

Experimental Investigation Using Egg shell Powder in Concrete for Durability

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Abstract— The Eggshell is a waste material and it is rich in calcium carbonate (CaCO_3) accounting for 93.70% of total composition of the eggshell which is the primary raw material in production of cement. So, this investigation is carried out to find eggshell could be or not better supplementary cementitious material (SCM). The study is to investigate the mechanical properties of concrete with different replacement levels of ordinary Portland cement by Eggshell powder. This study investigates the performance of concrete mixture in term of compressive, chloride attack, sulphate attack at 28days and 56 days and permeability and ph value at 28 days. The standard cubes (150mm X 150mm X 150mm), were caste. In all cubes with M20 grade mix concrete were caste and tested. The strength effect of concrete with various amounts of replacement of cement by 5%,10%,15%,20% with eggshell powder were determine for M20 grade of concrete.

Keywords— Egg shell powder, Durability test Chloride attack test, Sulphate attack, Ph value, Permeability.

I. INTRODUCTION

The durability of cement concrete is defined as its ability to resist weathering action, chemical attack, or any other process of deterioration. Durable concrete will retain its original form quality, and serviceability when exposed to environment. One of the main reasons for deterioration of concrete in the past is that too much emphasis is placed on concrete compressive strength rather than on the performance criteria. The deterioration of reinforced concrete structures usually involves the transport of aggressive substances from the surrounding environment followed by physical and chemical actions in its internal structure. The transport of aggressive gases and/or liquids into concrete depends on its permeation characteristics. As the permeation of concrete decreases its durability performance, in terms of physio-chemical degradation, increases. Therefore, permeation of concrete is one of the most critical parameters in the determination of concrete durability in aggressive environments.

A. Necessity of concrete used eggshell powder

The disposal of these wastes is a very important problem, which can cause risk to public health, contamination of water resources and polluting the environment. A large number of food plants are constantly accumulating substantial quantities of eggshell waste. This natural solid waste, although nonhazardous, is directly disposed in the environment. As a consequence, a huge problem of pollution is generated. In addition, it can attract rats and worms due the organic protein matrix, resulting in a problem of public health. The studies have been already made in this area by using egg shell powder Wall tile is a ceramic material primarily composed of clays, carbonates, and quartz. The potential use of this waste as a cementing material for concrete was examined.

B. Advantage of using eggshell powder in concrete

Replacing cement content with Eggshell powder we can reduce cement content in concrete. And there by also reduce cost of the concrete. Eggshell is waste material and replacing it with cement content in concrete we can take it in use and can solve disposal problem of that waste. Safe disposal of effluent using as a stabilizer and Return of income on it.

II. EXPERIMENTAL PROGRAM

A. Material

1) Cement

Ordinary Portland cement-53 grade (Binani Cement) have used in investigation. The cement was tested according to IS 4031:1988. It confirmed to IS 12269:1987. Its Properties is given in Table as per IS taken.

TABLE I

Property	IS CODE IS-12269-1976
Specific gravity	3.10-3.15
Initial setting time	30 min minimum
Final setting time	600 min maximum

2) *Fine Aggregate*

Natural sand as per IS: 383-1987 have used. Locally available river sand was used.

TABLE II

Sr. no	Property	Result
1	Specific gravity	2.595
2	Fineness modulus	3.50
3	Grading zone	I
4	Water Absorption	0.406%

3) *Course Aggregate*

Crushed aggregates confirming to IS: 383-1987 has been used. Aggregates of size 20 mm and 10 mm of specific gravity 2.815 and 2.828 respectively were used.

4) *Egg shell powder*

Egg shell powder of fineness 1.69 was used throughout the investigation.

B. *Mix Proportion*

Adopted Mix Proportion

TABLE III

Grade	Cement	Fine aggregate	Coarse Aggregate	Water
M20	344.44 kg	709.5 kg	1215.9 kg	186 lit

III. EXPERIMENTAL WORK

The specimen of cube has (150mmx150mmx150mm) used for compressive strength, chloride attack sulphate attack, permeability and ph value test.

A. *Test Methods*1) *Compressive Strength*

Concrete cubes of 150 X 150 X 150 mm dimension were casting for compressive strength. They have tested for compressive strength after 28 days of water curing.

2) *Chloride Attack Test*

Cubes of sizes 150 X 150 X 150 mm were casting and have cured for 28 days. After 28 days curing cubes were taken out and allowed for drying for 24 hours and weights were taken. For Chloride Attack Test 3.5% dilute NaCl is used. The cubes were to be immersed in solution for a period of 28 days. The concentration is to be maintained throughout this period. After 28 days and 56 days the specimens were taken from acid solution. The surface of specimen has cleaned and weights were measured. The specimen was tested in the compression testing machine. The loss of mass and loss of strength of specimen due to Chloride Attack was determined.

3) *Sulphate Attack Test*

Cubes of sizes 150 X 150 X 150 mm were casting and have cured for 28 days. After 28 days curing cubes were taken out and allowed for drying for 24 hours and weights were taken. For Sulphate Attack Test 5% dilute $MgSO_4$ is used. The cubes were to be immersed in

solution for a period of 28 days. The concentration is to be maintained throughout this period. After 28 days and 56 days the specimens were taken from acid solution. The surface of specimen has cleaned and weights were measured. The specimen was tested in the compression testing machine. The loss of mass and loss of strength of specimen due to Chloride Attack was determined

4) *PH Value Test*

In ph value test cube were crushed and made powder form. The powder of 30 gm by weight which were passed through 425 micron sieve were taken for the test and it is mixed with distilled water of 75 ml. Then this mixed is left for few minute till mixed were settled. Then instrument is calibrated with buffer solution like ph7 and ph 9.2. Then settled solution was put for the ph value test. When reading become steady that reading were taken as PH value for that solution.

5) *Permeability Test*

The permeability test gives a measure of concrete's resistance against the penetration of water at 28 days after casting specimens. The cubes were expose to a water pressure of 6 kg/cm² for a period of three days (24x3=72 hours) Cubes were considered failed if water permeated through the opposing surface or through the sides. Immediately after termination of test, cubes were cut and measured for the depth of water permeation.

IV. RESULTS AND DISCUSSION

The compressive strength of concrete grade of M20 with different percentage of Egg shell powder say 0%,5%,10%,15%,20% concrete mix with different curing medium was tested and shown below.

TABLE IV
COMPRESSIVE STRENGTH

% of Egg shell powder	Water cured 28 days N/MM ²	Sulphate Attack		Chloride Attack	
		28 days N/MM ²	56days N/MM ²	28 days N/MM ²	56days N/MM ²
0%	33.52	33.03	32.41	32.94	32.23
5%	28.13	27.63	27.12	27.65	27.13
10%	23.35	22.89	22.53	22.91	22.45
15%	21.40	20.91	20.56	20.87	20.38
20%	16.78	16.21	15.92	16.19	15.70

A. *Sulphate Attack Test*TABLE V
LOSS OF WEIGHT IN $MgSO_4$ (5%) SOLUTION

% of Egg shell powder	Loss of Weight in %	
	28 days	56 days
0%	1.01	1.69
5%	1.07	1.48
10%	1.51	1.89
15%	1.60	1.84
20%	1.69	1.88

TABLE VI
LOSS OF COMPRESSIVE STRENGTH IN MgSO_4 (5%) SOLUTION

% of Egg shell powder	Loss of compressive strength in %	
	28 days	56 days
0%	1.46	3.31
5%	1.77	3.59
10%	1.97	3.51
15%	2.28	3.92
20%	3.39	5.12

B. Chloride Attack Test

TABLE VII
LOSS OF WEIGHT IN NaCl (3.5%) SOLUTION

% of Egg shell powder	Loss of Weight in %	
	28 days	56 days
0%	1.22	1.78
5%	1.32	1.90
10%	1.38	1.91
15%	1.43	1.95
20%	1.68	2.32

TABLE VIII
LOSS OF COMPRESSIVE STRENGTH IN NaCl (3.5%) SOLUTION

% of Egg shell powder	Loss of compressive strength in %	
	28 days	56 days
0%	1.73	3.84
5%	1.70	3.55
10%	1.88	3.85
15%	2.47	4.76
20%	3.51	6.43

C. PH Value Test

TABLE IX
PH VALUE

% Egg shell powder	Ph Value
0%	12.36
5%	12.89
10%	12.70
15%	12.33
20%	12.35

D. Permeability Test

TABLE X
PERMEABILITY

% Egg shell powder	Permeability in mm
0%	15
5%	19.3
10%	20
15%	45
20%	60

V. CONCLUSION

Based on the result of this work it can be conclude that with increase replacement of cement with egg shell powder compressive strength in chloride attack test and also in sulphate attack test at 28 days and 56 days is decreased.

It can be conclude that with increase replacement of cement with egg shell powder weight loss in chloride attack and in sulphate attack test at 28 days and 56 days is increased

The result of Ph value remain above 12 for different percentage of Egg shell powder concrete mix shows that concrete mix remain basic it not become acidic.

The permeability of Egg shell powder mix concrete increase with replacement of cement with different percentage of Egg shell powder.

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