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UTILIZATION OF EGG SHELL POWDER AND PLASTIC WASTES IN THE PRODUCTION OF CONCRETE MIX

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Abstract – *Concrete known as hard rock mass prepared by mixture of ingredients cement, sand, aggregates, water and sometimes admixtures. Cement plays an important role in concrete production as it works as binder to bind the other constituents together effectively. But the serious thing is that the production of cement adversely affects our environment with emission of enormous amount of CO_2. Recycling trash to create usable items is one way to address this challenge. The feasibility, environmental suitability, and performance of using waste in the construction field—which requires better and more affordable construction materials and the reuse of wastes—have all been the subject of numerous studies and research projects undertaken by government agencies, private organizations and individuals. So, researchers worked a lot on the production of eco-friendly concrete using sustainable construction materials. In this research work, we emphasized on the recycled wastes to be used in our construction industry such as Egg Shell Powder and Plastic Wastes. ESP partially replaces the cement content by 0 to 20 % with offset of 5% and Plastic wastes are used as Plastic Coarse Aggregates as 0 to 40% with offset of 10% to determine the strength characteristics of the concrete mix. The specimens were prepared and cured for 7, 14 and 28 days. The optimum strength of the mix after 28 days of curing shows results within permissible limits.*

***Key Words*: Concrete, Egg Shell Powder, Plastic Waste Aggregates, Slump Test, Compression Test, Split tensile test, Flexural test, Strength.**

1. INTRODUCTION

With the advancement of technology and increase of population, their standard of living and demands also increased day by day. Thereby resulting in wastage of matters which leaves in our society as garbage and affects our environment badly, pollutes our surrounding with the emission of harmful gases. An issue in trash disposal has emerged due to the production of non-decaying and low biodegradable waste materials and an increase in consumer population. Concrete construction is prior to other construction materials. Concrete is blend of some ingredients mixed with each other properly at proper desired ratios to prepare desired strength of concrete. This type of construction is much preferred over others. Recycling trash to create usable items is one way to address this challenge. The feasibility, environmental suitability, and performance of using waste in the construction field—which requires better and more affordable construction materials and the reuse of wastes—have all been the subject of numerous studies and research projects undertaken by government agencies, private organizations and individuals adversely affects our environment with emission of enormous amount of CO_2. So, researchers worked a lot on the production of eco-friendly concrete using sustainable construction materials. In this research work, we emphasized on the recycled wastes to be used in our construction industry. One of the materials used in our research is an Agricultural waste such as Egg shells are agricultural waste products made in bakeries, fast food restaurants, chick hatcheries, and other facilities. Because they can harm the environment, egg shells include environmental contaminants that require proper handling. Another waste material used in this research is electronic plastic wastes which are recyclable in nature used in construction industry to reduce the impact of plastics in our environment and helps to production of sustainable strengthened concrete. E-waste is being produced at a rate of 3-4% annually over the world, and by 2025, that rate is anticipated to rise to 55 million tonnes annually. One of the greatest alternatives is to incorporate waste plastic into the building sector to create green concrete in order to lessen the negative effects on the environment and conserve natural resources.

1.1Egg Shell Powder

Copper Slag, Quarry dust, Fly ash, rice husk ash and egg shells are wastes generated largely from industrial and agricultural fields and are cause of environmental hazards and recycling. About 1.61 million tonnes egg shells are generated annually, which makes India a fifth largest country in the world. Both poultry and egg processing units have come predominantly in India. Using eggshell waste instead of natural lime instead of cement in concrete can bring many benefits, such as minimizing the use of cement, protecting natural lime and using waste. Eggshell is a good accelerator for cement binders. The eggshell and lime stone are almost same in chemical nature. To this end, we can minimize the use of cement and waste disposal. Literature has shown that the eggshell ash primarily contains lime, calcium and protein where it can be used as an alternative raw material in the production of wall tile material, concrete, cement paste and others.

1.1.1 Advantages of Egg Shell Powder

1. It is an effective calcium supplement.

2. It helps to reduce the emission of CO_2 from cement clinkers production.

3. It improves the compression and flexural strength of concrete mix.

4. It accelerates the hydration of cement.

5. Its usage performs Considerable reduction in alkali-silica and sulfate expansions.

6. Using ESP, Saves money and meets the most stringent environmental regulations nationwide.

1.2 Plastic Waste Aggregates

Reuse waste products is an important perspective as it helps to conserve energy in the product production, decrement the environmental pollution and also helps to sustain the non-renewable natural resources. Using plastic wastes in the construction or material industry becomes an environmental solution to reduce its adverse impacts on the surroundings. Promoting repurposed materials is seen as beneficial by the lightweight building materials industry. Concrete unit weight typically decreases when natural aggregates are replaced with lightweight materials. In this study, Plastic wastage are being used as coarse aggregates in the concrete mix with the variation to get optimum percentage replacement so that it can minimize the impact of wastage in surroundings and also helps in reduction of extinction of natural resources.

1.2.1 Advantages of Plastic Waste Aggregates

1. Improve mix cohesion, improving pumpability over long distances,
2. Improve freeze-thaw resistance, impact resistance– and abrasion–resistance
3. Increase resistance to plastic shrinkage during curing,
4. Improve structural strength and ductility,
5. Reduce steel reinforcement requirements and improving durability.

2. LITERATURE REVIEW

R. Nirmala (2016) makes an experimental study on the partial replacement of sand with ESP and coarse aggregates with CW. This study tend to utilize egg shell and ceramic waste by partially replacing it in concrete. The egg shell and ceramic waste is equally replaced for fine aggregate and coarse aggregate respectively in percentages of 5%, 7.5%, 10%, 12.5% and 15% during the manufacture of concrete. The concrete is cast in cubes and cylinders and it is tested for compressive strength and tensile strength to find the optimum percentage of their replacement. Thus, results represents that the egg shell and ceramic waste can be utilized in the manufacture of concrete at replacement rate of 12.5%.

S. Vanitha, V. Natrajan and M. Praba (2015) research deals with M20 grade of concrete with partial replacement of coarse aggregates by plastic wastage. Usually, grade M20 concrete mix is used for most constructional works. Waste Plastics were incrementally added in 0%, 2%, 4%, 6%, 8% and 10% to replace the same amount of Aggregate. To examine the physical properties, tests were conducted on coarse aggregates, fine aggregates, cement and waste plastics. Paver Blocks and Solid Blocks of size 200 mm X 150 mm X 60 mm and 200 mm X 100 mm X 65 mm were casted and tested for 7, 14 and 28 days strength. The result shows that the compressive strength of M20 concrete with waste plastics is 4% for Paver Blocks and 2% for Solid Blocks.

Lahakpa WangmoThinghTamanget. al. (2017) conducted an experiment using plastics as coarse aggregate in concrete. They tested the mechanical properties of concrete that contained plastic aggregates in proportions of 10 percent, 15 percent, and 20 percent. They discovered a slight decrease in strength and suggested a 15 percent replacement as the best outcome.

D. Rambabu (2021) makes a study on the partial replacement of cement with egg shell powder in the concrete. . The Egg shell usually which are disposed, is used as an alternate for the cement since the shell is made up of Calcium. Egg shell powder replaces 0%, 10%, 20% and 30% in addition of weight of cement. Concrete is cast and Compressive test, Tensile and Flexural tests were carried out to find the best combination which results in optimum percentage of strength.

Mr. V. Aravind1 , V. Ranjith (2022) Study on Partial Replacement of Cement and Coarse Aggregate by Egg Shell Powder and Steel Slag in Concrete. The main objective of the study was to determine the workability and reinforcing properties including compression, tensile and flexural strength of concrete using various percentages (0, 10, 20,&10) of ESP by weight instead of cement. The test results showed that during the. With ESP 20%, tensile strength increased by 30%, and a maximum strength of 20% was obtained using ESP 20% during 28-day cure. As the ESP content increases, the workability of fresh concrete decreases.

2.1 Objectives

1. To identify that the wastes can be reused as construction materials.
2. To study the effects of optimum replacement of Egg Shell Powder and Plastic Wastes.

3. Determination of Slump of concrete mix using ESP and PWA.
4. To find the Strength behaviour of concrete prepared using ESP and PWA.

3. MATERIALS

3.1 Cement

Cement of OPC 43 grade of trademark ACC has been used in our work which is collected from local cement store.

3.2 Water

Potable water is used for the preparation of concrete mix which helps in hydration of cement. Water having pH values ranges 6.5 to 7 are preferably used in this work.

3.3 Fine Aggregates

Locally available river sand along the banks of river is used in this study conforming to Zone II of as per Indian standard 383-1970.

3.4 Coarse Aggregates

Locally available crusher Coarse aggregates of size 20 mm are used in our study to achieve the objectives of the study.

3.5 Egg Shell Powder

In this study, it can be replaced partially with cement as it gives binding property. Locally available egg shells are collected and grinded then it can be sieved through the 90 micron sieve size and then packed to use it in the cement replacement. The chemical composition of egg shell powder is shown in Table 3.1.

Table 3.1: Chemical Composition of Egg Shell Powder

S.No	Composition	Percentage(%)
1.	CaO	53%
2.	MgO	1%
3.	SiO_2	1.5%
4.	Al_2O_3	0.28%
5.	Fe_2O_3	0.36%
6.	Cl_2	0.011%

3.5 Plastic Waste Aggregates

Plastic wastes are collected from surroundings nearby, crushed to required sizes as the sizes of coarse aggregates and then sieving can be done to define the different sizes. Finally, used in our study to replace the coarse aggregates at desired ratios. The different characteristics of the plastic wastage to be used as aggregates are tabulated in Table 3.2.

Table 3.2: Physical Characteristics of Plastic Waste

Property	Values
Max. nominal size (mm)	20
Min. nominalsize (mm)	4.75
Specific Gravity	1.21
Color	Black brown
Shape	Angular
Aggregate crushing value	1.3
Aggregate impact value	8.1
Bulk density (g/cm^3)	0.49

4. RESULTS AND DISCUSSIONS

4.1 Slump Test

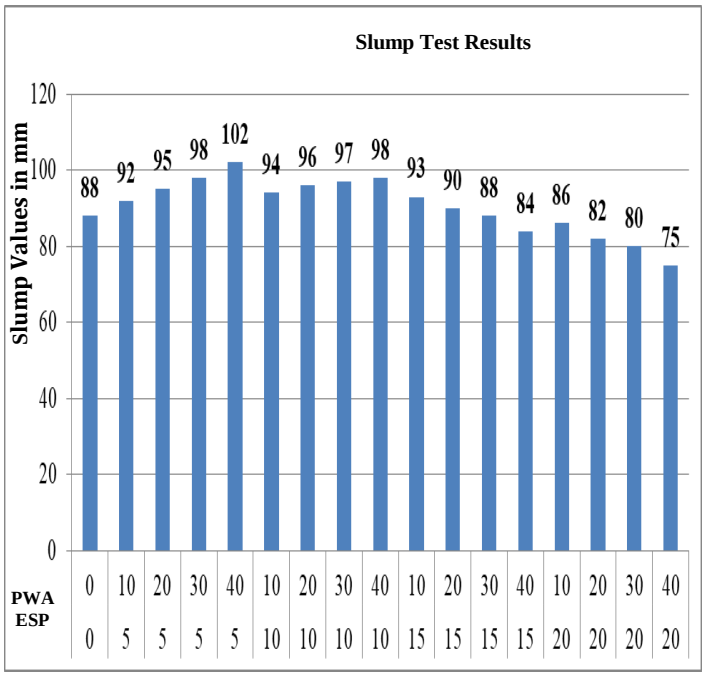

Figure 4.1: Slump of test in mm

4.2 Compression Test

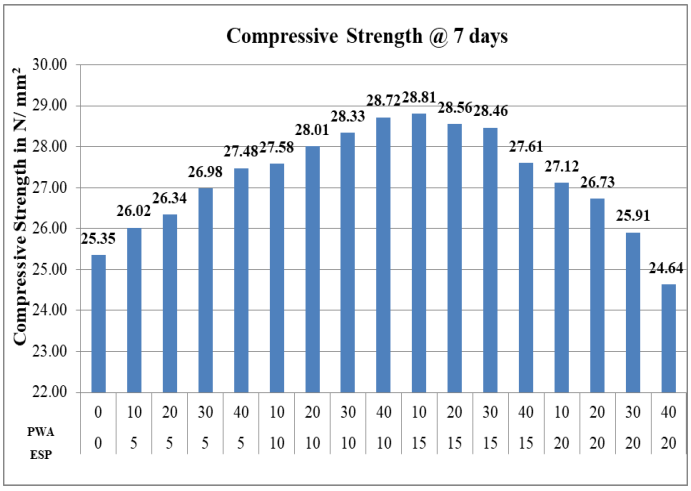

Figure 4.2: compression test after 7 days of curing

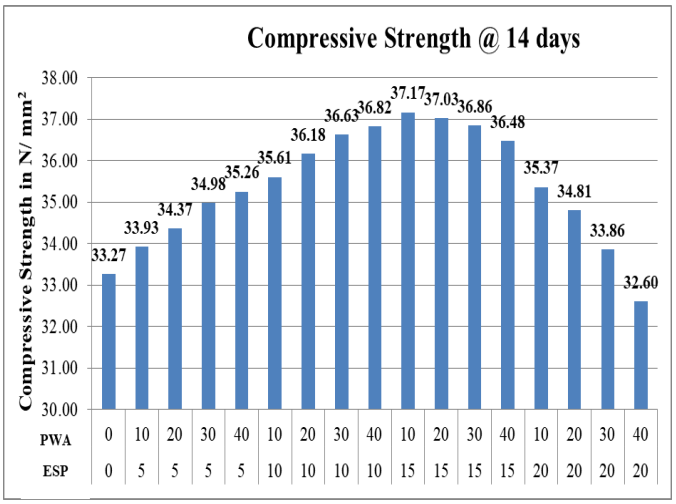

Figure 4.3: compression test after 14 days of curing

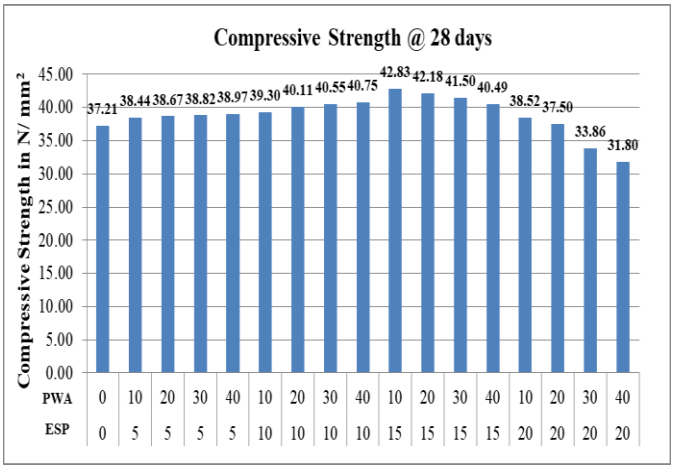

Figure 4.4: compression test after 28 days of curing

4.3 Split Tensile Test

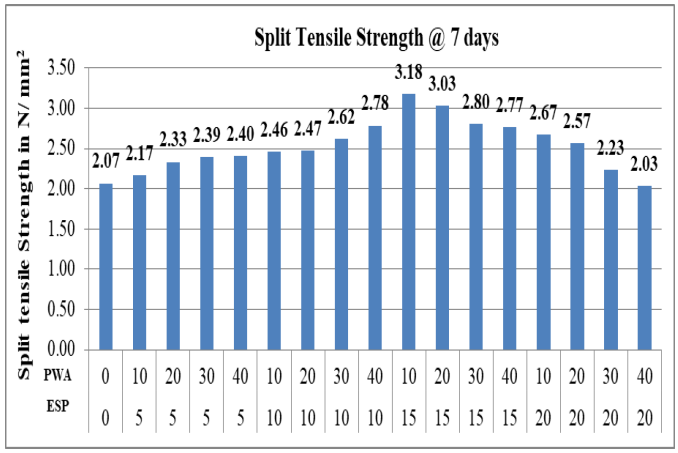

Figure 4.5: Split tensile test after 7 days of curing

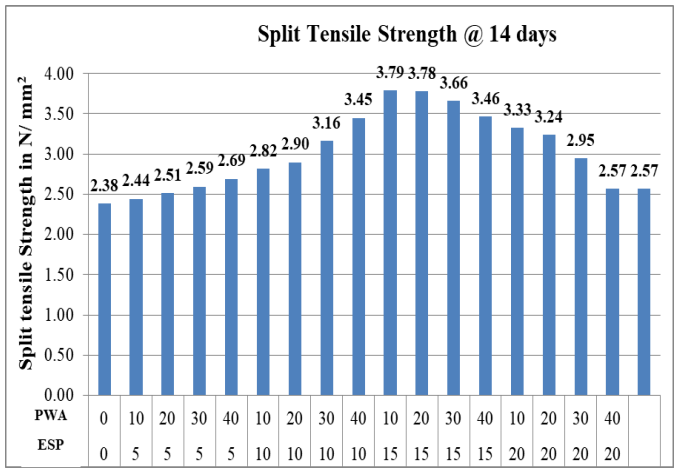

Figure 4.6: Split tensile test after 14 days of curing

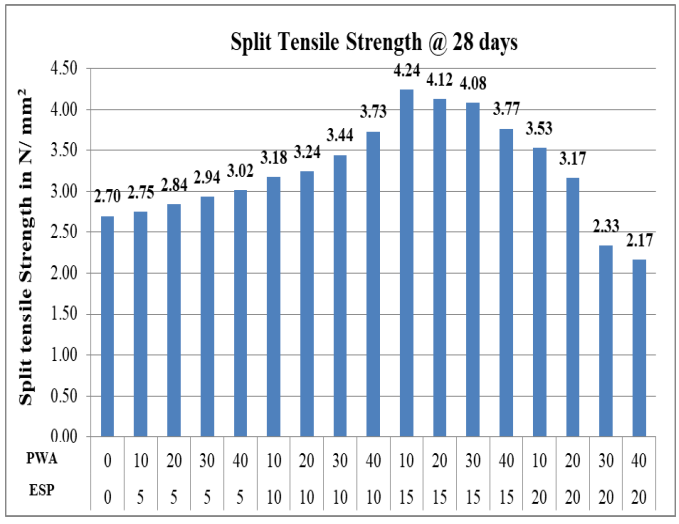

Figure 4.7: Split tensile test after 28 days of curing

4.4 Flexural Test

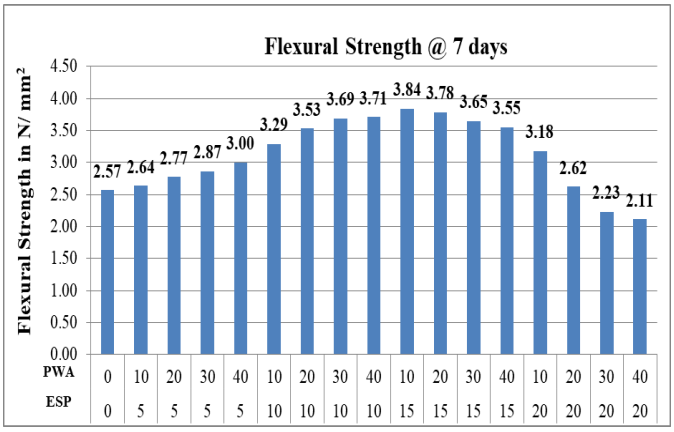

Figure 4.8: Flexural test after 7 days of curing

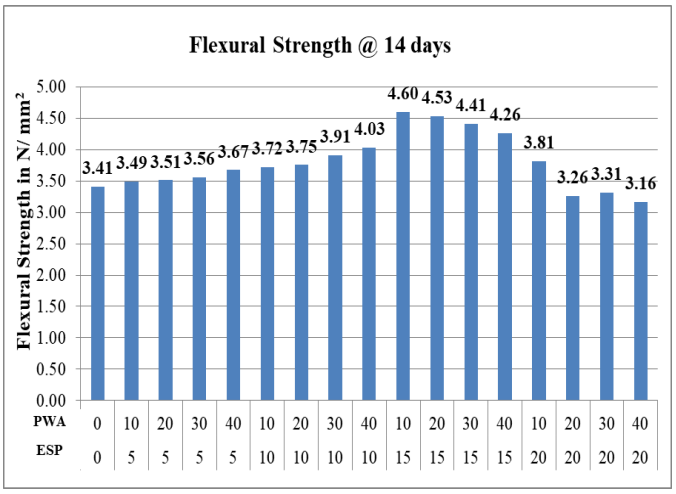

Figure 4.9: Flexural test after 14 days of curing

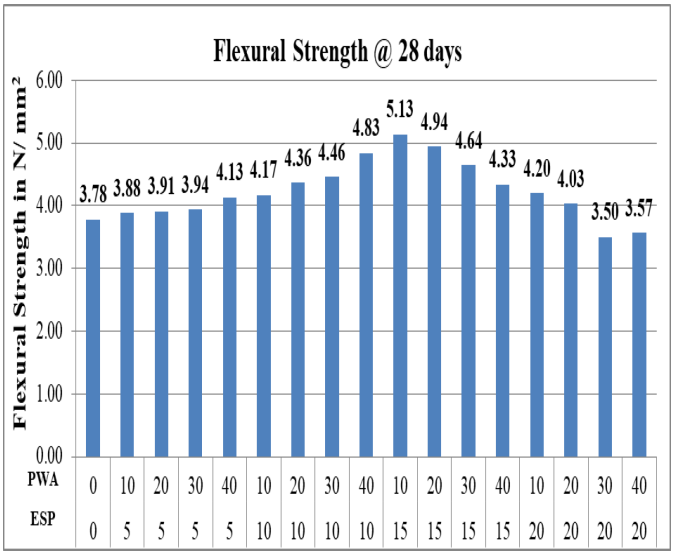

Figure 4.10: Flexural test after 28 days of curing

5. CONCLUSIONS

1. Concrete mix with cement replacement by 15% ESP and coarse aggregate replacement by 10% PWA can be used as structural concrete without compromising its strength properties as it is the optimum mix in terms of strength and economy.

2. The results of workability by Slump test concluded that workability increases with the increase in the Plastic Wastes content. This may be attributed to increase the water content in the mix as it doesn't absorb water. Maximum workability attained at mix of 5%ESP and 40% PWA. With the increase in content of ESP, the slump gets degraded.

3. The maximum Compressive Strength of Concrete mix after 7days, 14 days and 28 days of curing increases gradually by replacement of cement and coarse aggregates with 15% Egg Shell Powder and 10% Plastic Wastes as 28.81 N/mm², 37.17 N/mm² and 42.83 N/mm².

4. The Split Tensile Strength of mix achieves maximum value of 3.18 N/mm², 3.79 N/mmm² and 4.24 N/mm² when ESP is 15% and PWA is 10% added to concrete mix after 7, 14 and 28 days of curing.

5. The Ultimate Flexural Strength observed maximum with ESP is 15% and PWA is 10% i,e 3.84 N/mm², 4.60 N/mm² and 5.13 N/mm² of mix after curing of 7days, 14 days and 28 days.

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