PARTIAL REPLACEMENT OF CEMENT BY EGG SHELL POWDER AND EGG ALBUMEN

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INTRODUCTION

1.1 General

Concrete is a composite material which is good in compressive strength but weak in tensile strength. At present for a variety of reasons, the concrete construction industry is not sustainable. The reason is firstly, it consumes huge quantities of virgin materials which can remain for next generations. Secondly, the principal binder in concrete is Portland cement, the production of which is a major contributor to greenhouse gas emissions which results in global warming and climate changes. 900 kg of CO2 is emitted for production of per ton of cement. The production of cement also uses the natural lime in large quantity which results in scarcity of natural resources in future.

India is in fifth position of world annual egg production. About 2 million tones of egg shell is being wasted annually as landfills. The aim of this study is to find the changes in the properties of concrete due to addition of environmental waste-egg shell powder and egg albumen. The egg shell powder is added as partial replacement of cement because the egg shell is highly rich in calcium which is mostly similar to calcium carbonate (Caco3) used for the manufacturing of cement. the egg albumen is of 2/3 of weight of egg with 90% of it contains water and the remaining 10% is of proteins and fats. The cubes are tested for 7days, 14days and 28 days compressive strength and prisms are tested for 7days and 28 days for its flexural strength.

1.2 Aims and Objectives

- Efficient usage of agricultural waste in concrete and thereby reducing its cost and improving its properties.
- Effective usage of agricultural waste in order to reduce the impact of cement production in environment.
- Improving the strength and appearance of concrete by adding egg albumen.
- Reducing the water usage in concrete by using egg albumen as plasticizer

1.3 Scope

- Usage of egg shell powder (ESP) as partial replacement of cement in order to reduce the usage of natural lime in the production process of cement.
- By the addition of this easily available agricultural waste (ESP) the strength of the concrete increases.
- To study the strength parameters of egg shell powder mixed specimens and to compare it with conventional specimens.
- Reduces the global CO_2 up to an extent by usage of egg shell powder instead of natural lime.
- Addition of egg albumen to get glossy finish on concrete specimen.
- It won't change the cost because of usage of broken eggs and rotten eggs.
- Permeability decreases by the addition of egg albumen.

- Varies strength of concrete and setting time slightly increases by the egg albumen.

CHAPTER 2
LITERATURE REVIEW

Amarnath Yerramala [1]-"properties of concrete by egg shell powder as replacement of cement" concluded that Different ESP concretes were developed by replacing 5-15% of ESP for cement. The results indicated that ESP can successfully be used as partial replacement of cement in concrete production. The data presented cover strength development and transport properties.

Jayasankar et al.(2010) [2] conducted a experimental study on properties of concrete by substituting rice husk ash, fly ash and egg shell powder to cement in concrete. Therefore concluded that RHA, ESP and fly ash mixed cubes when added with grades M20, M25, M30, and M25 may results in the decreased strength level.

D. Gowsika et al [3] of "experimental investigation of egg shell powder as partial replacement with cement in concrete" paper reports the result of experiments evaluating the use of egg shell powder from egg production industry as partial replacement for ordinary Portland cement in cement mortar. The chemical composition of the egg shell powder and compressive strength of the cement mortar was determined. The cement mortar of mix proportion 1:3 in which cement is partially replaced with egg shell powder as 5%, 10%, 15%, 20%, 25%, 30% by weight of cement. The compressive strength was determined at curing ages 28 days. There was a sharp decrease in compressive strength beyond 5% egg shell powder substitution. The admixtures used are Saw Dust ash, Fly Ash and Micro silica to enhance the strength of the concrete mix with 5% egg shell powder as partial replacement for cement. In this direction, an experimental investigation of compressive strength, split tensile strength, and Flexural strength was

undertaken to use egg shell powder and admixtures as partial replacement for cement in concrete.

J.Karthick et al [4] of "Experimental Study on Usage of Egg Shell as Partial Replacement for Sand in Concrete" which involves about the entire construction industry is in search of a suitable and effective the waste product that would considerably minimize the use of ultimately reduces the construction cost. Few of such products have already been indentified like Rice Husk, flyash, Silica Fumes, Egg shell etc.

Earlier works on the combination concrete conducted by scholars have led us to the point that the egg shell powder can be used as a supplement for industrial lime. In their article "Effect of Eggshell powder on the Stabilizing Potential of Lime on an Expansive Clay Soil" by **O. O.Amu**, **A. B. Fajobi** and **B.O.Oke** [5] Department of Civil Engineering, Obafemi Awolowo University, Ileife, Nigeria have come to the conclusion that the 4% ESP + 3% lime as the optimal percentage of lime Egg shell Powder Combination. There were also studies on using Egg Shell Powder in wall tile materials. Egg Shell Powder is rich in CaCo3.

Lau Yih Bing [6] of "Effect of Foamed Concrete With Egg Albumen" which involves about In Malaysia, the usage of foamed concrete is widely used in construction of buildings which can reduce the cost and time of project. This study is to investigate the effect of foamed concrete strength with 1% and *5%* egg albumen were used. This study was conducted to improve the performance of foamed concrete by using egg albumen- where egg albumen is considered as an agriculture waste material. The tests conducted in this study were compression strength, flexural strength and drying shrinkage. Based on the researches conducted by **M. N. Freire**, **J. N.**

F. Holanda in their article "Characterization of avian eggshell waste aiming its use in a ceramic wall tile paste". Opine that the eggshell rich in CaCo3 can be used as an alternative raw material in the production of wall tile material. In west Malaysia, the usage of foamed concrete is widely used in construction of buildings which can reduce the cost and time of project. Basically, the dry density of the foamed concrete ranges from 300kg/m^3 to 1700kg/m^3 as stated by Aldridge, D. (2005). Several characteristic in using foamed are high strength to weight ratio, lower water absorption, thermal insulating properties, shock absorbing qualities and others.

Sathanantham et al.(2014) carried out a study on properties of M25 concrete by replacing fine aggregate partially by RHA and ESP. the maximum strength was observed at 20% for compressive, split tensile and flexural strength.

2.2 Background of the Study

The castle in place called manora in thanjavur is said to be constructed a dome with egg albumen and many ancient monuments are constructed using egg albumen for better aesthetic appearance. Eggs, blood, animal fat, cactus extract and so forth have been used as air entrainer and water reducer with varying success. Air in mortar, should optimally be as much as 20% which increases the volume of the mortar, improves freeze thaw resistance, prevents bleeding and increases the workability while water reducers increases the strength.

Padmanabhapuram palace is located in at Padmanabhapuram fort , in Kanyakumari district, tamilnadu, India. The initial structures of the complex date from 1400s, with other buildings added incrementally over time. It is a best example of wooden architecture that has come to symbolize the vernacular architecture of Kerala. The walls are usually made in laterite or brick & plastered over with egg so the interiors are cool & comfortable ambience inside. the flooring is unique and is black in colour, retaining a mirror like polish even now after many centuries. It is said that the flooring was done using a mixture of different structures like burnt coconut shells, egg whites, plant juices etc.

In Bruhadeeshwara temple which is located in thanjavur, egg shell powder and egg albumen mixture is used as a paste for binding between two rocks and also used as mortar for masonry works.

The temples of south India used egg albumen and lime surkhi as a sealing material in between masonry joints, rock joints. Mixture of lime and egg albumen are used for constructing domes and sculptures in temples. It is also used as plastering for walls in olden days to temples. Results in cool environment in hot climatic regions.

CHAPTER III

3.1 Materials Used

a) **Cement**: Ordinary Portland Cement 43 grade conforming to IS 8112-1989 is used. Develops early strength at 3 and 7 days with exceptionally high 28 days strength. Unbeatable consistency in quality gives better accountability for mix design.

b) **Egg shell powder**: Eggshell is generally thrown away as a waste. The egg shell also creates some allergies when kept for a longer time in garbage. Disposal is a problem. It creates undesirable smell which can cause irritation. The main ingredient in eggshells is calcium carbonate (the same brittle white stuff that chalk, limestone, cave stalactites, sea shells, coral, and pearls are made of). The shell itself is about 95% CaCO3 (which is also the main ingredient in sea shells). The remaining 5% includes Magnesium, Aluminum, Phosphorous, Sodium, Potassium, Zinc, Iron, Copper, Ironic acid and Silica acid. Eggshell has a cellulosic structure and contains amino acids; thus, it is expected to be a good bio-sorbent and it was reported large amounts of eggshells are produced in some countries, as waste products and disposed in landfills annually. collected from near by bakeries, dried in sunlight and grinded and sieved through 90 microns and then packed to use it in the cement replacement. Determined specific gravity of egg shell powder is 2.2

Fig 1. Le Chatlier flask (specific gravity of ESP)

Fig 2. Dried egg shells

Fig 3. Grinding of egg shells

Fig 4. Egg shell powder

Table 1. Composition of egg shell powder

S.No	OXIDE COMPONENTS	PERCENTAGE(%)
1.	CaO	60-70
2.	SiO_2	17-25
3.	Al_2O_3	3-8
4.	Fe_2O_3	0.5-0.6
5.	MgO	0.1-4.0
6.	K_2O, Na_2O	0.4-1.3
7.	SO_3	1.3-3.0

c) **Egg albumen**: Egg albumen is considered one of the agriculture wastes because of the primary usage of egg yolk only to make mayonnaise, custard, cake or others. The egg albumen is approximately 2/3 of the egg's weight without its shell-with nearly 90% of that weight is from water. The remaining weight of egg albumen comes from protein, trace mineral, fatty material, vitamins, and glucose.

Fig 5. Egg albumen

d) Fine aggregate: The fine aggregate used in this project was locally available river sand which is sieved through 4.75mm sieve and it was tested as per Indian standard specification IS: 383 [10]. The specific gravity and fineness modulus of fine aggregate were 2.0 and 2.268 respectively.

e) Coarse aggregate: Naturally available quarry stone is crushed with two different sizes 20mm and 12.5mm are available. But 20mm down size was used as coarse aggregate the specific gravity of the coarse aggregate is 2.65 and its water absorption was 1.45% and tested as per Indian standard specification IS: 383.

f) Water: the quality of water used in this process is more important. It should be free from impurities, odourless and colourless. The pH of water used in this process ranges from 6.8 to 8 as drinking water. Both for mixing and curing ordinary drinking water is used.

3.2 Methodology

The mix proportioning for M20 grade concrete is used in this present work. Based on the design mix, proportion used in this study was 1:2:3(cement : fine aggregate : coarse aggregate)(M20) confirming to IS 10262-2009 standards and for batching and curing ordinary portable water is used respectively. Concrete cubes of 100 mm X 100 mm X 100 mm were casted with different proportions of egg shell powder 5%,7.5%,10% as partial replacement of cement and egg albumen of 1%,3%,5% of concrete weight as admixture are considered in mix proportions. Mixing was done by adding coarse aggregates followed by sand, water, cement, egg shell powder and finally egg albumen. Slump test is conducted to measure the workability. After which mould were casted and compacted on table vibrator. Once the cubes are hard enough, demoulding was done and specimens are cured in water tank for 7days, 14days and 28days respectively.

For compressive strength the specimen of 100mmx100mmx100mm is used to cast the cubes as shown in fig 6

Fig 6. Cube Mould

For flexural strength the specimen of 500mmx100mmx100mm is used to cast the prisms in fig 7.

Fig 7. Prism Mould

3.3 MIXING COMPOSITION

In this concrete, egg shell powder (ESP) is added as partial replacement of cement at 5%, 7.5% and 10%. The egg albumen (EA) is added as an admixture to improve the appearance of concrete, it also works as retarder and plasticizer. The EA is added at 1%, 3% and 5% to the weight of concrete. Based on the combinations of both the above said wastes, 9 different concrete mixes are prepared.

The percentage replacement of OPC 43 grade by egg shell powder and egg albumen are mentioned in table.

C-Cement;

ESP-Egg Shell Powder;

EA-Egg Albumen

Table 2. Table of proportions:

Name	Mix Proportion
M1	C-95%, ESP-5%, EA-1%
M2	C-95%, ESP-5%, EA-3%
M3	C-95%, ESP-5%, EA-5%
M4	C-92.5%, ESP-7.5%, EA-1%
M5	C-92.5%, ESP-7.5%, EA-3%
M6	C-92.5%, ESP-7.5%, EA-5%
M7	C-90%, ESP-10%, EA-1%
M8	C-90%, ESP-10%, EA-3%
M9	C-90%, ESP-10%, EA-5%

MIX DESIGN FOR M20 CONCRETE

Grade	=	M20
Type of cement	=	OPC 43 grade
Maximum size of aggregate	=	20mm
Minimum cement content	=	320Kg/m^3
Maximum water content ratio	=	0.50
Workability	=	75mm (slump)
Expose condition	=	Mild
Method of concrete placing	=	Manual
Degree of supervision	=	Good
Type of aggregate	=	Crushed angular aggregate
Maximum cement content	=	450Kg/m^3

Chemical admixture type = Nil

a) TEST DATA FOR MATERIALS

- Cement used = OPC 43 grade
- Specific gravity of cement = 3.15
- Specific gravity of coarse aggregate = 2.65
- Specific gravity of fine aggregate = 2.5
- Water absorption for coarse aggregate = 1.45%
- Water absorption for fine aggregate = 1%
- Free surface moisture for coarse aggregate = 2.7

- Free surface moisture for fine aggregate = 2.67

Sieve analyses as per code,

b) TARGET STRENGTH OF CONCRETE

- The target strength for specified characteristics cube strength at 28 days

$$f'ck = fck + 1.65S$$

where,

- $f'ck$ = it is the target compressive strength at 28 days
- fck = characteristic compressive strength
- S = is the standard deviation

(IS 10262-2009) (table 1. Page no.2)

S=4.0 N/mm^2

$f'ck$ = 20 + (1.65 x 4.0)

= 26.6 N/mm^2

c) SELCTION OF WATER CONTENT RATIO

Table(5) in IS456-2000

For mild exposure, in RC the maximum water cement ratio is 0.5<0.55

Hence it is ok

d) SELECTION OF WATER CONTENT

Maximum water content 1m3 for normal maximum aggregate

Table 3. Selection of Water Content:

Normal maximum size of aggregate (mm)	Water content for cubic meter for concrete (Kg)
10	208
20	186
40	165

We can use 20mm aggregate so, 186Kg/m3 (for slump of 25-50mm).But we need 75mm slump water content can be increased by 3% for every 25mm increase of slump. So, 191.58Kg/m3 (or) 192Kg/m3.

e) CALCULATION OF CEMENT CONTENT

- Water cement ratio = 0.50
- Cement content = 192/0.5 = 384Kg
- For mild exposure condition, minimum cement content is 300 Kg/m^3
- (see table 5 in IS456-2000)
- 384 > 300.
- Hence it is ok

f) PROPORTION OF VOLUME OF COARSE AGGREGATE & FINE AGGREGATE CONTENT

Maximum size of the coarse aggregate = 20mm

Zone of fine aggregate = zone II

Table 4. Selection of size of aggregate:

Normal maximum size of aggregate	Volume of coarse aggregate / unit volume of total aggregate for different zone of fine aggregate			
	Zone I	Zone II	Zone III	Zone IV
10	0.44	0.46	0.48	0.50
20	0.60	0.62	0.64	0.66

From the table,

20mm aggregate zone II,

Volume of coarse aggregate is 0.62

Volume of fine aggregate = 1-volume of coarse aggregate

= 1-0.62

= 0.38

g) MIX CALCULATION

- Volume of concrete = $1m^3$
- Volume of cement = (mass of cement / specific gravity of cement) X (1/1000)

  = (384 / 3.15) X (1 / 1000)

  = 0.122m3
- Volume of water = (192 / 1) X (1 / 1000)

  = 0.192m3
- Volume of admixture = NIL
- Volume of all in aggregate = (a - (b + c + d)) = (1 - (0.122 + 0.192 + 0))

  = 0.686m3
- Mass of coarse aggregate = e X vol. of coarse agg X sp.gr of coarse agg X 1000

  = 0.686 x 0.62 x 2.70 x 1000

  = 1148 Kg
- Mass of fine aggregate = e X vol. of fine agg X sp. gr of fine agg X 1000

  = 0.686 x 0.38 x 2.67 x 1000

h) MIX PROPORTION

- Cement = 384 Kg/m^3

- Water = 192 Kg/m^3
- Fine aggregate = 696 Kg/m^3
- Coarse aggregate = 1148 Kg/m^3
- Chemical admixture = NIL
- Water cement ratio = 0.50

  (384 / 384) : (696 / 384) : (1148 / 384)

  1 : 2 : 3
- Specific gravity of egg shell powder = 50 / (23.5-1) = 2.22
- Volume of cement = 0.122m^3
- Volume of 5% of egg shell powder = 0.122 x (5 / 100) = 6.1 x $10^{-3}m^3$
- Weight of egg shell powder = 6.1 x 10^{-3} x 1000 x sp.gr

  = 13.54 Kg/m^3
- Volume of 100mm x 100mm cube used = 0.01m^3
- Cement = 0.384 Kg
- Fine aggregate = 0.696 Kg
- Coarse aggregate = 1.148 Kg
- Water = 0.192 Kg
- W/C ratio = 0.50

3.4 EXPERIMENTAL STUDIES

1. COMPRESSIVE STRNGTH TEST

Compressive strength test is normally used in sites for testing the strength of concrete in the form of cubes.in our project, concrete is prepared in 9 different proportions of combinations of egg shell powder (ESP) & egg albumen (EA). With ESP of 5%, 7.5%, 10% in replacement of cement & EA of 1%, 3%,,5% is used as admixture in concrete.

Table 2. Table of proportions:

Name	Mix Proportion

M1	C-95%, ESP-5%, EA-1%
M2	C-95%, ESP-5%, EA-3%
M3	C-95%, ESP-5%, EA-5%
M4	C-92.5%, ESP-7.5%, EA-1%
M5	C-92.5%, ESP-7.5%, EA-3%
M6	C-92.5%, ESP-7.5%, EA-5%
M7	C-90%, ESP-10%, EA-1%
M8	C-90%, ESP-10%, EA-3%
M9	C-90%, ESP-10%, EA-5%

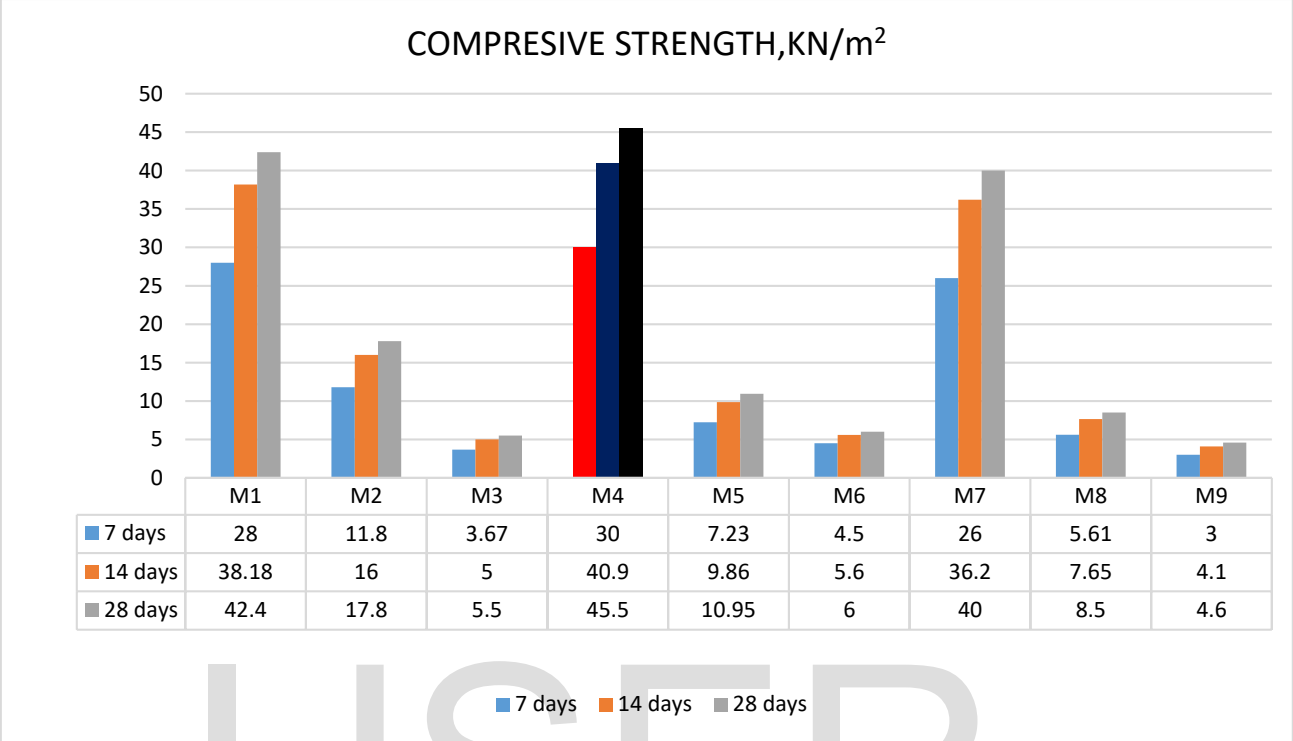
Cubes are prepared for 7 days, 14 days and 28 days curing respectively. Cubes are made in the size of (100mmx100mmx100mm). a total of 81 cubes are prepared in the ration of 3 cubes per proportions in which the mean value is taken as the compressive strength as shown in fig 8,9.

Fig 8. Curing of cube

Fig 9. Testing of cube

Based on this 9 proportions with the maximum strength is selected for further studies. The test results as follows. They been subjected to compression test on a 2000KN AIMIL compression testing machine.

Table 5. compressive strength of concrete:



	M1	M2	M3	M4	M5	M6	M7	M8	M9
7 days	28	11.8	3.67	30	7.23	4.5	26	5.61	3
14 days	38.18	16	5	40.9	9.86	5.6	36.2	7.65	4.1
28 days	42.4	17.8	5.5	45.5	10.95	6	40	8.5	4.6

Based on the above results obtained, it shows that M4 concrete mix has the highest strength. Hence the M4 proportion of 7.5% ESP and 1% of EA is selected for further studies.

The graph shows a line with a decreasing slope of strength, this shows that the increase in the amount of egg albumen results in reduction of strength. Hence a minimum amount of 1% of EA is enough for higher strength.

2. FLEXURAL STRENGTH

Flexural strength is conducted in prisms of size 500mmx100mmx100mm. The prisms are made based on the M4 mix proportion of 7 days & 28 days curing period. Prisms are made with M4 ratio and also nominal sample is made for comparison. After the specified curing period, the prisms are tested under flexural testing machine and the strengths are noted as shown in fig 10, fig 11, fig 12, fig 13

Fig 10. Prisms to be tested after curing period

Fig 11. Testing of flextural strength

Fig 12. Broken specimen

Fig 13. Length of broken specimen

Flexural strength results are as follows

Calculation of flexural strength

$$(PL/bd^2)$$

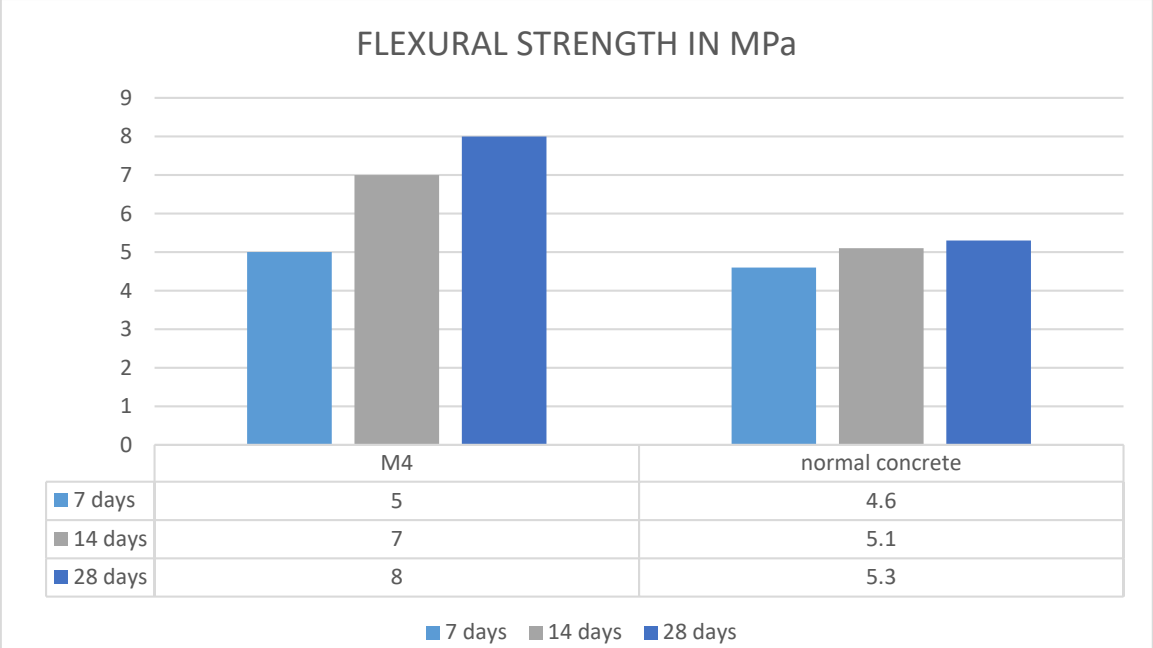
P = Failure load

L = 400mm (Centre to Centre distance between the supports)

b = breadth of prism (100mm)

d = depth of the prism (100mm)

Table 6. flexural strength of concrete:



3. WORKABILITY (SLUMP CONE TEST)

This test is to find the workability of concrete. Workability of concrete is defined as the degree of ease at which concrete is workable. In our studies, the concrete is prepared in M20 design mix, with 7.5% of ESP as partial replacement of cement and 1% of EA as admixture of concrete. Slump cone test is done in a mould size of height 30cm, 1 diameter 10cm, 2 diameter 20cm. and the respective amount of concrete required is found out and admixtures are added as per the design as shown in fig 14, fig 15, fig 16

The slump value obtained is **27**mm

Fig 14. Tamping of concrete

Fig 15. Removing of mould

Fig 16. Shape of slump (true slump)

Does from the workability table, it comes under the category of low slump. it is used for mass concrete foundations without vibration or lightly reinforced sections with vibrations

4. WATER ABSORPTION TEST

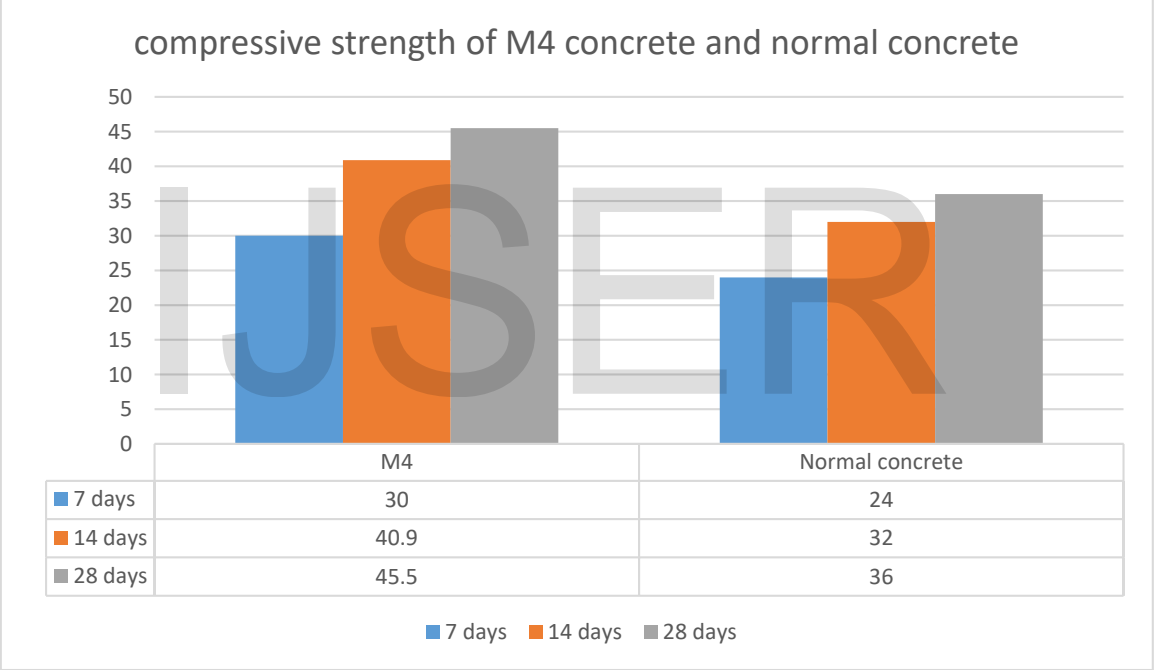
Water absorption test is carried out for increase in weight of a dry sample when immersed in water for 24 hours. The ratio of increase in weight to the weight of dry sample expressed as percentage is known as water absorption. First the concrete cube is immersed in water for curing 24 hours and weight is taken on next day. The concrete block absorbs only **0.33%** of water to its weight which shows the permeability of concrete is very less.

CHAPTER IV

4. 1 RESULTS AND DISCUSSIONS

- The compressive strength of various properties are found out and results are compared
- The results shows a decrease in the strength with the addition of egg albumen, which shows that minimum **1%** of EA gives higher strength and also will be economical
- The compressive strength of the **M4** concrete mix is **45.5 KN/m^2** at the end of 28 days

Table 7. compressive strength of M4 concrete and normal concrete:



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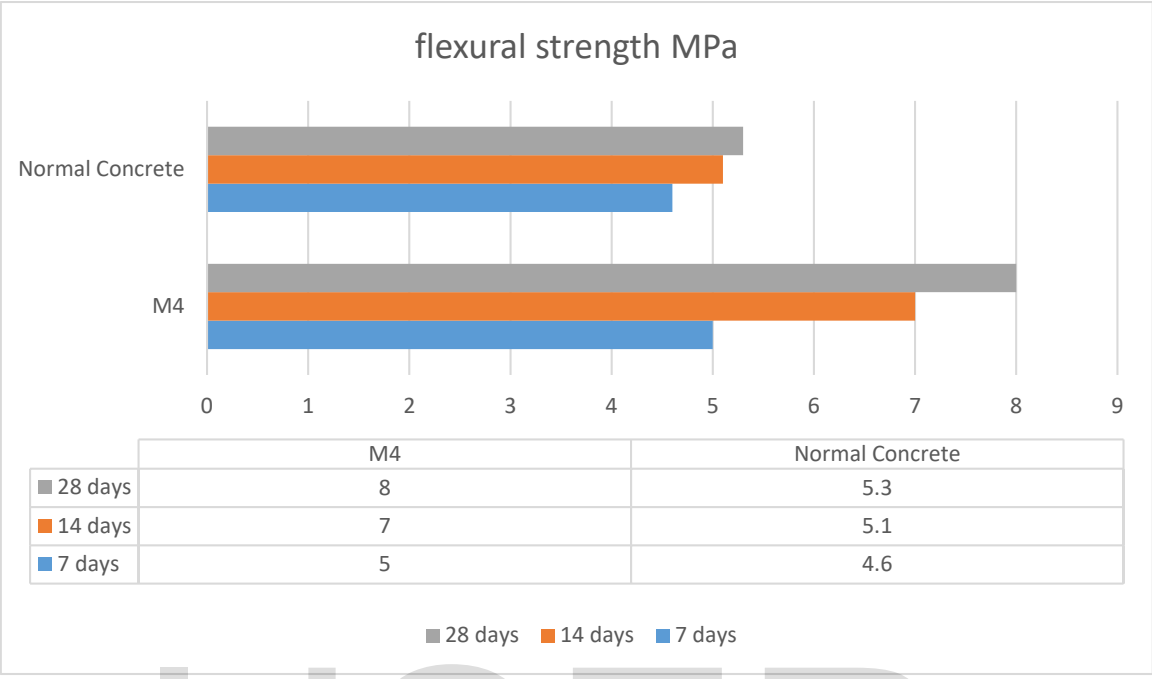
- The M4 concrete mix which has highest compressive strength is used for flexural strength test and strength are taken at 7 days, 14 days & 28 days respectively.
- The flexural strength of the concrete **5 MPa** at the end of 7 days and **8 MPa** at the end of 28 days.

Table 8. flexural strength of M4 concrete and normal concrete:



	M4	Normal Concrete
28 days	8	5.3
14 days	7	5.1
7 days	5	4.6

- But for nominal concrete the flexural strength obtained as **4.6 MPa** for 7 days and **5.3 MPa** for 28 days. This shows the adding of these admixtural (ESP & EA) makes the concrete more stronger both in compression and in tension.
- The concrete is then tested for its workability through the slump cone test and the slump value obtained comes under the **true slump** category which shows that the concrete is also good in workability
- Since the egg albumen is added to the concrete the bonding strength of the concrete gets increased thus reducing the permeability of concrete.
- To check the permeability of concrete, the concrete is undergone a water absorption test.
- In which, the concrete absorbed only **0.33%** of its weight of water which shows the **permeability** of **concrete** is **very less**.

CHAPTER V

5.1 CONCLUSION

- Replacement of cement by egg shell powder does not affect the properties of concrete significantly.
- The compressive strength obtained from the mix M1, M4, M5 upturns about 20% to 40% strength of conventional concrete.
- Mix design M4 gained more strength than the other mixes.
- Egg albumen used in this concrete increases the bonding nature in concrete.
- It will provides a good aesthetical appearance to the surface and has a glossy appearance.
- This will also maintain interiors cool and comfortable ambience nature and can be used for high temperatures like desert regions of India.
- This concrete is with no trouble manually compacted.
- Nearly 15% of cement can be replaceable by ESP it will reduces the usage of natural lime for cement.
- Usage of environmental waste in concrete brought a good result.
- Practice of natural admixtures does not change the assets of concrete considerably**.**
- Reduces the permeability, increases the workability and strength of the concrete both in compression and tension.
- Thus by the addition of egg albumen in concrete, it increases the setting time of concrete.
- The addition of albumen in concrete increases the setting time. This may either be a advantage or disadvantage. In arid region nominal concrete sets easily and also in the place where the resource is not available we need to transport from long distance which affects the workability in such cases this concrete can be useful.
- In tropical regions as the climate is cool it takes more time for setting in such case this concrete may have some backdrops.
- Even though the concrete is slightly costlier than the nominal concrete, the advantages it obtains over the nominal concrete makes it worthy to use instead of nominal concrete.

5.2 FUTURE SCOPE

This concrete is good in all the aspects except in setting time of concrete so, in further studies Aloe Vera gel can be used in order to maintain the setting time of concrete as that of nominal concrete.

REFERENCE

[1] Amarnath Yerramala-"Properties of concrete by egg shell powder as replacement of cement" of **Indian Concrete Journal Of October 2014.**

[2] Jayasankar et al.(2010)- **"**Studies on Concrete using Fly Ash, Rice Husk Ash and Egg Shell Powder" of **International Journal Of Civil And Structural Engineering Volume 1, No 3, 2010.**

[3] D. GOWSIKA et al of "experimental investigation of egg shell powder as partial replacement with cement in concrete" of **International Journal of Engineering Trends and Technology (IJETT) – Volume 14 Number 2 – Aug 2014.**

[4] J.Karthick et al of "Experimental Study on Usage of Egg Shell as Partial Replacement for Sand in Concrete" of **International Journal of Advanced Research in Education Technology (IJARET) Vol. 1, Issue 1 (July - Sept. 2014).**

[5] O. O.Amu, **A. B. Fajobi** and **B.O.Oke** Department of Civil Engineering, Obafemi Awolowo University, Ileife, Nigeria of article "Effect of Eggshell powder on the Stabilizing Potential of Lime on an Expansive Clay Soil".

[6] Lau Yih Bing of "Effect of Foamed Concrete With Egg Albumen" about the report submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Civil Engineering Faculty of Civil and Environmental Engineering University Malaysia Pahang November 2010.