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A Partial Replacement of Cement Concrete with ESP & Glass Powder: An Overview

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Abstract: *Concrete is a composite material composed of coarse aggregate bonded together with fluid cement that hardens over time, and in construction, it is used above all. Concrete is far supplementary manufactured all over the human race than any other substance. It is extremely adaptable, and is used in more or less all major construction projects. Concrete involves huge amount of consumption of cement depending on the grade of concrete. Traditional concrete is made from a mixture of cement, sand, gravel and water. Cement is an environmentally hazardous material. Most of CO_2 in concrete is from the cement manufacturing process. A typical cubic meter of concrete contains about 10% cement by weight. It is third producer of CO_2 emission in the global world. Cement production is increasing approximately 5% a year, making it one of the most environmental destructive materials. Aggregate materials like sand and stone that are mixed with cement are mined from quarries, further taxing our natural resources. In this research paper, it is described that how consumed waste glass powder and egg shell ash powder is been used as partial replacement for cement as it can't be dissolved by natural or normal recycling ways .*

Introduction: it is an eminent fact that one of the major carbon-di-oxide producing source is cement manufacturing units beside deformation and burning of fossil fuel. The global warming is caused by emission of greenhouse gages, such as emitted CO_2 to the atmosphere. It can be assumed that the unit of cement industry is causing approximate 12% of greenhouse green gases in our climate. The work examines the possibility of using glass powder as partial replacement as 0% , 20% , 30% , 40% and for its compressive strength up to 7 , 14 & 28 days of age and was compared with those of conversion concrete. Leaving the waste material has been emphasized waste can be used more efficiently and the environmental problem. Many of the non-decaying waste materials will remain in the environment for hundreds, perhaps thousands of years. The non-decaying waste materials cause a waste disposal crisis, thereby contributing to the environmental problems. However, the

environmental impact can be reduced by making more sustainable use of this waste. This is known as the *Waste Hierarchy*. Its aim is to reduce, reuse, or recycle waste, the latter being the preferred option of waste disposal. Concrete with waste materials sometimes give better workability than conventional concrete. It helps substantially in saving power, decrease emission of CO_2– pollution free environment. If all the fly ash generated each year were used in producing concrete, the reduction of carbon dioxide released from cement production would be equivalent to eliminating 25% of the world's vehicle.

Use of Egg Shell and Glass Powder in Concrete: Research efforts have been done to match society's need for safe and economic disposal of waste materials. The use of waste materials saves natural resources and dumping spaces, and helps to maintain a clean environment. The current concrete construction practice is thought unsustainable because, not only it is consuming enormous quantities of stone, sand, and drinking water, but also two billion tons a year of Portland cement, which releases green-house gases leading to global warming. Experiments have been conducted for waste materials like- Egg Shell & Glass Powder etc. Construction waste recycle plants are now installed in various countries but they are partly solution to the waste problems.

Egg shell*:* An eggshell is the outer cover of an egg which contains calcium carbonate crystals, which are stabilized by a protein matrix. Most good quality eggshells from commercial layers contain approximately 2.2 grams of calcium in the form of calcium carbonate. About 95% of the dry eggshell is calcium carbonate weighing 5.5 grams. The average eggshell contains about 0.3% of magnesium, phosphorous, and traces of sodium, zinc, potassium, iron, copper and manganese. Egg shells are known to have good strength characteristics when mixed with concrete.

Whereas ESA is not a readily available form of the waste material, it is produced by incineration or controlled combustion of ESW/ESP at elevated temperatures. ESP is predominantly composed of carbonate of calcium. When subjected to high temperatures, the carbonate of lime decomposes into calcium oxide with the release of carbon dioxide**.**

$CaCO_3 \rightarrow Heat \rightarrow CaO + CO_2$

The ESA used in this study was also obtained by controlled combustion of ESP in a muffle furnace. The ESP used for preparation of ESA was obtained from M/s. The chemical composition reveals that ESA

has calcium oxide content even higher than industrial grade lime. Thus, it can play a very pivotal role in enhancing the stabilization achieved by lime by augmenting the calcium supply of the primary stabilizer, i.e. lime.

Thus eggshells can be applicable to reduced cost of construction material and produced a new raw material for development in the construction industry. Egg Shell Powder (ESA) was obtained by controlled combustion of egg shell powder in a muffle furnace at a temperature of 500^{å}C for three hours. This ash was used as additive to 4% lime in three doses of 0.5%, 1% and 2%. The soil to be stabilized was mixed with 4% lime which formed the control specimen along with other combinations of lime and ESA and was molded into cylindrical samples for determination of their uniaxial compressive strength. The samples were cured for periods of 7 and 28 days, followed by strength, plasticity and mineralogy tests. The results of the tests indicated that the addition of ESA to lime stabilization resulted in enhanced early as well as delayed strength and reduced plasticity. The strength of the lime stabilized soil increased in addition of ESA at 28 days of curing. This translated to a strength gain at the end. Mineralogical analysis revealed the formation of calcium silicate and calcium aluminates hydrate minerals. In consonance with numerous studies and practical in lab ESP gives the results as under:

Percentage Increase in Strength with ESP (Mix Proportion of Cement: M20)

	7days	28 days
ESP 5%	6.82%	6.91%
ESP 10%	33.66%	19.32%

Comparison between Normal Concrete & Concrete with ESP

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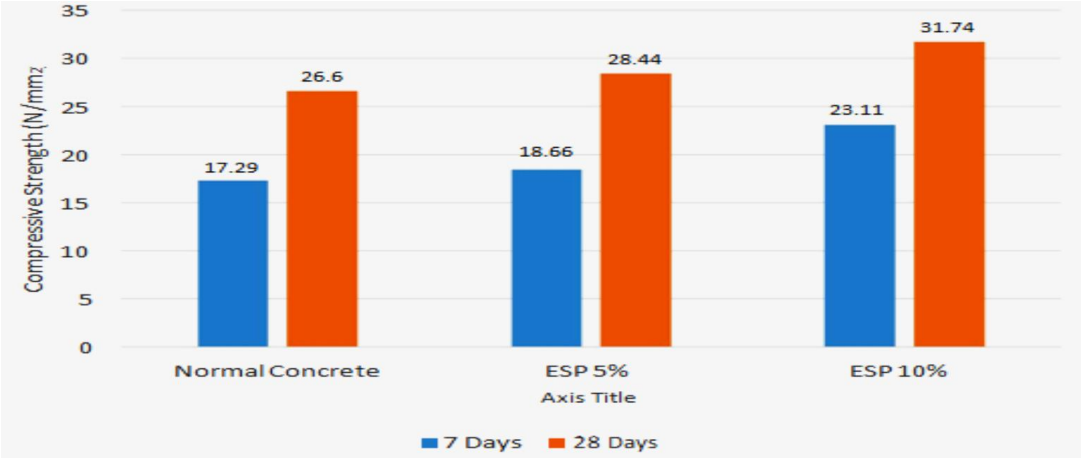
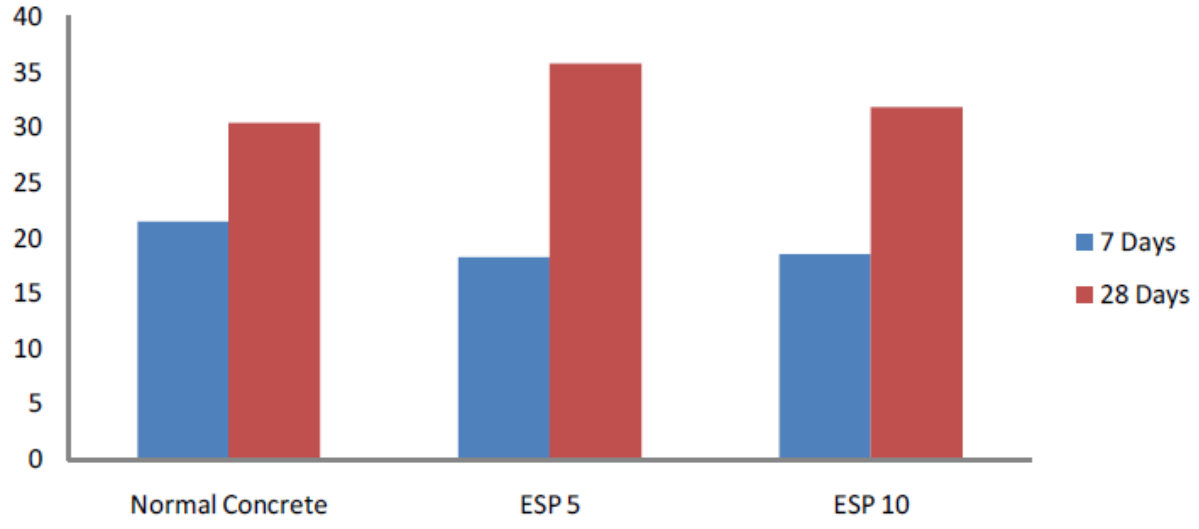


Graphical Comparison of Strength of Normal & Egg Shell Powder Containing Concrete for M20

On the behalf of the test results it is clear cut to say that the conventional cement replaced with ESP mixed concrete given the better results than the conventional concrete in respect to 7 and 28 days. At the end, compressive strength of concrete containing ESP is as under:

Percentage Increase in Strength with ESP (Mix Proportion of Cement: M30)

	7days	28 days
ESP 5%	-15%	8%
ESP 10%	-13.66%	-3%



Graphical Comparison of Strength of Normal & ESP Containing Concrete for M30

In the above cited results, both M 20 Grade & M 30 Grade gives positive results. Using 5% ESP gives a percentage increase of minimum 6.82% strength after 7 days & further 6.91% after 28 days in compressive strength of concrete, meanwhile using10% ESP there is percentage increase of 33.66% after 7 days & 19.32% after 28 days. Similarly, in M30 we have better results with the help of ESP. Therefore, it is significance to say that 10% of ESP gives appropriate amplify in strength and it is good to use for implementation.

GLASS POWDER:

The use of glass powder significantly increased the aesthetic appeal of the concrete. Modern studies investigate that concrete made with glass powder have shown better strength and thermal insulation due to its better thermal properties of the glass aggregates. When tested for the compressive strength values at the 10% & 20% aggregate replacement by waste glass with 0–10mm particle size were 3%, 8% and 5% above the value of conventional concrete. It has been concluded that 20% glass powder could be incorporated as cement replacement in concrete without any long-term detrimental effects. Up to 50% of both fine and coarse aggregate could also be replaced in concrete of 32 MPa strength grade with acceptable strength development properties. Better results are achieved when the waste glass powder replaced 20% of the sand with particles sizes ranging between 50µm and 100 µm. Used glass waste, which is cylindrical in shape, prevents crack propagation in concrete structures. From the research carried out on glass powder it was found that glass of particle size 1.18 to 2.36 mm produced the highest expansion where as low expansion was observed at smaller particle sizes. It was also observed that with a 20% replacement of cement by amber waste glass content of particle size 75µm along with fly ash, the compressive strength of concrete increase both for 7 days and 28 days. This effect provide ample evidence that both fly ash and waste glass sand can be used together to produce concretes with relative high strength without any adverse reaction. Particle sizes under that threshold had no effect on length variations. Glass was ground to a particle size of 300 or smaller, the alkali reaction (ASR) induced expansion could be reduced.

Implication:

It is to be predetermined before adding glass powder in the concrete that it has to be powdered in desired size. A glass powder must be ground in ball/ pulverizer for a period of 30 to 60 minutes resulted in particle sizes less than size 150 µm and sieved in 75 µm. The use of recycled glass as aggregate greatly enhances the aesthetic appeal of the concrete. Recent research findings have shown that concrete made with recycled glass aggregate have shown better long term strength and better thermal insulation due to its better thermal properties of the glass aggregates When tested for the compressive strength values at the 10 % and 20% aggregate replacement by waste glass with 0–10mm particle size were 3%, 8% and 5% above the value of conventional concrete. It has been concluded that 20% glass powder could be incorporated as cement replacement in concrete without any long - term detrimental effects. Up to 50% of both fine and coarse aggregate could also be replaced in concrete of 32 MPa strength grade with acceptable strength development properties. Better results are achieved when the waste glass powder replaced either 20 % or 30% of the sand with particles sizes ranging between 50 µm and 100 µm. Used glass waste, which is cylindrical in shape prevents crack propagation in concrete structures. From the research carried out on glass powder, it is found that glass of particle size 1.18 to 2.36 mm produced the highest expansion where as low expansion was observed at smaller particle sizes. It was observed that with a 20% replacement of cement by amber waste glass content of particle size 75µm along with fly ash, the compressive strength of concrete increase both at 7 days and 28 days. This effect provide ample evidence that both fly ash and waste glass powder can be used together to produce concretes with relative high strength without any adverse reaction. Particle sizes under that threshold had no effect on length variations. Glass was ground to a particle size of 300 or smaller, the alkali reaction (ASR) induced expansion could be reduced. In fact, data reported in the literature show that if the waste glass is finely ground, under 75 µm. This effect does not occur and mortar durability is increased. The tensile and flexural strength are adversely affected by the addition on waste to replace the virgin aggregate, at a replacement level of 20% for the fine aggregate, the tensile strength decreased by 3%, in comparison to the control conventional concrete. The comparison results of normal concrete with concrete containing partially replaced Glass powder are as under:

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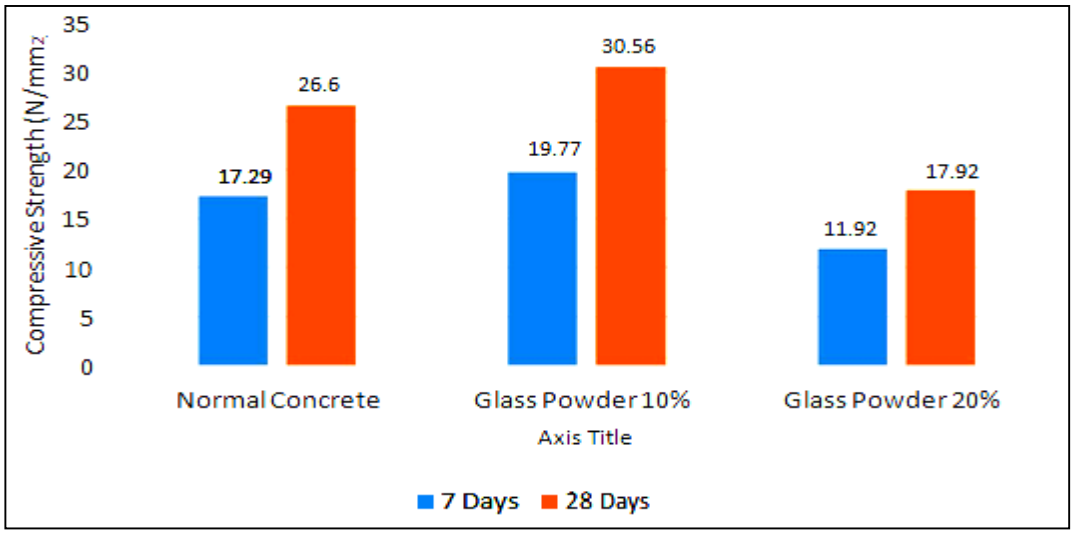
Compressive Strength of Normal & Glass Powder Containing Concrete for M20

	7 Days	28 Days
Glass Powder 10%	14.34%	14.88%
Glass Powder 20%	-31.05%	-32.6%



Graphical Comparison of Strength of Normal & Glass Powder Containing Concrete for M20

According to the above results it is clearly get to know that there is an increase of 14.34% & 14.88% in compressive strength of concrete using 10% Glass Powder, at an age of 7 and 28 days respectively and a decrease of 31.05% & 32.6% in compressive strength of concrete with 20% Glass Powder partially replaced with sand, at an age of 7 and 28 days respectively. Therefore, it is evident that Glass powder gives an appropriate strength.

Based on the test results it was inferred that at which percentage replaced with Glass powder given the better results than the conventional concrete with respect to 7 and 28 days Compressive strength with respect to the grade of concrete. Therefore, compressive strength of concrete containing glass powder is as under:

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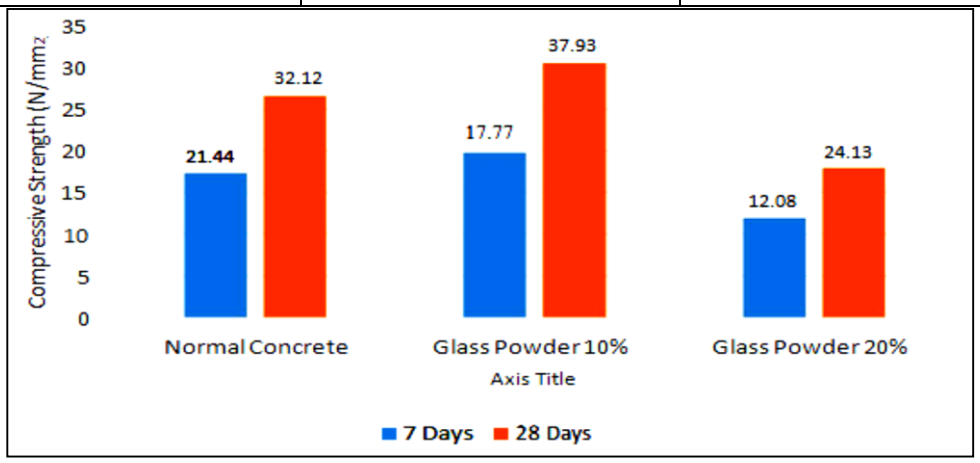
Compressive Strength of Normal & Glass Powder Containing Concrete for M30

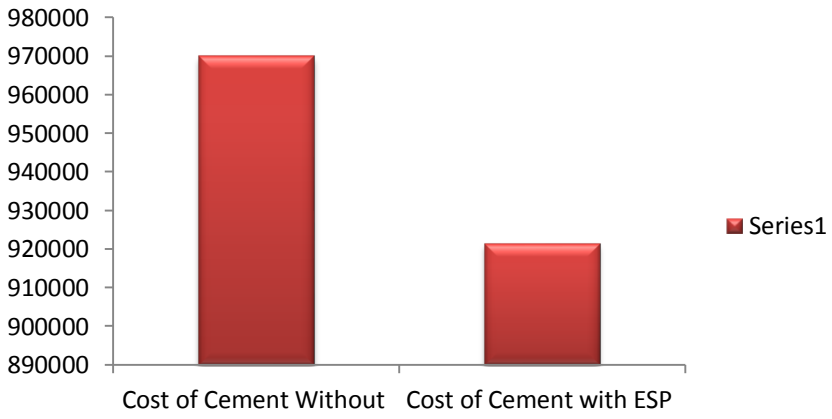
	7 Days	28 Days
Glass Powder 10%	-17.11%	18.08%
Glass Powder 20%	-43.6%	-24.8%



Graphical Comparison of Strength of Normal & Glass Powder Containing Concrete for M30

The results obtained from compressive strength tests at both 7 and 28 days appear to display inconsistent results. After 7 days of testing, compressive strength for the sample containing 20% glass aggregate replacement achieved a much compressive strength.

All values of compressive strength obtained for the samples in question achieved higher compressive strength than the control. As such it is suggested that the discrepancies noted are due to variations in the properties of concrete specimens and as such do not diminish the validity of the identified trend. Further, the experimental results show unexpectedly high readings of compressive strength development by both the control and samples containing fine glass aggregate.



Economical Benefits:

Cost of Construction using 5% of ESP (M30)

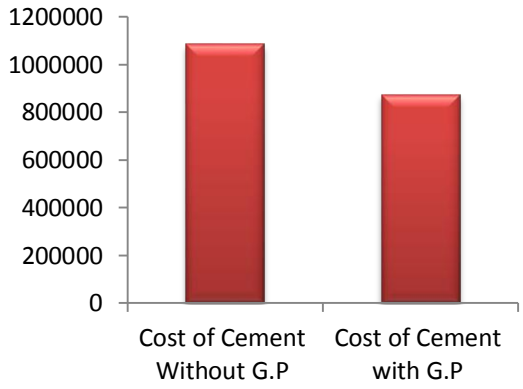
DETAILS:-

Height of Building- 15 metre

Area of building- 250sq. Feet

Comparison of Cost with ESP → Cost without ESP Cost with ESP

Economical Benefit - 48493.71 rupees (Approx 50,000 Rupees)



Cost of Construction using 10% Glass Powder (M30)

DETAILS:-

Height of Building- 15 metre

Area of building- 250sq. Feet

Comparison of Cost with Glass Powder →

Economical Benefit - 211945.5/-rupees

Conclusions:

The above mentioned experimental work clearly shows that glass powder and Egg Shell Powder can be used as a partial replacement of cement in concrete because of its increased workability, strength parameters like compressive strength and split tensile strength. As disposal, utilization of waste glass powder and Egg Shell Powder in concrete will not only provide economic, it will also help in reducing disposal problems.

As a conclusion, Concrete with using waste glass powder & ESP has a very high workability from control sample. This result achieved from the various testing method that use of Glass powder & ESP were increased the workability of concrete. In term of strength, concrete with using Glass powder & ESP averagely have higher strength both in 7 & 28 days.

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