. a concrete mix of proportions 1:2:4 means that cement, fine and coarse aggregate are in the ratio 1:2:4 or the mix contains one part of cement, two parts of fine aggregate and four parts of coarse aggregate. The proportions are either by volume or by mass. The water cement ratio is usually expressed in mass.

Factors to be considered for mix design

- The grade designation giving the characteristic strength requirement of concrete.
- The type of cement influences the rate of compressive strength of concrete.
- Maximum nominal size of aggregates to be used in concrete may be as large as possible within the limits prescribed by is 456:2000.
- The cement content is to be limited from shrinkage, cracking and creep.
- The workability of concrete for satisfactory pacing and compaction is related to the size and shape of section, quantity and spacing of reinforcement and technique used for. transportation, placing and compaction.

2.5. PROCEDURE

- Determine the mean target strength f from the specified characteristic compressive strength at 28 day f_{ck} and the level of quality control.

  $f_t = f_{ck} + 1.65\, S$

  Where S is the standard deviation obtained from the Table of approximate contents given after design mix.

- Obtain the water cement ratio for the desired mean target using the empirical relationship between compressive strength and water cement ratio so chosen is checked against the limiting water cement ratio. The water cement ratio so chosen is checked against the limiting water cement ratio for the requirement of durability given in table and adopts the lower of the two values.
- Estimate the amount of entrapped air of maximum nominal size of the aggregate from the table.
- Select the water content for the required workability and maximum size of aggregates from table.
- Determine the percentage of fine aggregate in total aggregate by absolute volume from the table for the concrete using crushed coarse aggregate.
- Adjust the values of water content and percentage of sand as provided in the table for any difference in workability water cement ratio, grading of fine aggregate and for rounded aggregate the values are given in table.
- Calculate the cement content from the water cement ratio and the final water content arrived after adjustment. Check the cement against the minimum cement content from the requirements of the durability and greater of the two values is adopted.
- From the quantity of water and cement per unit volume of concrete and the percentage of sand already determined in step 6 and 6 above calculation of the content of coarse and fine aggregate per unit volume of concrete from the following relations:

Where V = absolute volume of concrete = gross volume minus the volume of entrapped air.

S_c = specific gravity of cement

W = Mass of water per cubic metre of concrete, kg

C = mass of cement per cubic metre of concrete, kg

p = ratio of fine aggregate to total aggregate by absolute volume

f_a, C_a =Total masses of fine and coarse aggregate per cubic metre of concrete respectively, kg

S_{fa}, S_{ca} = Specific gravities of saturated surface dry fine and coarse aggregate, respectively.

- Determine the concrete mix proportions for the first trial mix.
- Prepare the concrete using the calculate proportions and cast three cubes of 150mm size and test them wet after 28 days moist curing and check for the strength.

2.6. CONCRETE MIX PROPORTION AS PER IS10262:2009:

The target average compressive strength (f_{ck}) at 28 days was determined by using the following equations:

$f_{c'k} = f_{ck} + t*S = 30+1.65*5 = 38.25$N/mm
Where, $f_{c'k}$ = target strength after 28 days

f_{ck} = characteristic strength of course after 28 days

t = a statistic depending upon the accepted proportions of low results and the number of tests; the value of t was taken from table 2 of IS 10262-1982Page no. 6, t=1.65

s = standard deviation, for M30 standard deviation s= 5 for good control, taken from table no 1 IS 10262-1982.

Selection of mix proportion:

Water cement ratio for the target strength of 38.25N/mm is 0.450. This is obtained from the graph/figure 1 IS 10262-1982 for target strength 38.25.

From table 4 of IS 10262-1982 for 20 mm nominal maximum size aggregate and sand conforming to grading, Water content per cubic meter of concrete =186kg and sand content as percentage if total aggregate by absolute volume = 35%.

Adjustment required = 3% (given in IS 10262-1982)

Therefore, required water = 186 + ((186*3) (100)) =191.61 kg. Accordingly, the required cement content = 191.6/0.450=425.7kg/m^3

Determination of coarse aggregate:

Amount of entrapped air is 2% as given in Table no.3 IS 10262-1982 page 9.

Therefore, the design volume V =1-0.2 =0.98m^3

Putting this in formula given in Clause 3.5.1 IS 10262-1982 and putting all the other values we get

0.98 = ((191.6+ (425.7/3.15) + ((1*fs) / (0.315*2.8))) * (1/1000)

Equation no.1

0.98 = ((191.6+ (425.7/3.15) + ((1*Cs) / (0.685*2.89))) * (1/1000)

Equation no.2

Solving equation 1 and 2 we have:

f_s = 576kg/m^3 and

c_s = 1293kg/m^3.

Where f_s = the quantity of fin aggregate.

C_s = the quantity of coarse aggregate

Hence the mix proportion that we get is:

Cement	**Fine aggregate**	**Corse Aggregate**	**Water**
425 kg	576kg	1293kg	191.2kgl or 0.450
1	1.35	3.04	

Table 1: Mix Proportion

Actual Qualities required for 3 cubes mold of dimension 150*150*150mm each.

Volume of each mold = (0.150*0.150*0.150) = 0.003375m^3

Design volume =1.52*0.003375=0.00513m^3

MIX PROPORTION FOR CUBE:

Quantity of cement = (0.00513/5.39)*1440*1=1.37 kg

Quantity of water =1.37*.45 = 0.61 kg

Quantity of fine aggregate = (0.00513/5.39)*2520*1.35 = 3.23 kg

Quantity of coarse aggregates = (0.00513/5.39)*1560*3.04 = 4.50 kg

Sr. No.	**Mix % eggshell**	**Water content kg**	**Cement kg**	**Fine aggregate kg**	**Coarse aggregate Kg**		**Eggshell kg**	**Silica fume Kg 15%**
					10mm	**20mm**		
1	0	0.61	1.37	3.23	2.25	2.25	0	0
2	5	0.61	1.096	3.23	2.25	2.25	0.0685	0.205
3	10	0.61	1.0485	3.23	2.25	2.25	.1165	0.205
4	15	0.61	0.9902	3.23	2.25	2.25	0.1747	0.205

Table 2: Quantity of mix proportion for cube

MIX PROPORTION FOR BEAMS:

Volume of beam = 100*100*500 = 0.005m^3

Design volume = 1.52*0.005= 0.0075m^3

Quantity of cement = (0.0075/5.39) *1*1440 = 2 kg

Quantity of fine aggregate = (0.0075/5.39) *1.35*2520 = 4.73 kg

Quantity of coarse aggregate = (0.0075/5.39) *3.09*1560= 6.85 kg

Sr. No.	**Mix % eggshell**	**Water content kg**	**Cement kg**	**Fine aggregate kg**	**Coarse aggregate Kg**		**Eggshell kg**	**Silica fume Kg 15%**
					10mm	**20mm**		
1	0	0.90	2	4.73	3.29	3.29	0	0
2	5	0.90	1.615	4.73	3.29	3.29	0.085	0.3
3	10	0.90	1.53	4.73	3.29	3.29	0.17	0.3
4	15	0.90	1.445	4.73	3.29	3.29	0.255	0.3

Table 3: Quantity of mix proportion for beams

MIX PROPORTION FOR CYLINDER:

Volume of cylinder = 3.14*.1*.1*.2/4 = 0.00157m^3

Design volume = 1.52*0.00157 = 0.0023864m^3

Quantity of cement = (0.002386/5.39) *1*1440 = 0.637 kg

Quantity of fine aggregate = (0.002386/5.39) *1.35*2520 = 1.506 kg

Quantity of coarse aggregate = (0.002386/5.39) *3.09*1560 = 2.13 kg

Sr. No.	**Mix % eggshell**	**Water content kg**	**Cement kg**	**Fine aggregate kg**	**Coarse aggregate Kg 10mm**	**20mm**	**Eggshell kg**	**Silica fume Kg 15%**
1	0	0.288	0.637	1.506	1.04	1.04	0	0
2	5	0.288	0.514	1.506	1.04	1.04	0.0270	0.0955
3	10	0.288	0.487	1.506	1.04	1.04	0.0540	0.0955
4	15	0.288	0.460	1.506	1.04	1.04	0.0812	0.0955

Table 4: Quantity of mix proportion for cylinder

CHAPTER 3

MATERIAL PROPERTIES

3.1. EGGSHELL POWDER:

Eggshell powder consists of fine, powdered particles predominated spherical shape, glassy which is amorphous in nature. The particle size distribution of eggshell is generally similar to silt less than 0.075mm and specific gravity ranges from 1.8 to 2.6. Eggshell has been added as percentage by weight of total cementitious material replacing cement by various percentage. Eggshell can be added to the concrete with the view of obtaining engineering properties. Since Eggshell poses pozzolanic properties similar to cement, it is expected to obtained the properties of concrete with the addition of eggshell through proper studies.

Figure1: Eggshell powder

3.1.1. MANUFACTURING OF EGGSHELL POWDER:

First, we have to collect the eggshell from the wanders, restaurants and dhabha. Eggshell is the outer part of eggs which is a waste material which can be pollute environment so it is the best way to utilize waste eggshell. Eggshell contains calcium to prepare eggshell powder we put the eggshells in water and cook for 30 min. After that we dry it completely. Once completed we put the shells into the grinder and grind it till it becomes a fine powder. After that we sieve the eggshells so that remaining large particle of eggshell can be remove.

Figure 2: Boiling of eggshell

- After collecting eggshells, we have to the inner layer.
- For that we have to first boil the eggshells so that the layer can easily taken out.
- After removing the layer let them dry and convert into powder form with the help of mixer.
- The main purpose of eggshells converting into powder form so that it can be easily mix with other material and gain higher strength as compare to normally mix design.
- And it can also be used as a admixture rather than being a waste product.

Figure 3: Grinding of eggshell

Figure 4 : Eggshell powder

3.2. PROPERTIES OF FRESH CONCRETE:

Properties of concrete:

Properties of concrete can be divided into two parts:

- Fresh properties
- Hardened properties

Fresh concrete or plastic concrete is freshly mixed concrete material that can be mounted into any shape. The quantity of materials cement, aggregates and water mixed together control the properties of concrete in wet state as well in the hardened state. The fresh properties are:

- Workability
- Segregation
- Bleeding
- Setting time of concrete
- Hydration of concrete

3.2.1. PROPERTIES OF HARDENED CONCRETE:

The important property of the hardened concrete is its strength which represents the ability of concrete to resist force. The strength is the important parameter which indirectly represents other properties of concrete. A stronger concrete is dense, compact, impermeable and resistant to weathering and to some chemicals. The various hardened properties are

- Strength
- Impermeability
- Durability
- Shrinkage
- Creep
- Elasticity
- Thermal properties
- Fire resistance

3.3. CEMENT

A cement is binder and a substance used in construction that sets hardens to others binding them together. Cement is seldom used solely. But is used to bind sand and gravel together. Cements used in construction are usually inorganic often lime or calcium silicate. Cements manufacture cause environment impact at all stage of the process. These include emission of airborne pollution in the form of dust, gases, noise ,and vibration when operating machinery and during blasting in quarries and damage to countryside.

The cement used was Ordinary Portland cement (43 grade) with a specific gravity of 3.15.
Initial and final setting time of the cement was 30 min and 600 min respectively.

- Initial Setting = 30 min.
- Final Setting Time = 10 hrs.
- Specific Gravity = 3.15.

Figure 5: Cement

3.4. AGGREGATE:

3.4.1. COARSE AGGREGATE:

Coarse aggregate passing through 20mm and retained 10 mm sieve was used. Its specific gravity was 2.7.

Figure 6: Coarse Aggregate

3.4.2. FINE AGGREGATE

Good quality sand was used as a fine aggregate. The specific gravity is 2.68 respectively.

Figure7: Fine Aggregate

3.5. SILICA FUME:

Silica fume also known as micro silica is an amorphous polymorph of silicon dioxide. It is an ultrafine powder collected as a byproduct of silicon and ferrosilicon alloys production.

First testing of silica fume in Portland cement based concrete carried out in 1952.The biggest drawback of silica fume was exploring the properties of silica fume with which to experiment.

PROPERTY:

Silica fume is an ultrafine material with spherical particles less than 1 μm in diameter, the average being about 0.15 μm. This makes it approximately 100 times smaller than the average cement particle. The bulk density of silica fume depends on the degree of densification in the silo and varies from 130 (unidentified) to 600 kg/m^3. The specific gravity of silica fume is generally in the range of 2.2 to 2.3. The specific surface area of silica fume can be measured with the nitrogen adsorption method. It typically ranges from 15,000 to 30,000 m^2/kg

APPLICATION:

Because of its extreme fineness and high silica content, silica fume is a very effective puzzolonic material. Standard specifications for silica fume used in cementitious mixtures are ASTM C1240

Silica fume is added to Portland cement concrete to improve its properties, in particular its compressive strength, bond strength and abrasion resistance. These improvements stem from both the mechanical improvements resulting from addition of a very fine powder to the cement paste mix as well as from the pozzolanic reactions between the silica fume and free calcium hydroxide in the paste.

Addition of silica fume also reduces the permeability of concrete to chloride ions, which protects the reinforcing steel of concrete from corrosion, especially in chloride-rich environments such as coastal regions and those of humid continental roadways and runways (because of the use of salts) and saltwater bridges.

Prior to the mid-1970s, nearly all silica fume was discharged into the atmosphere. After environmental concerns necessitated the collection and landfilling of silica fume, it became economically viable to use silica fume in various applications, in particular high-performance concrete. Effects of silica fume on different properties of fresh and hardened concrete include

- Workability: With the addition of silica fume, the slump loss with time is directly proportional to increase in the silica fume content due to the introduction of large surface area in the concrete mix by its addition. Although the slump decreases, the mix remains highly cohesive.
- Segregation and bleeding: Silica fume reduces bleeding significantly because the free water is consumed in wetting of that large surface area of the silica fume and hence the free water left in the mix for bleeding also decreases. Silica fume also blocks the pores in the fresh concrete so water within the concrete is not allowed to come to the surface.

3.5.1. MANUFACTURING OF SILICA FUME

Silica fume is a byproduct of producing silicon metal and other ferrosilicon alloys. These products are produced in an electric furnace and the smoke generated from the furnace is collected and known as silica fume or microsilica. This also helps reduce the carbon emissions of the producer.

Use of Silica Fume

The most common use of silica fume is in the production of concrete in which its compressive strength, bond strength and abrasive resistance improve the properties of the concrete. As the particle sizes are 1/100th the size of a normal cement particle, the compressive strength of the cement is increased resulting in high-strength concrete capable of a compressive strength of over 15,000psi - useful in supporting high rise building structures.

Figure: 8 Silica fume

CHAPTER 4

TESTS

- Specific gravity test on cement
- Specific gravity of aggregate
- Initial and final setting time
- Compressive strength

4.1. INITIAL AND FINAL SETTING TIME OF CEMENT:

Purpose

The duration of time required to transform paste to an initial solid state is termed as initial setting time of the cement. It also used to detect the deterioration of cement due to storage.

Apparatus used:

Vicat's apparatus with square needle

Procedure:

- After determining the consistency filled cement paste again in a Vicat mold
- Square needle of a cross section (1mm* 1mm) is attached to a moving rod.
- The needle is quickly released and allows penetrating into the cement paste.
- In beginning the needle penetrates completely.
- Again, take out this needle and penetrate at fresh point and repeat this process at regular interval of time, till the needle does not penetrate.
- The penetration should be measured from bottom of the mold and its value should be 5mm.
- The initial setting time is that time when water is added to paste and needle stop penetrating through paste. For OPC initial setting time is 30 minutes.

Results:

The initial setting time came out to be 34 min. For 400gm cement with 110ml. And 38 min for 400 gm cement with 115ml water.

Final Setting Time of cement:

The final setting time is the time taken for the cement mortar paste or concrete to harden sufficiently and attain the shape of the mold in which it is cast.

Apparatus:

Vicat apparatus with angular collar

Procedure:

- After filling the mold the needle with angular collar is attached to a moving rod of vicat apparatus.
- The needle releases gently. The time at which needle makes an impression on test block and collar fails to do so is noted.
- The final setting time is the difference between the time at which water is added to cement and time as recorded. For OPC the final setting time is 600 minutes or 10 hrs.

Figure 9: final setting time

Result:

Final setting time comes out to be 9 hours 3o min.

4.2 Specific Gravity of fine aggregate:

Purpose:

Specific gravity is defined as the ratio of mass of a unit volume of material to the mass of the same volume of water. With the specific gravity of each constituent known, its weight can be converted into solid volume and hence a theoretical yield of concrete per unit volume can be calculated.

Equipment:

Pycnometer, weigh balance

Procedure:

- Weigh empty pycnometer (w1).
- Fill dry sand up to half the pycnometer and weight (w2).
- Add water to the sample and fill it completely and weight (w3).
- Empty the contents of pycnometer, refill it with water and weigh (w4).
- Then specific gravity is calculated as below with the formula,

W1 = 0.68 kg

W2 = 0.79 kg

W3 = 1.62 kg

W4 =1.554 kg

S.G. = (W2-W1)/ (W4-W1) -(W3-W2)

= (0.79-0.68)/ ((1.554-0.68) -(1.62-0.79)) = 2.5

Normally for good sand S.G. ranges between 2.4 to 2.7.

Results:

The specific gravity of the fine aggregate is 2.5.

Figure 10: Aggregate.

Sieve Analysis:

Sieve analysis of sand is done to determine the particle size distribution present in it and the uniformity of grading. Sand consists of materials in between 4.75mm to 150 micron.

Equipment's:

Sieves of 10mm 4.75mm 2.36mm .18mm, 600mic, 300mic, &150 mic, weigh balance.

Procedure:

- Take the dry sample of sand 1kg in wt.
- Sieve the sand starting from the biggest sieve in descending order.
- Calculate the percentage of sand retained on each sieve.
- Calculate the cumulative percentage retained on each sieve.
- Calculate the cumulative percentage of sand passing through each sieve.
- Find out the fineness Modulus (FM) of sand. F.M. of satisfactory sand should lies between 2.6 to 3.5.

FM is a ready index of coarseness or fineness of the material. This is obtained by adding the cumulative percentage of aggregate retained on each sieve divided by 100 Following limits are taken for categorizing sand.

FM SAND CATEGORY

- 2.2 – 2.5 Fine Sand
- 2.5 – 2.9 Medium Sand
- 2.9 – 3.2 Coarse Sand

Fine modulus (FM) is comes out 3.21 which shows that our sand is coarser sand.

Zone:

As per IS 383 sands is classified into four zones based on sieve analysis. Sand confirming to zone I is the coarsest variety and sand confirming to zone IV is the finest one.

Equipment:

600-micron Sieve, Weigh balance.

Procedure:

Note the cumulative percentage of sand passing with the table given below and find out the zone. Percentage passing

IS Sieve	**Percentage Passing**			
	Zone I	Zone II	Zone III	Zone IV
600 micron	15 -34	35 – 59	60 – 79	80 – 100

IS Sieve	Sieve Individual Weight (gm)	Sieve + Sand wt (retained)	%retained On each sieve	Cumulative % retained on each IS sieve	% of fine Aggregates Passing	Fineness Module (FM)
4.75 mm	380	388	0.8	0.8	99.2	3.21
2.36 mm	338	442	10.4	11.2	88.8	3.21
600 mic	314	722	40.8	52	48.0	3.21
300 mic	284	452	16.8	68.2	312	3.21
180 mic	324	518	19.4	88.2	11.8	3.21
75 mic	286	350	11.8	100	0	3.21

Table 5: Result of the sieve Analysis

The Zone of fine aggregates is coming out to In Zone II, because our cumulative Percentage that passing from IS sieve 600 microns. The values lie in range 35-59 (Zone II) According to IS code 383 specifications.

CHAPTER 5.

COMPRESSIVE TEST ON CUBES

5.1. PURPOSE

To determine the compressive strength of concrete Specimens prepared and to verify the strength requirements as desired in the mix design and stipulated in the IS code.

5.2. APPARATUS USED: Compression testing machine

5.3. SPECIMEN:

12 cubes of 15 cm size

Mix: M30 design mix

5.4. HAND MIX OF CONCRETE:

Mix the cement and fine aggregate on a water tight none absorbent platform until the mixture is thoroughly blended and is of uniform color.

Add the coarse aggregate and mix with cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch. Add water and mix it until the concrete appears to b homogeneous and of the desired consistency.

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Fig 11: Hand Mixing

5.5 SAMPLING

- Clean the molds and apply oil.
- Fill the concrete in the molds in layers approximately.
- Compact each layer with not less than 35 strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm long, bullet at lower end
- Level the top surface and smoothen it with a trowel.

Fig 12: preparing a mold

5.6 CURING

The test specimens are stored in moist air for 24hours and after this period the specimen are marked and removed from the molds and kept submerged in clear fresh water until taken out prior test.

5.7 PRECAUTIONS

The water for curing should be tested every 7days and temperature of the water must be at $(27+2)^0$C.

5.8 PROCEDURE

- Remove the specimen from water after specified curing time and wipe out excess water from the surface.
- clean the bearing surface of testing machine.

- Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
- Align the specimen centrally on the base plate of the machine.
- Rotate the movable portion gently by hand so that it touches the top surface of the specimen
- Apply the load gradually without shock and continuous through the Compressive testing machine. Set the on machine according capable capacity of mold and automatically machine would apply the load on mold.
- Record the maximum load and note any unusual features in the type of failure.

5.9 CALCULATION

Size of cube =150mm*150mm*150mm

Figure: 13 Curing

figure14: Curing

Split tensile strength test on cylinder:

Figure 15: Split tensile strength test

Compressive test on cubes:

Compressive test result for M30 concrete block with replacement 10%, 20%, 30% of egg shell powder in cement

Figure 16: compressive test

PROCEDURE:

- First, we dry the cubes, cylinder and beams.
- After that we put the cube into the CTM and adjust the reading into the machine manually.
- For cube, we have adjusted load 5.2kN/s and for beam and cylinder 0.1kN/s.
- After that we adjust pressure valve and applied load and release load simultaneously.
- Allow the machine to apply the set load gradually.
- Keep checking both the load and finally note down the reading at failure point.

Flexural test for beam:

Figure: 17 Flexural strength test

- Beams of dimensions (100*100*500) mm were casted and cured for various curing period.
- Central two-point loading method has been adopted for this test.
- Test has been performed in Compression Testing Machine of capacity 1000KN.
- Rate of loading was 0.1KN/s.
- Peak load was determined and flexural strength of each specimen was calculated and average of value of 3 specimens was recorded as a flexural strength of concrete.

Flexural strength = Total applied load/bearing area of beam

View of cube before and after compressive load:

Figure 18: View of cubes before and after compressive load

Compressive test results for Eggshell powder:

Compressive Strength N/mm^2					Area
Sr. No.	**% Eggshell**	**7 days**	**14 days**	**28 days**	**150*150mm^2**
1	0	15.60	20.20	25.50	22500
2	5	14.10	18.20	23.80	22500
3	10	14	15.80	22.10	22500
4	15	15.40	18.40	21.30	22500

Table 6: Compressive test result

Flexural strength test results for beam Eggshell powder:

Flexural Strength N/mm^2					Area
Sr. No.	% Eggshell	7 days	14 days	28 days	100*100mm^2
1	0	1.6	2.2	2.86	10000
2	5	1.065	1.66	2.34	10000
3	10	0.53	1.12	1.82	10000
4	15	0.665	1.16	1.915	10000

Table 7: Flexural strength test results

Split tensile strength test results for cylinder Eggshell powder:

Split tensile Strength N/mm^2					**Area**
Sr. No.	% Eggshell	7 days	14 days	28 days	$100*200mm^2$
1	0	0.62	1.34	2.36	20000
2	5	0.78	1.42	2.06	20000
3	10	0.94	1.5	1.76	20000
4	15	0.83	1.28	1.595	20000

Table 8: split tensile strength test results

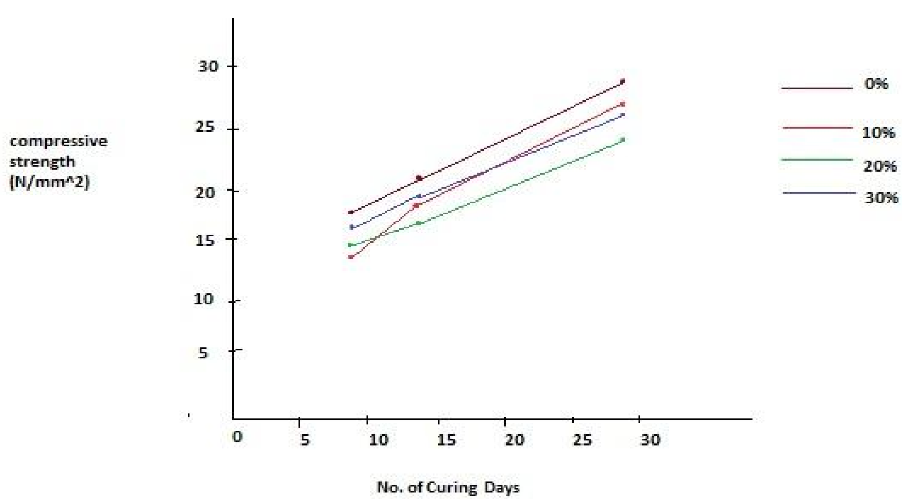

Figure 19: Graph drawn on Compressive strength w.r.t. no. of curing days

Test for silica fume:

Figure 20: view of cube failed under the compressive load

CHAPTER 6

6.1. CONCLUSIONS

Conclusion from the test performed and the analysis of the results following conclusions seem to be valid with respect to the utilization of Eggshell powder. Use of eggshell powder improves the workability of concrete and workability increases with the increase in the eggshell powder content. Bleeding in Eggshell concrete is significantly reduced and other properties like cohesiveness and surface finish are improved. Compressive strength of the concrete made with 25% showed a greater value of strength as compared to that other partial replacement. Further it can be clearly concluded from the results of the compressive tests that replacement of cement is satisfactory only when the initial strength of the structure is not of much importance.

It can be easily and satisfactory used for concrete used in Dams and other heavy structure where the heat of hydration is required to be kept to a smaller value. This can be easily proved from the strength that the 10%, 20%, 30% replacement of cement with eggshell powder showed after 28 days. This clearly proves that the initial strength of concrete with silica fume has lower strength but acquire higher strength after 28 days. This strength will be even more after 56 days. Though initial strength seems to be low it can be satisfactorily used for even in areas where initial strength keeps importance by adding admixtures. Adding admixtures accelerates the setting time hence greater initial strength.

As the replacement of cement with eggshell powder showed satisfactory results, we would highly recommend the replacement of eggshell in areas of construction like Dams, pavements, in bricks manufacturing. Use of eggshell powder should be encouraged as it not only makes the concrete economical but also saves the environment from the pollution eggshell. So that we can have a developed and healthy nation. Egg shell powder obtained from industrial wastes is added in various ratios for cement replacement and it was found that replacement of 5% Egg shell powder + 20 % Micro silica can be added without any reduction in compressive strength properties of conventional cement. And replacement of 5% Egg shell powder + 10% Micro silica replacement in cement yields similar flexural strength as in conventional concrete. And replacement of 5% Egg shell powder + 10% Micro silica replacement in cement yields higher Split Tensile strength as compared to other compositions.

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