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Strength Investigation of Cement Concrete by Industrial Waste (Saw dust, Fly ash, Micro Silica & Egg Shell Powder)

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A B S T R A C T

The chemical composition of the egg shell powder and com- pressive strength of the cement mortar was determined. The ce- ment mortar of mix proportion 1:3 in which cement is partially replaced with egg shell powder as different percentages by weight of cement. The compressive strength was deter- mined at curing ages 28 days. There was a sharp decrease in com- pressive 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 pow- der as partial replacement for cement. In this direction, an exper- imental 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 con- crete.

Keywords: Saw dust ash, Fly ash, Micro silica, compressive strength, split tensile strength, Flexural strength

1. INTRODUCTION

Industrial waste is the waste produced by industrial activity which includes any material that is rendered useless during a manufacturing process such as that of factories, mills and mines. It has existed since the outset of the industrial revolution. In recent years, special attention has been devoted to industrial sectors that are sources of pollution of the environment. The industry produces large volumes of solid wastes such as Fly Ash, Saw dust Ash, Micro silica, which canend up in rivers, lakes and coastal waters. The disposal of these wastes is a very important problem, which can cause riskto public health, contamination of water resources and polluting the environment. A large number of food plants are constantly accumulating substantial quantities of industrial waste.

1.1 Egg Shell Powder

Eggshell consists of several mutually growing layers of $CaCO_3$, the innermost layer-maxillary 3 layer grows on the outermost egg membrane and creates the base on which palisade layer constitutes the thickest part of the eggshell. The top layer is a vertical layer covered by the organic cuticle. The eggshell primarily contains calcium, magnesium carbonate (lime) and protein. In many other countries, it is the accepted practice for eggshell to be dried and use as a source of calcium in animal feeds. The quality of lime in eggshell waste is influenced greatly by the extent of exposure to sunlight, raw water and harsh weather conditions. It is the fine grained powder with suitable proportion which is sieved to the required size before use with concrete/mortar.

1.2 Saw Dust Ash

Sawdust or wood dust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood with a saw or other tool; it is composed of fine particles of wood. Saw dust affect adversely the setting and hardening of Portland cement owing to the content of taming and soluble carbohydrates. Sawdust is the main component of particleboard. Saw dust ash is obtained from the combustion of saw dust. Sawdust is an organic waste resulting from

the mechanical milling or processing of timber (wood) into various shapes and sizes. The dust is usually used domestic fuel. The resulting ash known as saw-dust ash (SDA) is a form of pozzolana. Dry sawdust concrete weighs only 30% as much as normal weight concrete and its insulating properties approximate those of wood. With proper cement to sawdust ratios, it is not flammable.

1.3 Fly Ash

Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity. These mi- cron-sized earth elements consist primarily of silica, alumina and iron. When mixed with lime and water the fly ash forms a cementitious compound with properties very similarto that of Portland cement. Because of this similarity, fly ash can be used to replace portion of cement in the concrete, providing some distinct quality advantages. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (both amorphous and crystalline) and calci- um oxide, both being endemic ingredients in many coal- bearing rock strata.

1.4 Micro silica

Micro silica, or silica fume, is an amorphous type of silica dust mostly collected in bag house filters as by-product of the sili- con and ferro-silicon production. Micro silica contains trace amounts of heavy metal oxides and organic deposits, which originate from natural raw materials. Since the concentration of these impurities is very low. The effect of silica fume can be explained by two mechanism i.e. pozzolanic reaction and micro filler effect. The first product is calcium silicate-hydrate (C-S-H) gel, that is cementitious and binds the aggregate together in concrete and $Ca(OH)_2$ The C-S-H formed by the reaction be- tween micro-silica and the product $Ca(OH)_2$ which comprises 25% of volume of hydration product.

2.Experimental Work

Ordinary Portland Cement of 53grade confirming to IS 12269- 1987 was used in this study. River sand confirming to grading zone III of Is 383-1970 was used as a fineaggregate. Well graded coarse aggregate passing through 20mm sieve accord- ing to IS 383-1970 was used. Well graded coarse aggregate passing through 20mm sieve according to IS 383-1970 was used. Egg shell procured from local industry. It grained and sieved to the required size before used in concrete mix. Saw dust was obtained from sawmill and saw dust ash was obtained by incineration process and sieved before used. Fly ash was collected from Salem steel Plant, Salem, Tamilnadu and sieved before used confirming to IS 3812 (part I). Micro silica was a by product of the silicon and Ferro- silicon production. Portable water was used in the investigations for both mixing and curing purposes.

TABLE 1: Chemical properties of cement andindustrial waste

Compo-sition	Cement	ESP	Sawdust ash	Fly ash	Micro silica
CaO	63.8%	47.49%	9.39%	5.0%	0.5%
SiO2	21.4%	0.11%	65.79%	52%	96%
Al2O3	5.1%	Nil	4.88%	23%	1.0%
Fe2O3	2.6%	Traces	2.01%	11%	1.5%
MgO	0.36%	Nil	3.92%	Nil	2.0%
SO3	3.38%	0.38%	0.98%	0.8%	0.4%
K2O	1.88%	Nil	2.68%	1.0%	3.0%
Na2O	0.14%	0.14%	0.07%	1.0%	0.5%
Sp. Gravity	3.12	2.14	2.19	2.17	2.2

2.1 Mix Proportioning

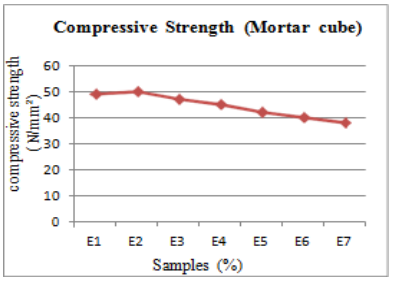
The mix proportioning for M20 grade concrete used in the present work. It is designed as per IS 10262-1982 stand-ards. The mix proportioning adopted was cement: sand: coarseaggregate: water/cement ratio respectively.

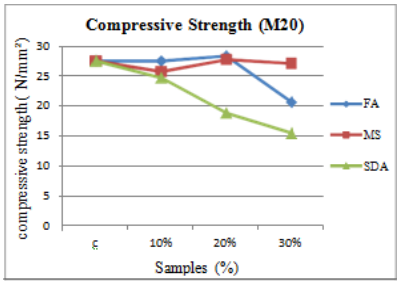
2.2 Experimental Work

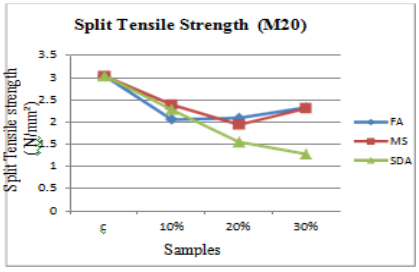
Determination of strength for M20 grade concrete, using Ordi- nary Portland cement (OPC) with 5% egg shell powder and increasing admixtures content as a part replacement of cement. The different proportion of admixtures (Fly ash, Micro silica, Saw dust ash) will be 0%, 10%, 20%, 30%. The different mixes are conveniently designates as C, F10, F20, F30, M10, M20, M30, S10, S20 and S30 respectively. The cubes of 150 x 150 x 150 mm size and

beamof 100 x 100 x 500 mm were tested. The concrete specimens will be tested for following strengths: i) Compressive strength for 28 days curing using standard cube specimen and ii) Flexural strength after 28 days curing using standard beam specimen.

2. RESULTS







3. Conclusion

Egg shell powder obtained from industrial wastes is added in various ratios for cement replacement and it was found that replacement of 5% Egg shell powder + 20 % Microsilica can be added without any reduction in compressive strength proper- ties of conventional cement. And replacement of 5% Egg shell powder + 10% Microsilica replacement in cement yields simi- lar flexural strength as in conventional concrete. And replace- ment of 5% Egg shell powder + 10% Microsilica replacement in cement yields higher SplitTensile strength as compared to other compositions.

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