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Research Article

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An Experimental Study on Check of Flexural Strength of M30 Concrete Using Seashell Powder and Eggshell as a Partial Replacement of Fine Aggregate in Comparison with Conventional Concrete

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Abstract

Aim: The project's objective is to compare the flexural strength of seashell and eggshell-based powder M30 concrete with that of traditional concrete.

Method: There are two groups taken into account. Group 1 consists of powder M30 concrete made of eggshells and seashells, while group 2 is made of regular concrete. There are 18 samples in each group, for a total of 36 sample sizes. With the aid of SPSS software, the sample count was determined. A load gauge's flexural testing machine was used to measure the specimens' strength after they had been cured for 28 days. The standard mean of the specimens' strength is their flexural strength.

Results: Independent sample t-test was for significant difference observed for strength. The mean flexural strength of a conventional concrete sample is 12.57 N/mm^2, whereas the mean flexural strength of a seashell and eggshell-based powder M30 concrete sample is 14.47 N/mm^2. T-test and G-power in an unrelated sample is 80%, and the p-value is 0.000 (p - 0.05). This demonstrates that the two groups taken into account in this study differ statistically significantly from one another. The standard mean analyzed from the SPSS software was 12.5689 for conventional concrete and the seashell and eggshell based powder M30 concrete was 14.4744.

Conclusion: The seashell and eggshell based powder M30 concrete had more flexural strength when compared to the conventional concrete.

Keywords

Seashell powder, Eggshell powder, Cement, Water, Fine aggregate, Sustainable infrastructure, Flexural strength, M30 grade, Conventional concrete

Introduction

Concrete, a ubiquitous construction material, has been extensively studied for its macroscopic properties, yet the characteristics of its cementitious components at the micro/nano scale remain incompletely understood [1]. Enhancing our understanding of concrete's structure and behavior at these tiny scales could lead to improvements in its properties [2].

Numerous studies have investigated the use of nanoparticles in cement and concrete, with a focus on nano-oxides such as silicon dioxide and iron oxide [3-6]. For instance, Amin and Abu el-Hassan [7] explored the compressive strength of Portland cement pastes and mortars incorporating Cu-Zn nano-ferrite. They determined that the optimal dosage of nano-ferrite was one percent of the cement weight, resulting in an average 45% increase in compressive strength [5].

The impact of nano-silica (NS) on self-compacting concrete, replacing cementitious materials at various ratios [6]. Their findings indicated that a 0.5%

replacement ratio of NS yielded higher compressive strengths across different ages [8].

Abbas [9] conducted a study on the influence of NS addition on both conventional and ultra high-performance concretes. The research revealed that the inclusion of NS necessitated additional water, with each kilogram of NS requiring 0.4 kg of water to maintain workability. Furthermore, the addition of 5% NS resulted in a significant early increase in compressive, splitting, and flexural strengths, with a 50% increase in 7-day compressive strength and a 40% increase in 28-day compressive strength compared to concrete without NS [9, 10].

Materials and Method

To ascertain the concrete specimen's typical compressive strength, 150 mm cubic standard specimen was engaged since the nominal size of aggregates used in this study is of 20 mm. Experiments were conducted in two groups, one group of the concrete specimens was made using conventional concrete of M30 grade in accordance with Indian Standards (IS) regulations. Flexural strength was taken into account when the project was being investigated. The beam specimen size was 500 x 100 x 100 mm. Two groups of experiments were done. Conventional concrete of M30 grade was used in one set of concrete specimens, as per IS criteria, while 15% seashell powder and 25% eggshell were mixed in with cement, aggregate, and water to create the other groups of concrete specimens. Figure 1a shows the seashell and figure 1b shows the seashell powder.

The eggshell and eggshell powder are seen in figure 1c and 1d. The G-power was used to compute the sample size, which indicates that each group contains 18 samples and that a total of 36 tests can be run. The SPSS software (version 21) can be used for the statistical analysis comparative study.

Group 1 is ready to make concrete specimens by batching and mixing with the necessary components. Direct addition of the equally in typical M30 grade concrete. The moulds were prepared and filled by mixed concrete by the IS codal provisions levels of equal height, with each layer tamped 25 times. Figure 2 depicts the concrete mixing process.

The vibration method is also used during the casting process to eliminate voids from the specimen. Figure 3 testing of beam specimen. Flexural beam casting is seen in figure 4. Similarly, the same procedures were followed for group 2, with the exception that a 15% of seashell powder and 25% of eggshell to the amount of cement was added to it when mixing the concrete.

The flexural strength of 18 group 1 specimens, i.e., traditional self-healing specimens, was determined. Similarly, the flexural strength of 18 concrete examples from group 2 (Seashell powder and eggshell powder) was determined.

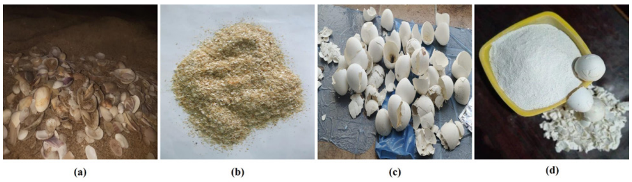

Figure 1: (a) Collection of seashells, **(b)** Seashell powder, **(c)** Collection of eggshells, and **(d)** Eggshell powder.

Figure 2: Mixing of concrete.

Figure 3: Testing of beam specimen.

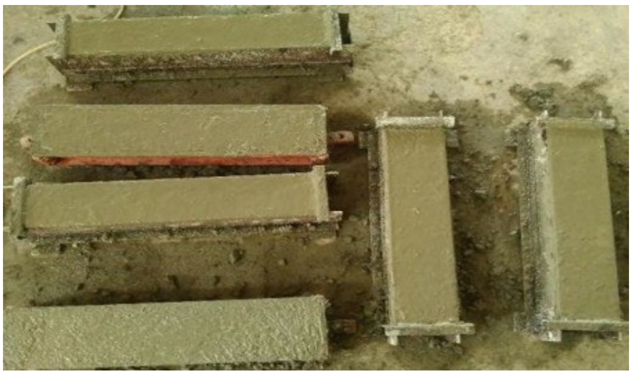

Figure 4: Casting of flexural beams.

Statistical analysis

The concrete's compressive strength grade, the amount of water cement, and the curing days, and analytical differences factors were independent variables used in the study, which was conducted using SPSS (version 21) software. To determine the study's analytical differences variable, independent sample t-tests were used. In order to determine the study's analytical differences variable, the water-to-cement ratio of the concrete's flexural strength grade. The SPSS carried out has a significance of 0.000 ($p < 0.05$). This shows that there is a statistically significant difference between the two groups considered in this study. Figure 5 shows the bar chart. X-axis group statistics of conventional concrete and modified concrete and

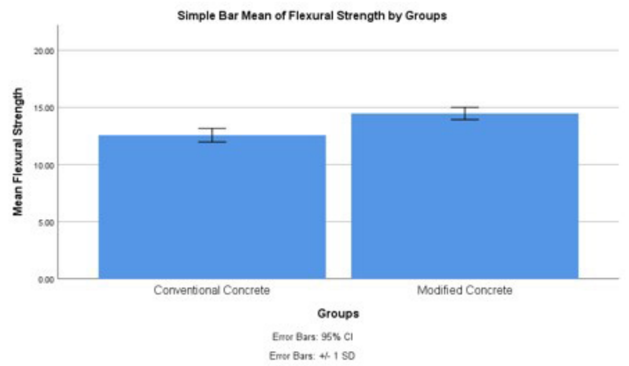

Figure 5: Bar chart shows the X-axis group statistics of conventional concrete and modified concrete, and the Y-axis is about the mean flexural strength of M30 grade concrete and the standard deviation ± 1 and the confidence interval (CI) is about 95%.

the Y-axis is about the mean flexural strength of M30 grade concrete and the standard deviation ± 1 and the CI is about 95%.

Results

The mean flexural strength of conventional concrete was 12.57 N/mm^2 whereas the flexural strength of seashell and eggshell based powder M30 concrete was 14.47 N/mm^2. Table 1 shows the result of flexural strength of the conventional concrete (M30 grade). Table 2 shows the result of flexural strength of seashell and eggshell based powder M30 concrete. The standard deviation of the flexural strength was conventional concrete 0.59330 while the flexural strength of the seashell powder and eggshell concrete was 0.53335. There is a significant difference, because the G-power of p-value was greater than 0.05 i.e., $p = 0.524$. Table 1 shows the flexural strength values of 18 samples with conventional concrete and seashell powder added, while the table shows the flexural strength values of 18 samples without conventional concrete.

Table 3 shows the statistical analysis of comparison conventional concrete and seashell and eggshell concrete. Table 4 shows the independent sample t-test for significant difference $p = 0.000$ as it is smaller than ($p < 0.05$). This shows that there is a statistically significant difference between the two groups considered in this study.

Discussion

The accompanying perceptions were produced using the test directed. The flexural strength of control concrete with halfway substitution of concrete by 15% of seashell powder and 25% of eggshell powder levels and that the flexural strength of substitution by seashell powder and eggshell powder concrete expanded at all times of relieving as contrasted with flexural Strength of control concrete.

Experiment on self-compacted concrete mix with admixtures and compare its performance to standard concrete M30. An examination of the influence of fly ash on eggshell concrete. Eggshell powder concrete experiment with partial substitution of micro silica.

Table 1: Result of flexural strength of the conventional concrete (M30 grade).

S. No.	Mix type	Flexural strength (N/mm^2)	Average flexural strength (N/mm^2)
1	M30 grade conventional concrete	12.14	12.57
2		12.80	
3		12.60	
4		12.40	
5		11.50	
6		12.60	
7		11.80	
8		12.40	
9		13.50	
10		13.40	
11		12.60	
12		12.80	
13		11.80	
14		12.20	
15		13.40	
16		12.40	
17		13.50	
18		12.40	

Table 2: Result of flexural strength of seashell and eggshell based powder M30 concrete.

S. No.	Mix type	Flexural strength (N/mm^2)	Average flexural strength (N/mm^2)
1	Seashell and eggshell based powder M30 concrete	14.74	14.47
2		14.50	
3		14.30	
4		15.00	
5		13.90	
6		13.70	
7		14.40	
8		14.10	
9		14.60	
10		16.00	
11		14.30	
12		13.90	
13		14.40	
14		13.90	
15		14.50	
16		15.00	
17		14.60	
18		14.70	

Table 3: Statistical analysis of comparison conventional concrete and eggshell concrete.

Group	N	Mean	Std. deviation	Std. error mean
Conventional concrete	18	12.5689	0.59330	0.13984
Seashell powder and eggshell concrete	18	14.4744	0.53335	0.12571

The utilization of eggshell debris in substantial creation decreases the expense of unrefined substances and also adds to the development business. Eggshell additionally adds to the

Table 4: For each of the two groups, an independent sample t-test is conducted to determine whether there is a significant difference in strength (p = 0.000) between the two groups, meaning that the difference is less than (p < 0.05). This indicates that the two groups taken into consideration in this study differ statistically significantly.

Load	Levene's test for equality of variances		T-test for equality of means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% CI of the difference	
								Lower	Upper
Equal variance assumed	0.414	0.524	-10.134	34	0.000	-1.90556	0.18804	-2.28770	-1.52341
Equal variance not assumed	-	-	-10.134	33.621	0.000	-1.90556	0.18804	-2.28786	-1.52325

development industry which tends to be lessened in development spending plans with high strength sturdiness of the substantial. In this manner, eggshells can be relevant to the decreased expense of development material and deliver another natural substance for advancement in the development business.

Conclusion

Mean comparative analysis between conventional concrete and seashell and eggshell powder-based concrete of M30 grade was 1.90 N/mm^2 increased in flexural strength compared to conventional concrete. Hence as per flexural strength result seashell powder and eggshell mixed concrete can achieve good results.

Acknowledgements

None.

Conflict of Interest

None.

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