IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Partial Replacement Of Cement With Egg Shell Powder And Corn Cob Ash

Mr. S. ARUN KUMAR
Assistant professor
Department of Civil Engineering
JNTUH University College of Engineering Sultanpur

Abstract: This study aims to focus on the possibilities of using waste materials from different manufacturing activities in the preparation of concrete. The use of waste corn cob ash and egg shell powder was proposed in partial replacement of cement, for the production of Concrete Mix. In particular, tests were conducted on the concrete mix cured for different times in order to determine their compressive as well as flexural strength. Partial replacement of cement by varying percentage of egg shell powder and corn cob ash was taken in this study. In the same way cube specimens and beams samples of M30 grade of concrete have been tested in laboratory for which each percentage of egg shell powder and corn cob ash i.e. 5% and 10%. Two properties of concrete namely compressive strength and flexural strength have been selected for study and evaluated. Before initiating the test properties of materials were determined according to respective IS codes.

Keywords: Corn cob ash, steel fiber, compressive strength, split tensile strength, flexural strength.

Introduction: Concrete is a mixture of different materials like binder (cement), fine aggregate, coarse aggregate and water. Use of concrete is very large so availability of natural material is reduced and there is no material which plays the role of this ideal material. So to fulfill the requirement of industries we have to replace fully or partially all the materials. In India number of waste materials is produced by different manufacturing companies, thermal power plant, municipal solid wastes and other wastes. Solid as well as liquid waste management is one of the biggest problems of the whole world.

During manufacturing of one tone Ordinary Portland Cement (OPC) we need about 1.1 tones of earth resources. Further during manufacturing of one tones of cement an equal amount of carbon dioxide is released in to the atmosphere which acts as a silent killer in the environment as various forms. In this backdrop, the search for cheaper substitute to OPC is a needful one. The cost of concrete depends largely on the availability and cost of its constituent with the cost of cement in a cubic meter of concrete being higher than another constituent.

LITERATURE REVIEW

- **Amarnath Yerramala (2015)** studied the Properties of concrete with eggshell powder as cement replacement. This paper describes research into use of poultry waste in concrete through the development of concrete incorporating eggshell powder (ESP). Different ESP concretes were developed by replacing 5-15% of ESP for cement. The results indicated that ESP can successfully be used as partial replacement of cement in concrete production. In this study, Compressive loading tests on concretes were conducted on a compression testing machine of capacity 2000 KN. For the compressive strength test, a loading rate of 2.5 kN/s was applied as per IS: 516.1959. The test was conducted on 150mm cube specimens at 1, 7 and 28 days. Compressive strength was higher than control concrete for 5 % ESP replacement at 7 and 28 days of curing ages. ESP replacements greater than 10 % had lower strength than control concrete. Addition of fly ash improved compressive strength of ESP concrete.
- **Freire et al (2016)** carried out the investigation on egg shell waste and found out its use in a ceramic wall tile paste. Based on the presence of $CaCO_3$ in egg shell it can be used as a alternative raw material in the production of wall tile materials they alsofound that egg shell can be used as an excellent alternative for material reuse and waste recycling practices.
- **Anjaneyulu (2017)** evaluated the effects of partially replacing cement in concrete with waste Materials. Concrete cubes of size 150mm x 150mm x 150mm with different percentages of CCA and SDH to cement in the order of 0 %, 10 % and 15 % were cast. The concrete cubes were tested at the ages of 7, 14, 21, 28 and 56 days. The highest compressive strength was 24.9 N/mm2 and 22.4 N/mm2 at 56 days for 0 % and 10 % of CCA (M25) and 24.9 N/mm2, 23.9 N/mm2 for SDA (M25) respectively. The researcher concluded that the use of CCA and SDA as a partial replacement for cement in concrete, particularly in plain concrete works and non-load bearing structures, will improve waste to wealth initiative through only 10 % CCA and SDA replacement.
- **Binici et al (2008)** had concluded in a research that an increase in ash content caused a significant increase in the sodium sulphate resistance of the concretes. The researcher reported that microscopic analysis showed that CCA as an additive had a more condensed physical structure than Portland cement, making it more resistant to sulphate attack.

MATERIALS AND PROPERTIES

In this investigation, the following materials were used:

Ordinary Portland Cement of 53 Grade cement - conforming to IS: 12269-1987 : Ordinary Portland Cement of 53 Grade of brand name Bharathi Cement Company, available in the local market was used for the investigation. Care has been taken to see thatthe procurement was made from single batching in air tight containers to prevent it from being affected by atmospheric conditions. The cement thus procured was tested forphysical requirements.

Fig 1 Cement

Fine aggregate and coarse aggregate -conforming to IS: 2386-1963:

- **Fine Aggregate**: Locally available river sand conforming to Grading zone II, clean and dry river sand available locally have been used. Sand passing through IS 4.75mm Sieve is used for casting all the specimens.

Fig 2 Fine Aggregate

- **Coarse Aggregate:** Crushed aggregates of less than 20mm size produced from local crushing plants were used. The aggregate exclusively passing through 20mm sieve size and retained on 10mm sieve is selected. The aggregates were tested for their physical requirements such as gradation, fineness modulus, specific gravity and bulk density. The individual aggregates were mixed to induce the required combined grading. The particular specific gravity and water absorption of the mixture are given in table.

Fig 3 Coarse Aggregate

Corn cob ash (CCA) and Egg shell powder (ESP) - as a replacement of cement.:

Egg Shell Powder: Egg shells are agricultural throw away objects produced from chick hatcheries, bakeries, fast food restaurants among others which can damage the surroundings and as a result comprising ecological issues/contamination which would need appropriate treatment. Egg shell consists of several mutually growing layers of $CaCO_3$. The shells cleaned in normal water and air dried for five days approximately at a temperature range of 25 – 30 °C. The shells then hand crushed, grinded and sieved through 90 µm. Material passed through 90 µm sieve was used for cement replacement and the retained material was discarded.

Fig .4 Egg shell powder

Corn Cob Ash: Corn cob is the hard thick cylindrical central core of maize or corn. Corn cobs are obtained from crop fields. Corn cobs are sundried for 1 hour. Corn cobs are then burnt on an open surface by exposing them to air and then cooled for some time. Each burnt corn cob was then grounded separately and was sieved through an Indian standard sieve of 90μm. The portion passing through the sieve is the resultant corn cob ash.

Fig 5 Corn cob ash

Water: Water plays a vital role in achieving the strength of concrete. For complete hydration it requires about 3/10th of its weight of water. If water content exceeds permissible limits it may cause bleeding. If less water is used, the required workability is not achieved. Potable water fit for drinking is required to be used in the concrete and it should have pH value ranges between 6 to 9.

TESTS CONDUCTED

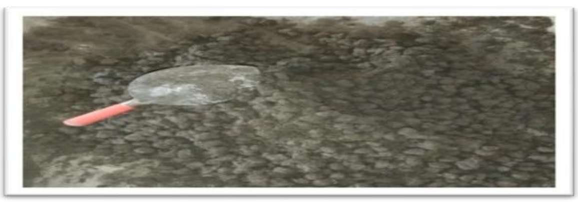
- **Object:** Determination of the optimum quantity of water required to produce a cement paste of standard consistency.
- **Object:** Determination of the Initial and Final setting times of cement.
- **Object:** Determination of the Soundness of cement by the Le Chatelier method.
- **Object:** To determine the fineness of cement by dry sieving.
- **Object:** To determine the specific gravity of cement using Le Chatelier Flask or Specific Gravity Bottle.

METHODOLOGY

This experimental program involves all the preliminary tests which are carried out on the materials and the concrete. These tests help us to know the properties of the material beingused for the process of concreting and in the derivation of the mixed ratio

- **Mix Designed**: M30 it is a design to attain the given strength of that particular mix. The mix design of the project is taken as M30 grade of concrete. The mix proportions as per are 1026-1982 are 1:1.63:2.75:0.45
- **Batching:** The batching of concrete is done by the measuring and combinations of concrete ingredients by their weight as per mix design. i.e., 1kg of cement, 1.63kg of sand, 2.75kg of aggregates, 0and .45 liters of water.
- **Mixing:** The ingredients are cement, sand, aggregate and water are mixed together to make a concrete partial replacement of cement with considered egg shell and fly ash ingredientsare added to the mix.

Fig 6 Mixing of concrete



- **Casting:** After the concrete is well mixed it is dumped into mould of 150×150×150mm cube and also in 150mmx 150mmx700mm beam to achieve the required shape.

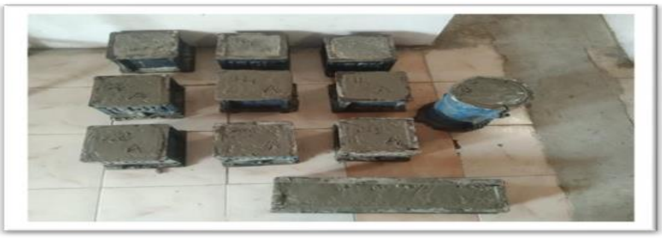


Fig 7 Casting of concrete

- **Compaction:** The concrete which is well mixed is dumped into the mold and is compacted by using atamping rod and then by vibrator for the removal of air block.

Fig 8 Compaction of concrete

- **Curing:** Concrete curing is the process of maintaining adequate moisture in concrete within a proper temperature range in order to aid cement hydration at early ages. The curing period of concrete is taken as 7, 14, and 28 days.

Fig 9 Curing of Concrete

TESTS CONDUCTED

Compressive Strength Test:

- Compressive strength of concrete is the strength of hardened concrete measured by the compression test. The compression strength of concrete is a measure of concretes ability to resistsload which tends to compress it.It is measured by crushing cylindrical concrete specimens in compression testingmachine. Units N/mm^2 in SI units.
- Uniaxial compression test is carried out on the specimen (150×150×150 mm cubes) at various days to check the development of compressive strength due toeffect of curing.

TEST PROCEDURE FOR COMPRESSIVE STRENGTH:

- For this test, mainly 150mm * 150 mm * 150 mm cubes are used.
- Designed mix of M30 grade is taken in this study and the obtained ratio in 1 : 1.63:2.8: 0.45; cement: fine aggregate: coarse aggregate: water content.
- Egg shell powder and corn cob ash are partially replaced by 5% and 10%individually to the cement ratio.
- The concrete shall be mixed manually. Clean the moulds properly and apply oil inside the cube frame . Fill the concrete in the moulds in layers approximately 50mm thick
- Compact each layer with not less than 25 strokes per layer using a tamping rod(steel bar 16mm diameter and 600 mm long) . Level the top surface and smoothen it with a trowel. . And also by using a vibrator compact the concrete cubes for accurate compaction. The concrete cubes are removed from the moulds after 24 hours.
- Place the specimen in water and remove it after a specified curing time and wipe out excess water from the surface. (we considered 7, 14 and 28 days of curing period)

- Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast. Align the specimen centrally on the base plate of the machine. Rotate the movable portion gently by hand so that it touches the top surface of the specimen. Apply the load gradually without shock and continuously at the rate of 140kg/cm^2/min. till the specimen fails. Record the maximum load and note it.

Calculations Format ; Size of the cube =150mm x 150mm x 150mm Area of the specimen =22500mm2 Compressive strength = (Load in N/ Area in mm2) [N/mm2]

Fig 10 Compressive Strength Test

FLEXURAL STRENGTH TEST:

- Flexural strength is a measure of the tensile strength of a concrete beam or a slab to resist failure in bending.
- It is useful in knowing the quality of concrete, work done in construction.
- A concrete beam of size ((150×150×700mm) is supported on a steel roller manner near each end and is loaded through two-point loadings.
- It is generally used to measure the tensile strength of concrete. The flexural strength is expressed as the Modulus of Rupture (MR) in MPa or psi.

Fig 11 Flexural strength test

Test Procedure for Flexural Strength:

- Designed mix of M30 grade is taken in this study and the obtained ratio in 1 : 1.63
- : 2.8 : 0.45; cement: fine aggregate: coarse aggregate: water content.
- Egg shell powder and corn cob ash are partially replaced by 5% and 10% individually to the cement ratio. The quantities of cement, each size of aggregate, and water for each batch shall bedetermined by weight.

The concrete shall be mixed manually.

- Mould: The standard size shall be 15 × 15 × 70 cm. Alternatively, if the largest nominal size of the aggregate does not exceed 19 mm, specimens 10 × 10 × 50 cmmay be used. (In our lab only 10x10x50 cm size is available)
- The freshly mixed concrete is placed in the mould and compacted not less than 25times using compacting rod
- During: The test specimens shall be stored in a place in moist air and at a temperature of 27° ± 2°C for 24 hours ± ½ hour from the time of addition of water to the dry ingredients and placed in water for 7, 14,28 days of curing period.

- Remove the specimen from water and clean the surface and any loose sand or othermaterial removed from the surfaces of the specimen where they are to make contactwith the rollers.
- The specimen shall then be placed in the machine in such a manner that the load shall be applied to the uppermost surface as cast in the mould, along two lines spaced 20.0 or 13.3 cm apart. (In our lab the spacing between two rollers is 13.3cm)
- The load shall be applied without shock. The load shall be increased until the specimen fails, and the maximum load applied to the specimen during the test shall be recorded. Each specimen is tested and the values are noted in Test Machine.
- When a> 200 mm for a 150 mm specimen or >130mm for a 100mm specimen the flexural strength fb, is calculated from:fb=pl/bd^2 But, if 200> a> 170 mm for a 150 mm specimen or <130mm but>110mm for 100mm specimen fb, is calculated from: fb=3pa/bd^2 a= distance between the line of fracture and the nearer support, measured on thecentreline of the tensile side of the specimen b=width of specimen(cm) d=failure point depth(cm), l=supported length(cm) ,=maximum load(kg)

RESULTS

Mix	Specimen	Compressive strength at 7days(N/mm^2)			Compressive strength at 14days(N/mm^2)			Compressive strength at 28days(N/mm^2)		
		Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg
100% OPC	1	410	18.23	17.67	572	25.45	26.66	737	32.76	32.22
	2	394	17.58		603	26.82		716	31.85	
	3	387	17.2		623	27.71		721	32.05	

Table 1 Compressive strength of Conventional Concrete Mix

Age of concrete	Weight (kg)	Length (mm)	Distance between the line of fractureand nearer support(a)	Load at failure (P)(KN)	Flexural strength (N/mm^2)
7 days	11.5	400	158	7.25	2.9
14 days	12	400	160	8.25	3.3
28 days	12.5	400	144	10.5	4.2

Table 2 Flexural strength of Conventional Concrete Mix

Mix	**Specimen**	**Compressive strength at 7days (N/mm^2)**			**Compressive strength at 14d14 days/mm^2)**			**Compressive strength at 28days (N/mm^2)**		
		Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg
5%	1	439	19.50	18.66	604	26.87	27.15	575	25.57	32.75
	2	424	18.85		406	26.96		604	26.83	
	3	397	17.63		621	27.62		591	26.26	

Table 3 Compressive strength of Concrete with Partial replacement of cement with5% of ESP.

Beam age	**Weight (kg)**	**Length (mm)**	**Distance between the line of fracture and nearer support(a)**	**Load at failure (P)(KN)**	**Flexural strength (N/mm^2)**
7 days	12	400	193mm	7	2.81
14 days	11.5	400	180mm	8.1	3.25
28 days	11.2	400	166mm	9.5	3.81

Table 4 Flexural strength of Concrete with Partial replacement of cement with 5%of ESP

Mix	**Specimen**	**Compressive strength at 7days (N/mm^2)**			**Compressive strength at 14days (N/mm^2)**			**Compressive strength at 28days (N/mm^2)**		
		Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg
10%	1	529	23.51	23	635	28.23	28	843	35.51	35
	2	505	22.44		632	28.10		799	32.49	

	3	556	24.71		639	28.38		731	30.80	

Table 5 Compressive strength of Concrete with Partial replacement of cement with10% of ESP

Beam age	Weight (kg)	Length (mm)	Distance between the line of fracture and nearer support(a)	Load at failure (P)(KN)	Flexural strength (N/mm^2)
7days	420	500	207	6.8	2.72
14 days	414	500	212	7.8	3.13
28 days	413	500	210	9.2	3.68

Table 6 Flexural Strength of Concrete with Partial replacement of cement with10% of ESP

Mix	Specimen	Compressive strength at 7days (N/mm^2)			Compressive strength at 14days (N/mm^2)			Compressive strength at 28days (N/mm^2)		
		Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg
5%	1	366	16.28	16.82	550	24.47	25.45	649	28.85	28.78
	2	390	17.33		576	25.63		656	29.17	
	3	380	16.85		590	26.25		637	28.32	

Table 7 Compressive strength of Concrete with Partial replacement of cement with5% of CCA

Beam age	Weight (kg)	Length (mm)	Distance between the line of fracture and nearer support(a)	Load at failure (P)(KN)	Flexural strength (N/mm^2)
7 days	12.3	400	163mm	7	2.82

14 days	11.92	400	166mm	7.7	3.1
28 days	12.2	400	175mm	9.9	3.96

Table 08 Flexural Strength of Concrete with Partial replacement of cement with 5%of CCA

Mix	Specimen	Compressive strength at 7days (N/mm^2)			Compressive strength at 14days (N/mm^2)			Compressive strength at 28days (N/mm^2)		
		Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg	Load KN	Stress N/mm^2	Avg
10%	1	388	17.24	17.23	507	22.56	22.20	575	25.57	26.22
	2	380	16.89		490	22.26		604	26.83	
	3	395	17.56		500	21.78		591	26.26	

Table 9 Compressive strength of Concrete with Partial replacement of cement with10% of CCA

Beam age	Weight (kg)	Length (mm)	Distance between the line of fracture and nearer support(a)	Load at failure (P)(KN)	Flexural strength (N/mm^2)
7 days	12	400	193mm	6.7	2.71
14da0ys	11.52	400	180mm	7.4	2.95
28days	11.80	400	177mm	9.2	3.69

Table 10 Flexural strength of Concrete with Partial replacement of cement with10% of CCA

CONCLUSION

- The compressive strength of concrete of partially replaced cement with ESP of 5%of 7,14 and 28 days obtained greater strength when compared with conventional concrete.
- The flexural strength of concrete of partially replaced cement with ESP of 5% of 7,14 and 28 days obtained lower strength when compared with conventionalconcrete.
- The compressive strength of concrete of partially replaced cement with ESP of 10%of 7,14 and 28 days obtained greater strength when compared with conventional concrete and concrete with partially replaced cement with ESP of 5%.
- The flexural strength of concrete of partially replaced cement with ESP of 10% of7,14 and 28 days obtained lower strength when compared with conventional concrete and concrete with partially replaced cement with ESP of 5%.
- The compressive strength of concrete of partially replaced cement with CCA of 5%of 7,14 and 28 days obtained lower strength when compared with conventional concrete.
- The flexural strength of concrete of partially replaced cement with CCA of 5% of 7,14 and 28 days obtained lower strength when compared with conventionalconcrete.
- The compressive strength of concrete of partially replaced cement with CCA of 10% of 7,14 and 28 days obtained lower strength when compared with conventional concrete and concrete with partially replaced cement with CCA of 5%.
- The flexural strength of concrete of partially replaced cement with CCA of 10% of7,14 and 28 days obtained lower strength when compared with conventional concrete and concrete with partially replaced cement with CCA of 5%.

REFERENCES

- Manzoor Ahmad Allie' A Review Study of Egg Shell Powder as A Cement Replacing Material in Concrete 'May 2018 | Volume 3, Issue5.
- Pradeep Sharma1'an experimental investigation on partial replacement of cement with egg shell powder and fine aggregate with copper slag in concrete 'Volume 5, Issue 10,June- 2018.
- N. Parthasarathi1'Experimental Study on Partial Replacement of Cement with Egg Shell Powder and Silica Fume Vol. 10 | No. 2 |442 - 449 | April - June |2017.
- "A Study of the Workability and Compressive Strength Characteristics of Corn cob Ash Blended Cement Concrete", Construction and Building Materials, Vol. 23, pp. 311 – 317.Adesanya, D. A. and Raheem A. A. (2009a).
- Priya(2017)"Strength Properties of Corn Cob Ash Concrete" – Journal of Emerging Trends in Engineering and AppliedSciences (JETEAS) 3 (2): 297-301© Scholarlink Research Institute Journals, 2012 (ISSN: 2141-7016).
- S. Shetty (2013) "Concrete Technology Theory and Practice", S. Chand & company Pvt.Ltd, New Delhi.
- Amarnath Yerramala, Properties of concrete with eggshell powder as cement replacement. The Indian Concrete Journal October2014.
- "A Study of the Permeability and acid attack of Corn cob Ash blended Cements", Construction and Building Materials, Vol. 24, pp.403 – 409. Adesanya, D. A. and RaheemA. A. (2010).