ISSN: 2278-4632
Vol-10 Issue-5 No. 10 May 2020

# Strength analysis of M40 Concrete Replacing Cement Partially with Egg Shell Powder

Amol Singh Ramana[1], Naitik Jangir[2], Poorvi Shivhare[3] & Manish Singh[4]

[1]Departmrnt of Civil engineering, Poornima Institute of Engineering and Technology, Jaipur.
[2,3,4]Departmrnt of Civil engineering, Poornima Institute of Engineering and Technology, Jaipur

Email Id: [1] amol.ramana@poornima.org
[2] 2016pietcvnaitik045@poornima.org
[3] 2016pietcvpoorvi051@poornima.org
[4] 2016pietcvmanish040@poornima.org

***Abstract***:

*The egg shells are mainly disposed, it is assumed as poultry waste. Egg Shell powder is Calcium rich poultry waste with pozzolanic chemical composition. Cement can be replaced by egg shell powder to improve the overall strength of concrete. This experimental study aims to investigate the strength of concrete by replacing 5%, 10%, 15% and 20% amount of cement by egg shell powder by weight. The compressive strength of the concrete mixture is noted down for 7 days and 28 days respectively of M40 grade concrete and also split tensile strength and flexure strength standard samples are analyzed after 28 days of curing. The ratio of water binder was kept constant for all cases. On the basis of observation and result by adding the egg shell powder in certain amount shows the increase in strength.*

***Keywords***

*Egg shell powder, Fine and Coarse aggregate, Cement (OPC- 43 grade), Compressive strength, Tensile strength.*

## 1. Introduction

A huge amount of waste is produced or generated from the poultry farm of India. According to a study about 190 thousand tons per annum of egg shell waste is generated in India. Majority of this egg shell waste is used as landfills deposition. Vermin are attracted by egg shell due to presence of attached membrane in landfills, and causes problems to human health and environment. So the egg shell waste is useless as the landfills materials. In the manufacturing of 1 tons of OPC and equal amount of $CO_2$ are released into the atmosphere. This emission of $CO_2$ gas causes the major problem of global warming. For this the search of cheaper substitute to OPC is needed.

## 2. Literature review

Divya et.al. [2] had made M20 by replacing cement by 5%, 10%, 15%, 20% and found that there is increase in the strength till 15% cement replacement with egg shell powder and decease is seen in the 20%. Dhanlakshmi et. al. [1] also repeated the experiment by making M40 grade concrete by partially replacing cement by egg shell powder up to 12.5% also they replaced the cement with fly ash up to 30% and found a slight decrease in the strength after replacement. Likewise Minakshi et. al. [3] also replaced cement with egg shell (up to 7.5%) and micro silica (also up to 7.5%) and found that increase in compressive strength when cement is replace by 5% (2.5% egg shell powder and 2.5% micro silica) and after that nearly a constant decrease is noticed. Now in this research M 40 is made with replacement of cement with only egg shell up to 20%.

## 3. Material Used

Materials used in project are the following;

**3.1. Cement:** OPC cement of grade43 is used as specified in the IS 8112:1989 [6].

**3.2. Aggregate:** Coarse and fine aggregate were used which is produced by nearby crushing of Aravali hills. The specific gravities of fine aggregate and coarse aggregate were 2.65 and 2.7 respectively.

**3.3. Water:** Water is used in which every constituent is in permissible limit as per IS 3025.

**3.4. Egg shell powder:** The 90 micron sieve is used to sieve the grinded egg shells which

 

ISSN: 2278-4632
Vol-10 Issue-5 No. 10 May 2020

are then used in the replacement of cement. Eggshell is rich in calcium and has the same property as lime stone. As cement is costly, difficult to obtain and have one of the drawbacks of generating of $CO_2$ in large quantity. So this paper describes use of poultry eggshell waste as partial substitute of cement. Instead of natural lime egg shell waste can be use as replacement of cement which will help in saving natural lime. Eggshell primarily contain calcium, magnesium, carbonate (lime) and protein. The composition of egg shell is shown in following Table-1.

Table-1 Chemical Composition of Eggshell
(As per ISSN:2319-1058, Vol-5)

| Content | Percentage of contents |
|---|---|
| CaO | 60-70 |
| $Sio_2$ | 15-25 |
| $Al_2O_3$ | 4-9 |
| $SO_3$ | 1.5-3.5 |
| $Fe_2O_3$ | 0.7-0.8 |
| $K_2O$ & $Na_2O$ | 0.5-1.5 |
| MgO | 0.2-4.0 |

## 4. Test Program

The main objective of the present investigation and research was to study performance of cement replaced partially by egg-shell in concrete (replacement of cement by egg-shell powder by 5%, 10%, 15%, and 20%) in terms of strength by performing normal water curing on the concrete specimen. Performance of the concrete was assessed through the 3 test: Strength in compression, Cylinder Split Tensile Strength, and Beam Flexural Strength as mentioned in the 516:1959 [4]. The compression test specimens were tested for 7 and 28 days and split tensile and flexural specimens are tested after 28 days.

### 4.1. Mix Proportioning Design

The mix design for M40 grade concrete produced in the present work by use of IS 10262:2009 [5].

## 5. Results

The above tests are done on the triplicate of each specimen and mean value is reported for M40 grade concrete.

### 5.1. Compressive Strength Test

This compressive loading test on concrete was conducted on compressive testing machine of capacity 2000 kN as loading rate of 5kN/sec. Compressive strength of the cube specimen of 150mm×150mm×150mm is obtained by the following fomula:

$$\text{Compressive strength} = \frac{\text{Ultimate compressive load}}{\text{loaded surface area}}$$

Table-2 Compressive strength in $N/mm^2$

| Percentage cement replacement with egg-shell powder | 7 days | 28days |
|---|---|---|
| 0% | 25.3 | 41.2 |
| 5% | 26.4 | 42.4 |
| 10% | 28.2 | 44.8 |
| 15% | 27.2 | 43.1 |
| 20% | 26.5 | 40.2 |

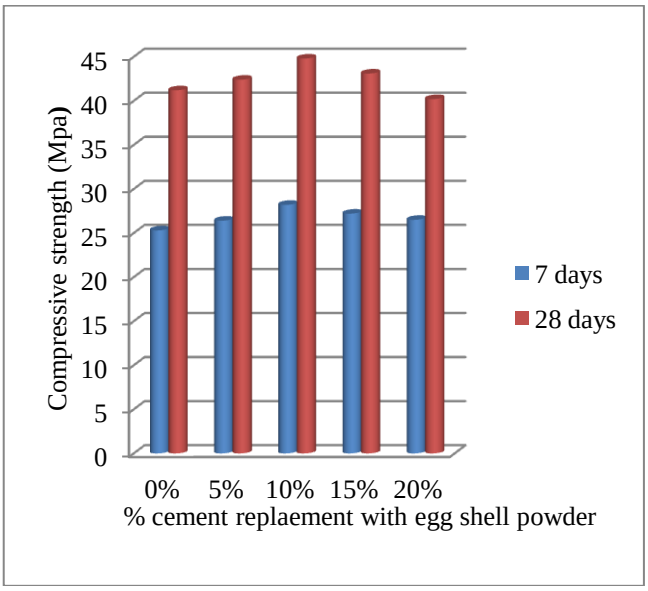


Figure-1 Result of compression strength

Figure-2 Compressive testing machine

### 5.2. Concrete Cylinder Split Tensile Strength Test

Concrete cylinder split tensile strength test is done with help of IS516:1959. Cylinder of size 150*300

 

ISSN: 2278-4632
Vol-10 Issue-5 No. 10 May 2020

mm is used for this test. The split tensile strength test was conducted on compressive testing machine.

$$\text{Split tensile strength} = \frac{\text{Total load applied}}{\text{Bearing area of cylinder}} = \frac{2P}{\pi DL}$$

Table-3 Concrete cylinder split tensile strength in N/mm$^2$

| Percentage cement replacement with egg-shell powder | 28days |
|---|---|
| 0% | 2.5 |
| 5% | 2.9 |
| 10% | 3.3 |
| 15% | 2.4 |
| 20% | 2.1 |

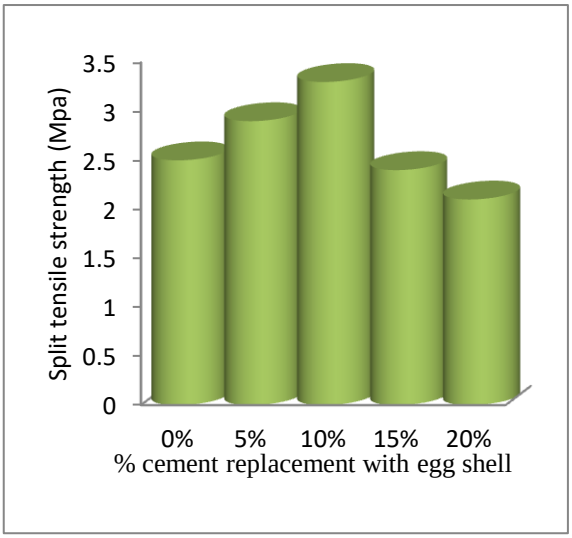


Figure-3 Concrete cylinder split tensile strength results

Figure-4 Split tensile test

### 5.3. Concrete Beam Flexural Strength Test

The concrete beam flexural strength test is conducted in accordance with IS 516:1959. Beam of 100*100*500mm size were used for this test as aggregate used is lesser than 20mm. The load is gradually applied at a rate of 0.7N/mm$^2$/min.

$$\text{Flexural strength} = \frac{\text{Total applied load}}{\text{Bearing area of prism}} = \frac{\text{P}\times\text{L}}{\text{B}\times\text{D}^2}$$

Table-4 Concrete beam flexural strength test in N/mm$^2$

| Percentage cement replacement with egg-shell powder | 28days |
|---|---|
| 0% | 5.9 |
| 5% | 6.1 |
| 10% | 6.4 |
| 15% | 6.2 |
| 20% | 5.8 |

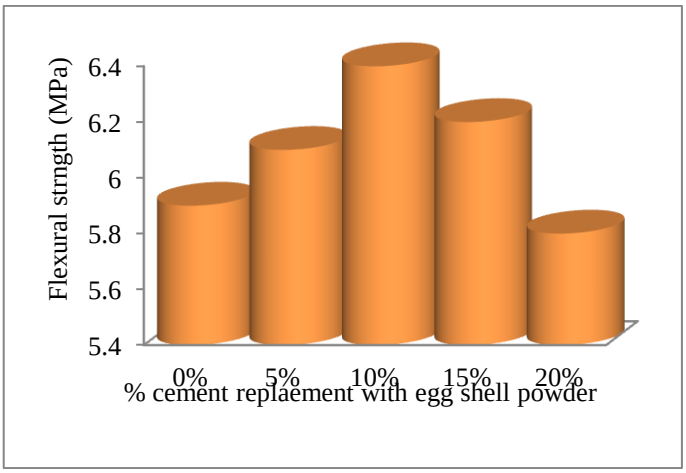


Figure-5 Flexural strength test results

Figure-6 Flexure test

## 6. Conclusion:

 

ISSN: 2278-4632
Vol-10 Issue-5 No. 10 May 2020

- Increase in the compression strength till 10 % of replacement of the cement with egg-shell.
- A small decrease in the compressive strength is seen on the 15% which continuous to decrease till 20%.
- Same above pattern is seen on split tensile strength and flexural strength.
- Gives better smooth surface of concrete.

## 7. Future Scope

1. Eggshell powder behavior can be seen with implementation of particular types of fibers in concrete.
2. Eggshell behavior can be checked with combination of other cementitous product.
3. Shrinkage properties eggshell concrete can be checked.

## References

[1] Dhanalakshmi M., Chandrashekahr A., Sowmya N. J., Comparative Study of Egg Shell Concrete with Partial Replacement of Cement by Fly Ash, International Journal for Research and Technology, Vol. 4 Issue 5, May 2015.

[2] Divya B., Vasanthavali K., Ambalavanan R., Investigation of Cement Concrete at Mixed with Egg Shell Powder, International Journal of Innovative Research in Science, Engineering and Technology, Vol.6, Issue 3, March 2017.

[3] Dixit M., Meena A., Malik A., Chhinderpal, Sundesha K., Effect of using Egg Shell Powder and Micro silica partially in place of cement in M25 concrete, SSRG International Journal of Civil Engineering, Vol. 3 Issue 5, May 2016.

[4] IS 516:1959, Bureau of Indian Standards, Methods of tests for strength of concrete.

[5] IS 10262 : 2009 Bureau of Indian Standards, Concrete Mix Proportioning – Guidelines.

[6] IS 8112 : 2013 Bureau of Indian Standards, Ordinary Portland Cement 43 Grade – Specifications.

 