



## Enhancing material performance using rice husk ash; A comparison

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### Abstract

This experimental study aimed to compare two types of concrete: one with rice husk ash (RHA) added and one without. The results indicated that the addition of RHA had minimal impact on the concrete's performance based on the tests conducted. In terms of density, the result shows that the concrete without RHA was 3387 kg/m<sup>3</sup>, while the concrete with RHA had a density of 3385 kg/m<sup>3</sup>. The difference was statistically insignificant (t-stat = 1.56, P > 0.05). For compressive strength the concrete without RHA was 20.96 MPa, and for the RHA-added sample, it was 21.02 MPa and result was statistically insignificant (t-stat = 1.24, P > 0.05). For Flexural Strength, the average flexural strength for the concrete without RHA was 8.39 MPa, while the sample with RHA had a value of 8.61 MPa and result was statistically insignificant (t-stat = 1.53, P > 0.05). In conclusion, the results suggest that the addition of rice husk ash to concrete does not lead to significant differences in most of the performance characteristics tested.

**Keywords:** Experiment, Compressive Strength, Flexural Test.

### INTRODUCTION

Research into enhancing concrete performance through the use of steel fibers and alternative materials like rice husk ash (RHA) holds significant promise. As noted, incorporating steel fibers into concrete, particularly in the form of steel fiber reinforced concrete (SFRC), has been shown to improve key properties such as flexural toughness, tensile strength, and impact resistance. When combined with rice husk ash—a waste material with pozzolanic properties—these improvements could be further enhanced. Rice husk ash, with its fine particles and high silica content, can replace a portion of cement in the mix, potentially boosting concrete's strength, durability, and resistance to chemical attacks, while also reducing the material's environmental footprint.

However, as previous studies, such as those by Eren and Celik (1997), have pointed out, adding fibers or other supplementary materials can affect the workability and other properties

of the concrete mix. Therefore, it is essential to find the right balance when combining steel fibers with rice husk ash to ensure that workability and strength are optimized. Your study, which explores how steel fibers influence the mechanical properties of rice husk ash concrete (such as modulus of elasticity, splitting tensile strength, flexural tensile strength, and compressive strength), will contribute valuable insights into the interaction between these materials and help determine the best mix proportions for specific applications. This research could play a key role in advancing the development of more durable and sustainable concrete for future construction.

### **EXPERIMENT DESIGN**

The study employed an experimental design in which two distinct samples were prepared: one consisting of rice husk ash concrete and the other without rice husk ash. Both samples were subjected to a series of tests to evaluate their performance. The materials used in the study are detailed as follows:

**Rice Husk Ash:** The rice husk ash had a specific gravity of 1.95 and a bulk density of 0.835 g/cc.

**Portland Cement:** The Portland cement used in the study had a specific gravity of 4.12, with an initial setting time of 135 minutes and a final setting time of 210 minutes.

**Steel Fiber:** Low-carbon, hooked-end steel fibers were selected, with a length of 35 mm, a diameter of 0.75 mm, a density of 8.43 g/cm<sup>3</sup>, and an aspect ratio of 60.

**Workability:** To ensure the workability of the fresh concrete, a commercial AC Green slump additive was used, with the amount kept constant at 1% of the binder content by mass.

**Fine Aggregate:** High-quality river sand was utilized as the fine aggregate. It had a dry density of 1735 kg/m<sup>3</sup>, a specific gravity of 2.87, and a fineness modulus of 2.45. The sand passed through a 20 mm sieve, and the material retained on a 10 mm sieve had a dry density of 1475 kg/m<sup>3</sup> and a specific gravity of 3.2.

These materials were selected with care to assess the effects of rice husk ash and steel fibers on the properties of concrete.

#### **Mixture Composition and Preparation**

The study adopted a mix design for M10 and M20 grade concrete. The water-cement ratios were maintained at 0.45 for M20 and 0.4 for M10, while the binder content was kept constant at 430 kg/m<sup>3</sup> for M20 and 360 kg/m<sup>3</sup> for M10. The weight of the aggregates was calculated based on their volume. Variations were introduced by replacing a portion of the Portland cement with rice husk ash, with the rice husk content ranging from 5% to 20%. Additionally, steel fiber reinforced concrete mixes were prepared, with steel fiber volumes varying from 0.30% to 2%. The aggregate weight per cubic meter was adjusted accordingly to accommodate these changes.

The process for mixing fiber-reinforced concrete began by adding sand and gravel to the dry mix, which was then blended in a concrete mixer for approximately 90 seconds. Water was gradually introduced and mixed for about 180 seconds. After that, the remaining plasticizer and water were added, and the mixture was further blended. The concrete was poured into specific molds and vibrated to remove any trapped air. The molds were left to rest for 24 hours before being demolded.

#### **Testing Method**

The experimental study focused on evaluating the properties of fiber-reinforced rice husk ash concrete. The testing process included the use of a slump cone and various tests to assess compressive strength, flexural strength, and splitting tensile strength. Two distinct sample sets were prepared: Sample 1, which contained rice husk ash, and Sample 2, which did not. A total of 36 sub-samples were collected at different time intervals to ensure the accuracy and reliability of the results.

### **RESULTS**

Table 1  
Unit Weight and Workability

No.	Without Rice Husk Ash			With Rice Husk Ash		
	Sample Kg/M3	1-Density V-B	Sample 1-Slump (cm)	Sample Kg/M3	2-Density 2-V-B	Sample 2-Slump (cm)
S1	3499	5.5	19	3591	7.5	21
S2	3455	5.8	15	3575	7.3	20
S3	3489	5.1	16	3573	8.2	19
S4	3467	5.9	19	3542	8.4	19
S5	3455	6.3	21	3571	8.5	17
S6	3421	6.4	21	3401	8.7	20
S7	3431	6.9	23	3412	7.9	18
S8	3441	6.1	21	3381	9.1	17
S9	3456	6.2	19	3373	8.3	16
S10	3423	6.4	17	3362	8.5	16
S11	3367	6.5	16	3342	8.5	16
S12	3367	6.5	15	3363	8.4	17
S13	3345	7.2	12	3383	8.3	17
S14	3451	7.7	11	3391	7.6	17
S15	3376	8.4	10	3382	8.4	20
S16	3391	8.9	11	3373	8.9	18
S17	3331	9.1	13	3363	8.4	18
S18	3313	9.3	12	3351	7.5	17
S19	3357	9.6	11	3361	7.3	16
S20	3343	9.9	9	3391	7.2	15
S21	3331	10.1	8	3363	7.3	18
S22	3332	10.2	10	3343	7.1	17
S23	3390	10.6	9	3372	8.3	18
S24	3388	10.9	9	3383	8.8	18
S25	3365	9.6	9	3392	8.9	18
S26	3363	9.3	9	3301	8.4	18
S27	3352	9.1	10	3313	8.2	16
S28	3312	8.6	11	3132	7.4	17
S29	3363	8.2	12	3343	7.8	17
S30	3351	8.1	10	3312	7.5	16
S31	3334	7.9	11	3333	7.9	18
S32	3395	7.6	12	3334	7.5	21
S33	3346	7.5	10	3315	7.2	21
S34	3377	7.2	11	3380	7.3	21
S35	3379	7.1	11	3396	7.7	20
S36	3390	6.9	11	3393	8.3	21
<b>Ave</b>	<b>3387</b>			<b>3385</b>		

In total, two main samples were prepared: one without rice husk ash and the other with rice husk ash. For each main sample, 36 sub-samples were created. The density measurements for both sets of samples were as follows:

- **Sample 1:** Density excluded sample = 3499 kg/m<sup>3</sup>; Density included sample = 3591 kg/m<sup>3</sup>
- **Sample 2:** Density excluded sample = 3455 kg/m<sup>3</sup>; Density included sample = 3575 kg/m<sup>3</sup>
- **Sample 3:** Density excluded sample = 3489 kg/m<sup>3</sup>; Density included sample = 3573 kg/m<sup>3</sup>
- **Sample 4:** Density excluded sample = 3467 kg/m<sup>3</sup>; Density included sample = 3542 kg/m<sup>3</sup>
- **Sample 5:** Density excluded sample = 2456 kg/m<sup>3</sup>; Density included sample = 2578 kg/m<sup>3</sup>
- **Sample 6:** Density excluded sample = 3421 kg/m<sup>3</sup>; Density included sample = 3401 kg/m<sup>3</sup>
- **Sample 7:** Density excluded sample = 3431 kg/m<sup>3</sup>; Density included sample = 3412 kg/m<sup>3</sup>
- **Sample 8:** Density excluded sample = 3441kg/m<sup>3</sup>; Density included sample = 3381 kg/m<sup>3</sup>
- **Sample 9:** Density excluded sample = 3456 kg/m<sup>3</sup>; Density included sample = 3373 kg/m<sup>3</sup>
- **Sample 10:** Density excluded sample = 3423kg/m<sup>3</sup>; Density included sample = 3362 kg/m<sup>3</sup>
- **Sample 11:** Density excluded sample = 3367 kg/m<sup>3</sup>; Density included sample = 3342 kg/m<sup>3</sup>
- **Sample 12:** Density excluded sample = 3367 kg/m<sup>3</sup>; Density included sample = 3363 kg/m<sup>3</sup>
- **Sample 13:** Density excluded sample = 3345 kg/m<sup>3</sup>; Density included sample = 3383kg/m<sup>3</sup>
- **Sample 14:** Density excluded sample = 3451 kg/m<sup>3</sup>; Density included sample = 3391 kg/m<sup>3</sup>
- **Sample 15:** Density excluded sample = 3376 kg/m<sup>3</sup>; Density included sample = 3382 kg/m<sup>3</sup>
- **Sample 16:** Density excluded sample = 3391 kg/m<sup>3</sup>; Density included sample = 3373 kg/m<sup>3</sup>
- **Sample 17:** Density excluded sample = 3331 kg/m<sup>3</sup>; Density included sample = 3363 kg/m<sup>3</sup>
- **Sample 18:** Density excluded sample = 3313 kg/m<sup>3</sup>; Density included sample = 3351 kg/m<sup>3</sup>
- **Sample 19:** Density excluded sample = 3357 kg/m<sup>3</sup>; Density included sample = 3361 kg/m<sup>3</sup>
- **Sample 20:** Density excluded sample = 3343kg/m<sup>3</sup>; Density included sample = 3391 kg/m<sup>3</sup>
- **Sample 21:** Density excluded sample = 3331 kg/m<sup>3</sup>; Density included sample = 3363 kg/m<sup>3</sup>
- **Sample 22:** Density excluded sample = 3332 kg/m<sup>3</sup>; Density included sample = 3343 kg/m<sup>3</sup>
- **Sample 23:** Density excluded sample = 3390 kg/m<sup>3</sup>; Density included sample = 3372 kg/m<sup>3</sup>
- **Sample 24:** Density excluded sample = 3388 kg/m<sup>3</sup>; Density included sample = 3383 kg/m<sup>3</sup>
- **Sample 25:** Density excluded sample = 3365 kg/m<sup>3</sup>; Density included sample = 3392 kg/m<sup>3</sup>

- **Sample 26:** Density excluded sample = 3363 kg/m<sup>3</sup>; Density included sample = 3301 kg/m<sup>3</sup>
- **Sample 27:** Density excluded sample = 3352 kg/m<sup>3</sup>; Density included sample = 3313 kg/m<sup>3</sup>
- **Sample 28:** Density excluded sample = 3312 kg/m<sup>3</sup>; Density included sample = 3132 kg/m<sup>3</sup>
- **Sample 29:** Density excluded sample = 3363 kg/m<sup>3</sup>; Density included sample = 3343 kg/m<sup>3</sup>
- **Sample 30:** Density excluded sample = 3351 kg/m<sup>3</sup>; Density included sample = 3312kg/m<sup>3</sup>
- **Sample 31:** Density excluded sample = 3334 kg/m<sup>3</sup>; Density included sample = 3333 kg/m<sup>3</sup>
- **Sample 32:** Density excluded sample = 3395 kg/m<sup>3</sup>; Density included sample = 3334 kg/m<sup>3</sup>
- **Sample 33:** Density excluded sample = 3346 kg/m<sup>3</sup>; Density included sample = 3315 kg/m<sup>3</sup>
- **Sample 34:** Density excluded sample = 3377 kg/m<sup>3</sup>; Density included sample = 3380 kg/m<sup>3</sup>
- **Sample 35:** Density excluded sample = 3379 kg/m<sup>3</sup>; Density included sample = 3396 kg/m<sup>3</sup>
- **Sample 36:** Density excluded sample = 3390 kg/m<sup>3</sup>; Density with rice husk ash = 3393 kg/m<sup>3</sup>

The average density for the samples without rice husk ash was 3387 kg/m<sup>3</sup>, while the average density for the samples with rice husk ash was 3385 kg/m<sup>3</sup>, showing negligible variation. A statistical test (t-stat = 0.891, P > 0.05) revealed that this difference was statistically insignificant.

The results for the V-B (Vebe consistency) test are as follows for each sample:

- **Sample 1:** V-B without rice husk ash = 6.5; V-B with rice husk ash = 7.5
- **Sample 2:** V-B without rice husk ash = 6.8; V-B with rice husk ash = 7.3
- **Sample 3:** V-B without rice husk ash = 6.1; V-B with rice husk ash = 8.2
- **Sample 4:** V-B without rice husk ash = 6.4; V-B with rice husk ash = 8.4
- **Sample 5:** V-B without rice husk ash = 7.3; V-B with rice husk ash = 8.5
- **Sample 6:** V-B without rice husk ash = 7.4; V-B with rice husk ash = 8.7
- **Sample 7:** V-B without rice husk ash = 7.9; V-B with rice husk ash = 7.9
- **Sample 8:** V-B without rice husk ash = 7.4; V-B with rice husk ash = 9.1
- **Sample 9:** V-B without rice husk ash = 8.2; V-B with rice husk ash = 8.3
- **Sample 10:** V-B without rice husk ash = 7.4; V-B with rice husk ash = 8.5
- **Sample 11:** V-B without rice husk ash = 7.5; V-B with rice husk ash = 8.5
- **Sample 12:** V-B without rice husk ash = 7.5; V-B with rice husk ash = 8.4
- **Sample 13:** V-B without rice husk ash = 8.2; V-B with rice husk ash = 8.3
- **Sample 14:** V-B without rice husk ash = 8.7; V-B with rice husk ash = 7.6
- **Sample 15:** V-B without rice husk ash = 8.4; V-B with rice husk ash = 8.4
- **Sample 16:** V-B without rice husk ash = 8.9; V-B with rice husk ash = 8.9
- **Sample 17:** V-B without rice husk ash = 9.1; V-B with rice husk ash = 8.4
- **Sample 18:** V-B without rice husk ash = 9.2; V-B with rice husk ash = 7.5
- **Sample 19:** V-B without rice husk ash = 9.4; V-B with rice husk ash = 7.3
- **Sample 20:** V-B without rice husk ash = 9.4; V-B with rice husk ash = 7.2
- **Sample 21:** V-B without rice husk ash = 9.3; V-B with rice husk ash = 7.3
- **Sample 22:** V-B without rice husk ash = 9.9; V-B with rice husk ash = 7.1
- **Sample 23:** V-B without rice husk ash = 9.8; V-B with rice husk ash = 8.3

- **Sample 24:** V-B without rice husk ash = 9.1; V-B with rice husk ash = 8.8
- **Sample 25:** V-B without rice husk ash = 9.4; V-B with rice husk ash = 8.9
- **Sample 26:** V-B without rice husk ash = 9.2; V-B with rice husk ash = 8.4
- **Sample 27:** V-B without rice husk ash = 9.4; V-B with rice husk ash = 8.2
- **Sample 28:** V-B without rice husk ash = 9.1; V-B with rice husk ash = 7.4
- **Sample 29:** V-B without rice husk ash = 8.9; V-B with rice husk ash = 7.8
- **Sample 30:** V-B without rice husk ash = 8.7; V-B with rice husk ash = 7.5
- **Sample 31:** V-B without rice husk ash = 8.4; V-B with rice husk ash = 7.9
- **Sample 32:** V-B without rice husk ash = 8.2; V-B with rice husk ash = 7.5
- **Sample 33:** V-B without rice husk ash = 8.1; V-B with rice husk ash = 7.2
- **Sample 34:** V-B without rice husk ash = 8.5; V-B with rice husk ash = 7.3
- **Sample 35:** V-B without rice husk ash = 7.9; V-B with rice husk ash = 7.7
- **Sample 36:** V-B without rice husk ash = 7.4; V-B with rice husk ash = 8.3

A statistical analysis showed that the difference between the two sets of samples was not significant (t-stat = 1.562,  $P > 0.05$ ).

The results for the slump test are as follows for each sample:

- **Sample 1:** Slump without rice husk ash = 19; Slump with rice husk ash = 21
- **Sample 2:** Slump without rice husk ash = 15; Slump with rice husk ash = 20
- **Sample 3:** Slump without rice husk ash = 16; Slump with rice husk ash = 19
- **Sample 4:** Slump without rice husk ash = 19; Slump with rice husk ash = 19
- **Sample 5:** Slump without rice husk ash = 21; Slump with rice husk ash = 17
- **Sample 6:** Slump without rice husk ash = 21; Slump with rice husk ash = 20
- **Sample 7:** Slump without rice husk ash = 23; Slump with rice husk ash = 18
- **Sample 8:** Slump without rice husk ash = 21; Slump with rice husk ash = 17
- **Sample 9:** Slump without rice husk ash = 19; Slump with rice husk ash = 16
- **Sample 10:** Slump without rice husk ash = 17; Slump with rice husk ash = 16
- **Sample 11:** Slump without rice husk ash = 16; Slump with rice husk ash = 16
- **Sample 12:** Slump without rice husk ash = 15; Slump with rice husk ash = 17
- **Sample 13:** Slump without rice husk ash = 12; Slump with rice husk ash = 17
- **Sample 14:** Slump without rice husk ash = 11; Slump with rice husk ash = 17
- **Sample 15:** Slump without rice husk ash = 10; Slump with rice husk ash = 20
- **Sample 16:** Slump without rice husk ash = 11; Slump with rice husk ash = 18
- **Sample 17:** Slump without rice husk ash = 13; Slump with rice husk ash = 18
- **Sample 18:** Slump without rice husk ash = 12; Slump with rice husk ash = 17
- **Sample 19:** Slump without rice husk ash = 11; Slump with rice husk ash = 16
- **Sample 20:** Slump without rice husk ash = 9; Slump with rice husk ash = 15
- **Sample 21:** Slump without rice husk ash = 8; Slump with rice husk ash = 18
- **Sample 22:** Slump without rice husk ash = 10; Slump with rice husk ash = 17
- **Sample 23:** Slump without rice husk ash = 9; Slump with rice husk ash = 18
- **Sample 24:** Slump without rice husk ash = 9; Slump with rice husk ash = 18
- **Sample 25:** Slump without rice husk ash = 9; Slump with rice husk ash = 18
- **Sample 26:** Slump without rice husk ash = 9; Slump with rice husk ash = 18
- **Sample 27:** Slump without rice husk ash = 10; Slump with rice husk ash = 16
- **Sample 28:** Slump without rice husk ash = 11; Slump with rice husk ash = 17
- **Sample 29:** Slump without rice husk ash = 12; Slump with rice husk ash = 17
- **Sample 30:** Slump without rice husk ash = 10; Slump with rice husk ash = 16
- **Sample 31:** Slump without rice husk ash = 11; Slump with rice husk ash = 18
- **Sample 32:** Slump without rice husk ash = 12; Slump with rice husk ash = 21
- **Sample 33:** Slump without rice husk ash = 10; Slump with rice husk ash = 22
- **Sample 34:** Slump without rice husk ash = 11; Slump with rice husk ash = 21

- **Sample 35:** Slump without rice husk ash = 11; Slump with rice husk ash = 20
- **Sample 36:** Slump without rice husk ash = 11; Slump with rice husk ash = 21

The statistical difference between these two groups was found to be significant (t-stat = 2.675, P < 0.05). This suggests that the addition of rice husk ash significantly influenced the slump of the concrete.

### Compressive Strength

The compressive strength test was conducted over a period of 4 weeks. The results are as follows:

Table 2

*Compressive Strength Comparison*

No.	Sample 1- Compressive Strength- Without Rice Husk Ash	Sample 2-Compressive Strength- With Rice Husk Ash
S1	21.56	19.56
S2	23.19	20.32
S3	19.43	20.43
S4	19.9	19.56
S5	19.4	20.43
S6	21.56	20.32
S7	21.34	20.04
S8	21.56	20.41
S9	23.34	20.44
S10	23.56	19.46
S11	23.76	19.73
S12	21.23	19.68
S13	21.55	19.33
S14	23.87	19.49
S15	21.9	19.72
S16	18.67	19.43
S17	19.03	21.43
S18	19.56	21.99
S19	18.55	21.45
S20	19.34	22.37
S21	18.65	22.56
S22	19.34	22.66
S23	18.77	22.33
S24	19.33	22.89
S25	18.43	22.55
S26	19.56	21.66
S27	19.43	21.63
S28	19.34	21.98
S29	21.56	21.55
S30	21.55	21.77
S31	21.67	21.45
S32	21.52	21.66
S33	21.9	21.53
S34	23.34	21.66
S35	23.56	21.43

S36	24.32	21.56
<b>Average</b>	<b>20.96</b>	<b>21.02</b>

The results for compressive strength are as follows:

- Sample 1: Excluded sample = 21.56, Included sample = 19.56
- Sample 2: Excluded sample = 23.19, Included sample = 20.32
- Sample 3: Excluded sample = 19.43, Included sample = 20.43
- Sample 4: Excluded sample = 19.9, Included sample = 19.56
- Sample 5: Excluded sample = 19.4, Included sample = 20.43
- Sample 6: Excluded sample = 21.56, Included sample = 20.32
- Sample 7: Excluded sample = 21.34, Included sample = 20.04
- Sample 8: Excluded sample = 21.56, Included sample = 20.41
- Sample 9: Excluded sample = 23.34, Included sample = 20.44
- Sample 10: Excluded sample = 23.56, Included sample = 19.46
- Sample 11: Excluded sample = 23.76, Included sample = 19.73
- Sample 12: Excluded sample = 21.23, Included sample = 19.68
- Sample 13: Excluded sample = 21.55, Included sample = 19.33
- Sample 14: Excluded sample = 23.87, Included sample = 19.49
- Sample 15: Excluded sample = 21.9, Included sample = 19.72
- Sample 16: Excluded sample = 18.67, Included sample = 19.43
- Sample 17: Excluded sample = 19.03, Included sample = 21.43
- Sample 18: Excluded sample = 19.56, Included sample = 21.99
- Sample 19: Excluded sample = 18.55, Included sample = 21.45
- Sample 20: Excluded sample = 19.34, Included sample = 22.37
- Sample 21: Excluded sample = 18.65, Included sample = 22.56
- Sample 22: Excluded sample = 19.34, Included sample = 22.66
- Sample 23: Excluded sample = 18.77, Included sample = 22.33
- Sample 24: Excluded sample = 19.33, Included sample = 22.89
- Sample 25: Excluded sample = 18.43, Included sample = 22.55
- Sample 26: Excluded sample = 19.56, Included sample = 21.66
- Sample 27: Excluded sample = 19.43, Included sample = 21.63
- Sample 28: Excluded sample = 19.34, Included sample = 21.98
- Sample 29: Excluded sample = 21.56, Included sample = 21.55
- Sample 30: Excluded sample = 21.55, Included sample = 21.77
- Sample 31: Excluded sample = 21.67, Included sample = 21.45
- Sample 32: Excluded sample = 21.52, Included sample = 21.66
- Sample 33: Excluded sample = 21.9, Included sample = 21.53
- Sample 34: Excluded sample = 23.34, Included sample = 21.66
- Sample 35: Excluded sample = 23.56, Included sample = 21.43
- Sample 36: Excluded sample = 24.32, Included sample = 21.56

On average, the excluded samples exhibited higher compressive strength than the included samples. However, the difference was statistically insignificant (t-value = 1.24, P > 0.05).

### ***Flexural Tensile Strength***

The flexural tensile strength test was conducted on steel fiber reinforced concrete, both with and without rice husk ash.

Table 3  
*Flexural Strength Comparison*

No.	Sample 1-Flexural	Sample 2-Flexural
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	<b>Strength</b>	<b>Strength</b>
S1	8.46	8.46
S2	8.64	8.42
S3	8.64	8.64
S4	7.8	8.46
S5	8.6	8.64
S6	9.12	8.42
S7	8.46	8.06
S8	8.64	8.61
S9	8.55	8.66
S10	8.32	8.66
S11	8.66	8.64
S12	8.8	8.68
S13	8.44	8.41
S14	8.86	8.68
S15	8.8	8.62
S16	8.66	8.64
S17	8.04	8.64
S18	8.46	8.88
S19	8.44	8.64
S20	6.46	9.46
S21	8.41	8.46
S22	8.46	8.66
S23	8.66	8.44
S24	6.44	8.88
S25	9.01	8.44
S26	6.64	8.66
S27	8.64	8.64
S28	9.09	8.88
S29	8.64	8.44
S30	8.32	8.66
S31	8.66	8.64
S32	8.42	8.66
S33	8.8	8.44
S34	8.46	8.66
S35	8.46	8.64
S36	8.42	8.46
<b>Average</b>	<b>8.39</b>	<b>8.61</b>

The results of the flexural strength test are as follows:

Sample 1: The flexural strength for the excluded sample was 8.46, and for the included sample, it was 8.46.

Sample 2: The flexural strength for the excluded sample was 8.64, and for the included sample, it was 8.64.

Sample 3: The flexural strength for the excluded sample was 8.64, and for the included sample, it was 8.65.

Sample 4: The flexural strength for the excluded sample was 7.8, and for the included sample, it was 8.46.

Sample 5: The flexural strength for the excluded sample was 8.6, and for the included sample, it was 8.64.

Sample 6: The flexural strength for the excluded sample was 9.12, and for the included sample, it was 8.42.

Sample 7: The flexural strength for the excluded sample was 8.46, and for the included sample, it was 8.06.

Sample 8: The flexural strength for the excluded sample was 8.64, and for the included sample, it was 8.61.

Sample 9: The flexural strength for the excluded sample was 8.55, and for the included sample, it was 8.66.

Sample 10: The flexural strength for the excluded sample was 8.32, and for the included sample, it was 8.66.

Sample 11: The flexural strength for the excluded sample was 9.76, and for the included sample, it was 8.66.

Sample 12: The flexural strength for the excluded sample was 8.8, and for the included sample, it was 8.68.

Sample 13: The flexural strength for the excluded sample was 8.44, and for the included sample, it was 8.41.

Sample 14: The flexural strength for the excluded sample was 8.86, and for the included sample, it was 8.68.

Sample 15: The flexural strength for the excluded sample was 8.8, and for the included sample, it was 8.62.

Sample 16: The flexural strength for the excluded sample was 8.66, and for the included sample, it was 8.64.

Sample 17: The flexural strength for the excluded sample was 8.04, and for the included sample, it was 8.64.

Sample 18: The flexural strength for the excluded sample was 8.46, and for the included sample, it was 8.88.

Sample 19: The flexural strength for the excluded sample was 8.44, and for the included sample, it was 8.64.

Sample 20: The flexural strength for the excluded sample was 6.46, and for the included sample, it was 9.46.

Sample 21: The flexural strength for the excluded sample was 8.41, and for the included sample, it was 8.46.

Sample 22: The flexural strength for the excluded sample was 8.46, and for the included sample, it was 8.66.

Sample 23: The flexural strength for the excluded sample was 8.66, and for the included sample, it was 8.44.

Sample 24: The flexural strength for the excluded sample was 6.44, and for the included sample, it was 8.88.

Sample 25: The flexural strength for the excluded sample was 9.01, and for the included sample, it was 8.44.

Sample 26: The flexural strength for the excluded sample was 6.64, and for the included sample, it was 8.66.

Sample 27: The flexural strength for the excluded sample was 8.64, and for the included sample, it was 8.64.

Sample 28: The flexural strength for the excluded sample was 9.09, and for the included sample, it was 8.88.

Sample 29: The flexural strength for the excluded sample was 8.64, and for the included sample, it was 8.44.

Sample 30: The flexural strength for the excluded sample was 8.32, and for the included sample, it was 8.66.

Sample 31: The flexural strength for the excluded sample was 8.66, and for the included sample, it was 9.65.

Sample 32: The flexural strength for the excluded sample was 8.42, and for the included sample, it was 8.66.

Sample 33: The flexural strength for the excluded sample was 8.8, and for the included sample, it was 8.44.

Sample 34: The flexural strength for the excluded sample was 8.46, and for the included sample, it was 8.66.

Sample 35: The flexural strength for the excluded sample was 8.46, and for the included sample, it was 8.64.

Sample 36: The flexural strength for the excluded sample was 8.42, and for the included sample, it was 8.46.

The average flexural strength for the excluded sample was 8.39, while for the included sample, it was 8.61. The difference in flexural strength between the excluded and included samples was statistically insignificant ( $t\text{-stat} = 1.53, P > 0.05$ ).

### CONCLUSION

The study was experimental in nature, designed to evaluate the impact of incorporating rice husk ash into concrete. Two sample groups were established: one containing rice husk ash and the other without. A range of tests, including compressive strength, flexural strength, and splitting tensile strength, were performed. The results showed that there were no significant differences between the two groups, as most of the outcomes were quite similar. Consequently, it was concluded that adding rice husk ash to concrete does not result in any substantial changes.

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