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Experimental investigation on partial replacement of cement by Egg shell powder in concrete

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ABSTRACT

This paper proposes a new algorithm for a real time charging recommendation for an electric vehicle (EV) driver based on an accurate real-time range indicator system to avoid range anxiety. In this algorithm the graphical user interface (GUI) of the real-time range indicator system is also used to show the driver an accurate estimation of the remaining range to destination and the current state of charge (SoC). This algorithm also calculates the minimum charging time required at the charging station to reach the destination. Charging recommendation system, electric vehicle, energy management, real-time range estimation model, state of charge estimation these are tools required for implementing this paper. The proposed system will enhance the use of electric vehicles by reducing range anxiety and reduce the necessary charging time along a route and also helps the driver to travel over a longer distance by a depleted electric battery.

Keywords: Cement, Aggregate, Egg shell powder, compressive strength, Split tensile strength and Flexural strength.

INTRODUCTION

Concrete is being widely used for the construction of most of the buildings, bridges and it is also known as backbone to the infrastructure development of a nation. Firstly, it consumes huge amount of natural resource due to which no virgin material will be left for future generation. Secondly, the major component of concrete is cement. Lot amount of greenhouse gas will be emitted in the manufacturing processes of cement. Thirdly, concrete structure suffers from durability problem due to which natural resources are wasted. Therefore, there is a need to find an alternative method so that concrete industry becomes sustainable. The cement produces about 5% of CO2 emissions of the world. 900kg of CO2 for every 1000kg of cement produced. The aim of the current study is to determine the potential use of these wastes as a cementing material for concrete. In the present work, egg shells which was a waste material was collected from bakeries, fast food restaurants and are sun dried. Stored egg shell was powdered in flour mill. The grinded egg shells were sieved through the 90 microns sieve size and then packed to use it in the cement replacement [1-5].

OBJECTIVES

The objectives of this study are as follows

- To investigate the best mix proportion of the partial replacement of egg shell powder for cement in concrete by the value of strength per weight ratio of sample specimen.
- To investigate the feasibility of the partial replacement of above material in concrete by determining its compressive strength and split tensile strength.

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- Based on the test results, to suggest most approximate level of adding egg shell powder.

MATERIAL DESCRIPTION

The materials used in the projects are cement, Fine aggregate, coarse aggregate, Egg shell powder is detailed below

Cement

Cement is the essential ingredient to bind all other materials to form workable concrete. The Ordinary Portland Cement of 53 grades was used in this experimentation conforming to IS: 12269:1987 is used in this experimental project.

Table No 1: Physical property on cement

PROPERTY	SPECIFICATIONS
Specific gravity	3.15
Fineness modulus	2.6 %
Standard consistency	31 %
Initial setting time	30 Minutes
Final setting time	10 Hours

Fine aggregate

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8 -inch sieve. We used manufactured sand (M - Sand). Specific gravity – 2.65.

Coarse aggregate

Coarse aggregate are components found in many areas of the construction industry. Crushed angular shape aggregate from a local source was used as coarse aggregate. Specific gravity - 2.7.

Egg shell powder

The egg shell waste lands in the poultry manufacturing have been highlighted because of its recovery potential [6-10]. Egg shell waste is available in huge amount from the food processing egg breaking and shading industries.

Fig No 1: Egg shell powder

Water

Portable water was used for the experimentation.

DESIGN MIX

As per IS 10292-2000 designed by M25 grade of concrete and water cement ratio 0.45.

Table No: 2 Mix proportion

Materials	Quantity	Mix ratio
Cement(kg/m^3)	420	1
FA(kg/ m^3)	663	1.51
CA(kg/ m^3)	1130	2.57
Water(litres)	197	0.45

Mixing of Concrete, Casting and Curing of test Specimens Hand mixing was done during the entire process of casting of specimens. Initially the dry mix constituents of the mix namely cement, fine aggregate and coarse aggregate was mixed for two minutes in the mixer and then the water were added and mixing continued for another 2 minutes. The total mixing time was kept at 4 minutes until a homogeneous mixture was obtained. Compaction was achieved by means of Tamping rod.

Fig No 2: Mixing of concrete

EXPERIMENTAL RESULTS

Fresh concrete

The fresh concrete properties slump test is conducted. The slump value of concrete was 72mm.

Hardened concrete

The hardened concrete specimen properties are checked by compressive strength, split tensile strength and flexural strength.

Compressive strength

For every percentage of replacement 8 cubes have been casted. Among them, 4 cubes were tested on the 7th and the other 4 cubes were tested on the 28th day. Totally 8 cubes were casted and 7th day and 28th day testing has been completed. Compressive test of concrete is carried out on specimens like cube by compression testing machine.

$fc = (P/A)\ N/mm^2$

Where,

P = Load at which the specimen fails in Newton(N)

A = Area over which the load is applied in mm

fc = Compressive Stress in N/mm2

Table No 3: Compressive Strength Results

Grade of concrete	% of Egg shell powder	7days (N/mm^2)	28days (N/mm^2)
M25	0	12.72	-
	20	16	-
	30	8	-

Fig No 3: Testing of cube

SPLIT TENSILE STRENGTH

For every percentage of replacement 8 cylinders have been casted. Among them, 4 cylinders were tested on the 7th and the other 4 cylinders were tested on the 28th day [11, 12].Totally 8 cylinders were casted and 7th day and 28th day testing has been completed. Split tensile Strength test of concrete is carried out on specimens like cylinders by compression testing machine. The Split tensile strength of the specimen was calculated by using the formula

$ft = (2P/\Pi dl)\ N/mm^2$

Where,

P = Maximum load in N applied to the specimen

d = Measured length in cm of the specimen

l = Measured diameter in cm of the specimen

kuft= Tensile strength N/mm^2

Table No 4: Split Tensile Test Results

Grade of concrete	% of Egg shell powder	7days (N/mm^2)	28days (N/mm^2)
M25	0	1.90	-
	20	2.12	-
	30	1.13	-

Fig No 4: Testing of cylinder

FLEXURAL STRENGTH TEST

For every percentage of replacement 8 prisms have been casted. Among them, 4 prisms were tested on the 7th and the other 4 prisms were tested on the 28th day. Totally 8 prisms were casted and 7th day and 28th day testing has been completed. Flexural strength is the one of the measure of the tensile strength of concrete. The flexural strength of the specimen was calculated by using the formula

Fb =(Pl/bd2) N/mm^2

Where,

P = Load at which specimen fails in (N)

l = Effective span in mm

b = Breadth of the specimen in mm

d = Depth of the specimen in mm

Table No 5: Flexural Strength Test Results

Grade of concrete	% of Egg shell powder	7days (N/mm^2)	28days (N/mm^2)
M25	0	3.98	-
	20	5	-
	30	2	-

Fig No 5: Testing of prism

CONCLUSION

Sustainable development is a key towards improving living conditions of the future generations. The results which came after carrying out all tests found successful which indicates that Egg shell powder can be used as replacement material for cement.

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