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# Experimental Study of Behavior of Conventional Concrete with Egg Shell Powder and Egg Yolk, Egg White

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**Abstract**

India is the third largest egg producer and fourth hen broiler production in the world reported by Food and Agriculture Organization (FAO) Statistics Division. Most of egg shell waste is willing in landfills without any pre-treatment because it is conventionally useless and eventually creates serious eco problems. The actual treatment and operation of bio-waste is a ecological and economic angle. Removal of egg shell waste is not a income Centre. Egg whites or egg yolk were generally used as adhesive which is a compound that adheres or bonds two items. Historically, they were also used to produce paint binder. the world's egg companies process an estimate done million eggs. Earlier works on the combination concrete conducted by scholars have led us to the point that the egg shell ash /powder can be used as an additive in concrete production. egg shells can be produced a new raw material for development in the construction industry as an additive in the conventional concrete. Eggshell powder and egg yolk, egg white used as a partial replacement without compromising performance characteristics of concrete including durability. The scope of study is to establish to achieve the objectives and this study will be mainly concentrated on experimental works. Experiments regarding compression strength and spilt tensile strength on the partial replacement of egg shell powder and egg yolk and egg white in concrete will be carried out in order to study the behavior of concrete. India used as natural admixture in this research work. White albumen and egg yellow yolk of broiler egg was thoroughly mixed and added to concrete. egg yolk and egg white was used as Natural admixture (NAD), both egg white albumen and yellow yolk was mixed thoroughly and added to concrete.

During the world, concrete is presence broadly used for the structure of greatest of buildings bridges etc. Presently, the complete construction industry is in exploration of an appropriate and operative the unused product that would greatly minimalize the use of cement and eventually decrease the creation cost. Such a substitute material is egg shell powder and egg yolk. Greatest of egg shell waste is willing in landfills short of any pre-treatment since it is conventionally unusable and eventually makes thoughtful eco glitches. Therefore, proper alternate is required to manage the wastes in eco-friendly way. In this developing world, many countries are going to urbanization due to population growth. Since Malaysia is one of developing countries, the construction will grow in the future. Hen egg is one of the waste materials which generated from the industry and it is contributed to the environmental and disposal problem due to egg shell increase continuously in recent years. Therefore, reuse egg shell as an additive in concrete is a better solution to reduce the environmental problem. The goal of this investigation work is to use the egg shell powder, egg yolk as a limited additional of cement. Egg shell powder is replaced by 0%, 1.5%, 3%, 4.5% and 6% and egg yolk and egg white is replaced by 0%, 0.2%, 0.4%, 0.6% and 0.8% in addition. After curing period of 28 days, it is checked for its compressive strength, spilt tensile strength test are taken.

**Keywords:** Egg shell powder • Egg yolk or Egg white • Concrete • Compressive strength • Flexural strength

## Introduction

Today India is the third largest egg producer and fourth in broiler production in the world reported by Food and Agriculture Organization (FAO) Statistics Division. India is developing as the world's second major poultry marketplace with a yearly development of additional than 14%, creating 61 million tons or 3.6 percent of global egg manufacture. The yearly growth amount of egg production is 5-8%. Separately from this, India ranks sixth in broiler production with a yearly output of 2.39 million tons of broiler meat, as per the approximations of the Ministry of Agriculture. The total poultry industry is appreciated at about 350 billion rupees. About 250,000 tons of egg shell left- over is shaped yearly universal by the food processing manufacturing only. In the account, it was projected that 10000-11000 tons of egg shell has to be willing of each year by egg mainframes and makers in India. Most of egg shell waste is willing in landfills without any pre-treatment because it is conventionally useless and eventually creates serious eco problems. Therefore, proper alternative is required to achieve the wastes. The bioconversion of waste to practical energy is part of the operation of wastes. The actual treatment and operation of bio-waste has been stressed in our society for ecological and economic angles. Removal of egg shell waste are usually not income centers but cost centers. Therefore, the smallest cost of discarding is most wanted. Some of the choices left must be observed at very disapprovingly and the greatest cost real method of reprocessing are considered. The research and reported that egg shell consisting 2.2 gms of calcium in the form $CaCO_3$ which is 94 percent. Remaining masses presented are of large amount of Phosphorous and Magnesium, trace amounts of Sodium, Potassium, Zinc, Manganese, Iron and Copper.

Throughout the world, waste products are seriously polluting the environment. There are many types of waste disposal system such as land filling, open burning, drains clogged up with rubbish and river fill definitely indicate solid waste is a major environmental problem in Malaysia. Despite the massive amount and complexity of waste produced, the standards of waste management in Malaysia are still poor. These include outdated documentation

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of waste generation rates and its composition, inefficient storage and collection systems, disposal of municipal wastes with toxic and hazardous waste, indiscriminate disposal or dumping of wastes and inefficient utilization of disposal site space. The construction industries are searching for 'alternative products that can reduce the Construction cost. Eggshells are known to have good strength characteristics when mixed with concrete Most of the eggshell waste is commonly disposed in landfills without any pre-treatment because it is traditionally useless [1,2].

In ancient period, the structures were constructed by using materials like lime, clay, mud, surki, wood, egg, jaggery, sugar, burnt coconut shells etc. Oral traditional sources tell us egg whites were used as ingredients of mortar, which were used to bind building materials for the ancient constructions. Egg whites were generally used as adhesive which is a compound that adheres or bonds two items. Historically, they were also used to produce paint binder [3].

# Materials and Methods

## Problem statement

In India, waste disposal is one of the factors contributing the environmental problem and increasing dramatically year by year. According to Antara News (2011), In India, the egg consumption of the Indian people which is still low. In India the per capita egg consumption of the people was recorded at one egg per week while in India the per capita egg consumption was noted at three per day. Hence, the egg consumption of India is increasing with high demand for local food industry. Eggshells wastes are seriously affecting the environment and causing pollution to public health. Eggshell is classified as a waste material by the food industry but is in fact a highly sophisticated composite.

The ultimate goal is to use the eggshells in packaging to protect egg products giving a second lease of life to the eggshell in the very role it was created for a true case of recycling. Therefore, recycling eggshells into the useful product gives good potential benefit on many levels, both for food manufacturers and a much wider construction industry. In this case, the egg yolk (hen egg) and egg shell which considered as waste materials was useful for our research that we need to add the foam of hen egg inside concert to increase its strength and thus decreasing its density. But the construction company would not use this kind of method due to the lack of research using this egg yolk and albumen.

## Objectives

1. To design of M20 grade of concrete by using egg shell powder (0%, 1.5%, 3%, 4.5% and 6%) are partially replacement in cement, Egg yolk and egg white are used as natural admixture (0%, 0.2%, 0.4%, 0.6% and 0.8%)
2. To study the fresh and hardener properties of mix concrete at 7, 14 and 28 days.
3. To find out optimum replacement and addition percentage of Egg shell powder and Egg yolk, Egg white for M20 grade of concrete.
4. To save Environment from waste disposal egg shell.

## Materials

**Cement:** Cement is a well-known building material has occupied an indispensable place in construction works. It is obtained by burning together, in a definite proportion, a mixture of naturally occurring argillaceous and calcareous materials to a partial fusion at high temperature. Generally Cement is a binding material used in the preparation of concrete. It binds the coarse aggregates and fine aggregates with help of water to a monolithic matter and also it fills the voids in the concrete. The cement used in this study is OPC 53 grade confining to IS 8112 is used throughout the work.

**Fine aggregate:** Fine aggregate Clean and Dry River sand available locally was used. Sand passing through IS 4.75 mm sieve. Test conducted on fine aggregate are specific gravity using pycnometer, fineness modulus by sieve analysis.

**Coarse aggregate:** Crushed granite aggregate with specific gravity of 2.6 and passing through 20 mm sieve and retained on 12.5 mm sieve and as given in IS: 383 - 1970 is used for all the specimens.

**Egg shell powder:** Eggshell is collected cleaned and dried and then crushed into fine powder form to use as a replacement with cement [3,4] (Figures 1 and 2).

**Egg white and egg albumen, egg yolk**: Hen eggs are collected from local poultry forms nearby Chittoor, A.P, India used as natural admixture in this research work. White albumen and yellow yolk of broiler egg was thoroughly mixed and added to concrete. Hen egg was used as Natural admixture (NAD), both egg white albumen and yellow yolk was thoroughly mixed and added to concrete. The chemical NAD was replaced by egg yolk at 1.5% of interval of 0% to 6% [5-7] (Figure 3).

It is the method followed to perform the experiment:

1) Mix designed

2) Batching

3) Experimental casting

4) Mixing

5) Compaction

6) Curing

7) Testing

**Figure 1.** Egg shell and Egg shell powder.

**Figure 2.** Egg white, Egg albumen and Egg yolk added to concrete.

**Figure 3.** Compression testing machines.

## Tests

The following tests are conducted to find the physical properties of materials:

**Tests on fine aggregate:** In this project, the river sand, which was available in saturated surface dry Condition was used as fine aggregate.

- Sieve analysis
- Density
- Specific Gravity
- Water absorption

## Tests on coarse aggregate:

- Impact value
- Sieve analysis
- Density
- Specific gravity
- Water absorption.

**Specific gravity test:** Table 1.

**Mix design:** Table 2.

## Experimental investigation

The Egg shell powder concrete specimens of various mixes has to be tested for Compressive and Split tensile test at 7 and 28 days in the lab

**Compressive strength:** compressive test are made at recognized ages of the test specimens. Least three specimens, preferably from different batches shall be made for testing at each selected age. The cubes are placed in the compression testing machine in such manner that the load is applied to the opposite sides of the cube as cast. Compression test was carried out on the specimens after 7 and 28 days of curing of concrete [8].

**Split tensile test:** The tensile strength of concrete is determined by splitting the cylinder across the vertical diameter. Split tensile strength is an indirect method of finding out the tensile strength of concrete. As per ASTM, the test was carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine. The load was applied until the specimen fails [9,10].

# Results and Discussion

The result of the investigations carried out for finding out compressive strength, and Spilt tensile test using Egg shell powder partially replaced for cement and adding white albumen, egg yolk.

**Compressive strength:** From each concrete mixture, cubes of size 150 mm × 150 mm × 150 mm have been casted for the determination of compressive strength and tested at 7, 14 and 28 days for determining Compressive strength. Experimental results for cube compressive strength for M20 grade of concrete for mix proportions 1.5% interval of 0% to 6% for 7,14 and 28 days are tabulated in Table 3 (Figure 4).

**Spilt tensile test:** from each concrete mixture, cylinders of size 150 mm x 300 mm have been casted for the determination of splitting tensile strength. The concrete specimens were cured under normal conditions and tested at 7 28 days. Experimental results for cylinders split tensile strength for M20 for mix of Egg shell powder at 0%, 1.5%, 3%, 4.5%, and 6% for 7, and 28 days are tabulated in Table 4. The graphical representation of split tensile strength for various mixes are shown in Figure 5.

**Table 1.** Specific gravity test.

| S. No | Material | Specific Gravity |
|---|---|---|
| 1 | Fine aggregate | 2.67 |
| 2 | Coarse aggregate | 2.83 |
| 3 | Cement | 3.15 |

**Table 2.** Mix design.

| S. No | Materials | Specific Gravity (kg/m$^3$) |
|---|---|---|
| 1 | Cement | 394.320 |
| 2 | Water | 197.160 |
| 3 | Fine aggregate | 687.553 |
| 4 | Coarse aggregate | 1189.021 |
| 5 | Water cement ratio | 0.50 |

**Table 3.** Compressive strength.

| Casting | Testing | | Resulting | |
|---|---|---|---|---|
| (ESP& Egg Yolk) | 7 Days | 28 Days | 7 Days | 28 Days |
| 8-2-22, (0% & 0%) | 8-2-22 | 1-3-22 | 19MPA | 38MPA |
| 8-2-22, (1.5% & 0.2%) | 14-2-22 | 7-3-22 | 18MPA | 39.5MPA |
| 9-2-22, (3% % 0.4%) | 15-2-22 | 8-3-22 | 20MPA | 36.MPA |
| 14-2-22, (3% & 0.6%) | 20 -2-22 | 13-3-22 | 20.5MPA | 29.5MPA |
| 15-2-22, (6% &0.8%) | 21-2-22 | 14-3-22 | 21 MPA | 28MPA |

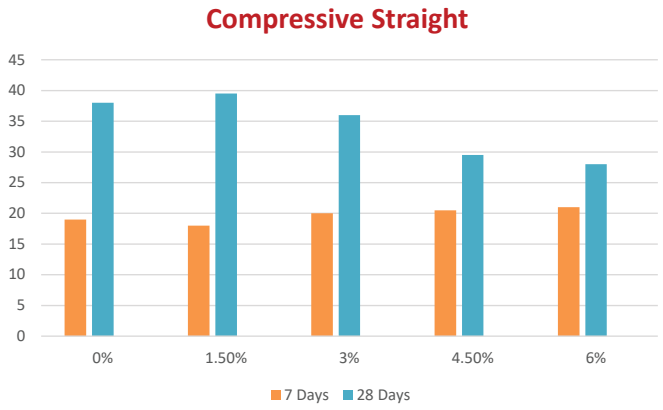


**Figure 4.** Graphical representation of compressive strength.

**Table 4.** Spilt tensile test.

| Casting | Testing | | Results | |
|---|---|---|---|---|
| (ESP & Egg yolk ) | 7 Days | 28 days | 7 Days | 28 days |
| 8-2-22, (0% & 0.0%) | 8-2-22 | 1-3-22 | 26 | 29.6 |
| 8-2-22, (1.5% & 0.2%) | 14-2-22 | 7-3-22 | 27.5 | 30.6 |
| 9-2-22, (1.5% & 0.4%) | 15-2-22 | 8-3-22 | 28 | 31.5 |
| 14-2-22, (3% & 0.6%) | 20 -2-22 | 13-3-22 | 26.5 | 30 |
| 15-2-22, (6% & 0.8%) | 21-2-22 | 14-3-22 | 25 | 28.5 |

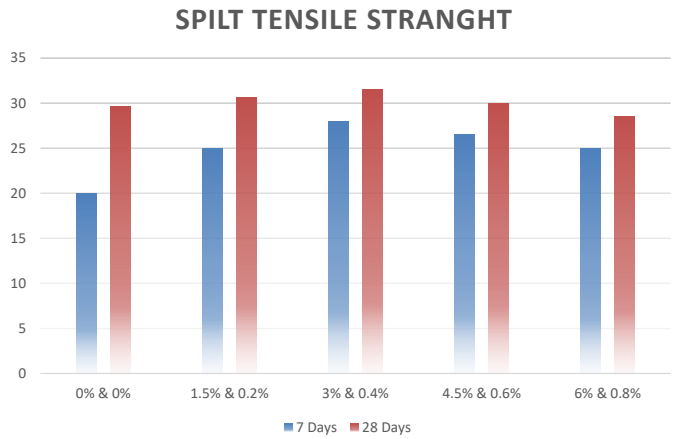


**Figure 5.** Graphical representation of split tensile strength.

## Conclusion

The following conclusions can be drawn from the present investigations:

- We use the egg shell in concrete for partially replacement of cement and egg yolk as natural adds mixture.
- We found that the compressive strength increases to the proportion 1.5% and 0.2%.
- This concrete is giving the initial proportion high strength but the we use proportion 4.5% and 6% it gives less strength.
- The proportion 4.5% and 6% give less compressive strength in concrete.
- The proportion 1.5% and 3% gives more strength than conventional concrete.
- So, we can use the egg shell powder as alternative solution to cement.

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