INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN APPLIED SCIENCE (IJRIAS)
ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VIII August 2026

Utilization of Waste Oyster Shell in Concrete: Effect of Conplast Sp430 on Compressive Strength

Ojo Bamidele Samuel., Adeleke Ademola Olufemi

Department of Building Technology, Moshood Abiola Polytechnic, Abeokuta, Ogun State, Nigeria

DOI: https://doi.org/10.51584/IJRIAS.2026.11080026

Received: 17 August 2026; Accepted: 22 August 2026; Published: 31 August 2026

ABSTRACT

The depletion of natural sand and the accumulation of oyster shell [OS] waste in coastal regions have necessitated the search for sustainable alternatives in concrete production. This study investigates the effect of partial replacement of fine aggregate with OS and the addition of Conplast SP430 superplasticizer [SP] on the workability and compressive strength of concrete. Fine aggregate was replaced with OS at 0%, 5%, 10%, 15%, and 20%, while SP was added at 0%, 0.5%, and 1.0% by weight of cement. A total of 13 mix combinations were prepared using a 1:2:4 mix ratio and 0.6 water-cement ratio. Slump and compressive strength tests were conducted at 7, 14, and 28 days of curing. Results showed that the inclusion of SP significantly improved workability, with the highest slump of 500 mm recorded at 20% OS + 0.5% SP. Compressive strength increased with curing age for all mixes. The optimum performance was achieved at 5% OS + 0.5% SP, which recorded the highest 28-day compressive strength of 31.63 N/mm², representing a 57.8% increase over the control. The study concludes that the combined use of OS and SP is effective for producing sustainable concrete with enhanced mechanical properties.

Keywords: Oyster shell; Superplasticizer; Compressive strength; Workability; Sustainable concrete

INTRODUCTION

Concrete is a composite construction material consisting of cement, water, fine aggregate, coarse aggregate, and chemical admixtures. It remains the most widely utilized material in civil infrastructure due to its versatility, durability, and availability. However, the increasing demand for concrete has led to the excessive extraction of natural sand and granite, resulting in environmental degradation and increased material costs. This has necessitated research into alternative materials that can partially replace conventional aggregates without compromising structural performance [6], [13].

Oyster shell [OS] is a calcium carbonate-rich biowaste generated in large quantities in coastal regions. The indiscriminate disposal of OS poses environmental challenges, while its utilization in concrete offers a dual benefit of waste management and conservation of natural resources. Due to its hardness and particle morphology, crushed OS has been investigated as a potential partial replacement for fine and coarse aggregate [10], [7].

Superplasticizers [SP] are high-range water-reducing admixtures commonly employed to enhance the rheological and mechanical properties of concrete. They function by adsorbing onto cement particles and inducing dispersion, thereby reducing the water demand while maintaining the required workability [11], [15]. The use of SP in concrete containing alternative aggregates is particularly relevant, as it can mitigate the adverse effects of irregular particle shape and high water absorption often associated with waste materials.

Compressive strength is a fundamental property used to assess the structural adequacy and quality of concrete. Several studies have examined the combined effect of OS and SP in concrete. [12] (2019) reported that the inclusion of SP in OS concrete improved workability; however, a marginal reduction in compressive strength of up to 10% was observed. [8] (2020) demonstrated that replacing up to 25% of granite with OS, in conjunction with SP, produced compressive strength comparable to conventional concrete. [9] (2019) found that a SP dosage of 0.5% by weight of cement yielded optimum compressive strength.

Despite these contributions, comprehensive data on the combined influence of varying OS replacement levels and SP dosages on the compressive strength of concrete under a fixed mix proportion remain limited. Therefore, this study investigates the compressive strength and workability of concrete in which fine aggregate is partially replaced with OS at 0%, 5%, 10%, 15%, and 20%, and SP is incorporated at 0%, 0.5%, and 1.0% by weight of cement. The objective is to determine the optimum combination for producing sustainable concrete with adequate mechanical performance.

MATERIALS AND METHODS

Materials

The materials used in this study are summarized in Table 1.

Table 1: Properties of materials used

Material	**Source/Description**	**Standard/Property**
Cement	Ordinary Portland Cement, Grade 42.5N	NIS 444-1:2018
Fine Aggregate	Natural river sand, washed and air-dried with specific gravity of 2.65	BS 812:1995
Coarse Aggregate	Crushed granite, max size 20mm, specific gravity 2.70	BS 882:1992
Oyster Shell	Crushed waste oyster shell, sieved < 4.75mm Specific Gravity of 2.58 and water absorption of 2.10	[8] (2020) reported 1.8 – 2.6
Superplasticizer	Conplast SP430, Polycarboxylate-based HRWR	ASTM C494-19 Type F
Water	Potable tap water	Free from impurities

Mix Proportion and Specimen Preparation

A concrete mix ratio of 1:2:4 with a water-cement ratio of 0.6 was adopted. Fine aggregate was partially replaced with OS at 5%, 10%, 15%, and 20%. Conplast SP430 was added at 0.5% and 1.0% by weight of cement. The mix details are presented in Table 2.

Table 2: Mix designations

Mix ID	**OS %**	**SP %**	**Cement : Sand : Granite**
CM	0	0	1 : 2.0 : 4
SA	5	0	1 : 1.9 : 4
SB	5	0.5	1 : 1.9 : 4
SC	5	1.0	1 : 1.9 : 4
AA	10	0	1 : 1.8 : 4
AB	10	0.5	1 : 1.8 : 4

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VIII August 2026

AC	10	1.0	1 : 1.8 : 4
BA	15	0	1 : 1.7 : 4
BB	15	0.5	1 : 1.7 : 4
BC	15	1.0	1 : 1.7 : 4
CA	20	0	1 : 1.6 : 4
CB	20	0.5	1 : 1.6 : 4
CC	20	1.0	1 : 1.6 : 4

For each mix, 150 mm × 150 mm × 150 mm concrete cubes were cast. Batching was done by weight. SP was pre-diluted in mixing water and added to the mix. Specimens were demolded after 24 hours and cured in water at 25 ± 2 °C until testing.

Testing Procedures

Slump test was conducted in accordance with BS EN 12350-2:2019. Compressive strength test was carried out at 7, 14, and 28 days using a 2000 kN compression machine at 0.3 N/mm²/s loading rate as per BS EN 12390-3:2019. Three specimens were tested at each age and the average was reported.

RESULTS AND DISCUSSION

Workability

The results indicate that SP significantly improved workability. The highest slump of 500 mm was recorded at 20% OS + 0.5% SP as shows in table 3.

Table 3: Slump values of concrete mixes

Mix ID	**OS %**	**SP %**	**Slump (mm)**
CM	0	0	60
SA	5	0	50
SB	5	0.5	70
SC	5	1.0	100
AA	10	0	60
AB	10	0.5	150
AC	10	1.0	130
BA	15	0	150
BB	15	0.5	40
BC	15	1.0	200

CA	20	0	400
CB	20	0.5	500
CC	20	1.0	70

Compressive Strength

Figure 1 shows the effect of conplast SP430 on compressive strength of oyster shell concrete. The compressive strength increased with age. Without SP, 15% OS [BA] gave the highest strength. With SP, 0.5% dosage was optimum. Mix SB [5% OS + 0.5% SP] achieved the highest 28-day strength of 31.63 N/mm², a 57.8% increase over control. This agrees with [9] (2019) and [8] (2020). Higher SP dosage of 1.0% at high OS content caused strength reduction, likely due to segregation.

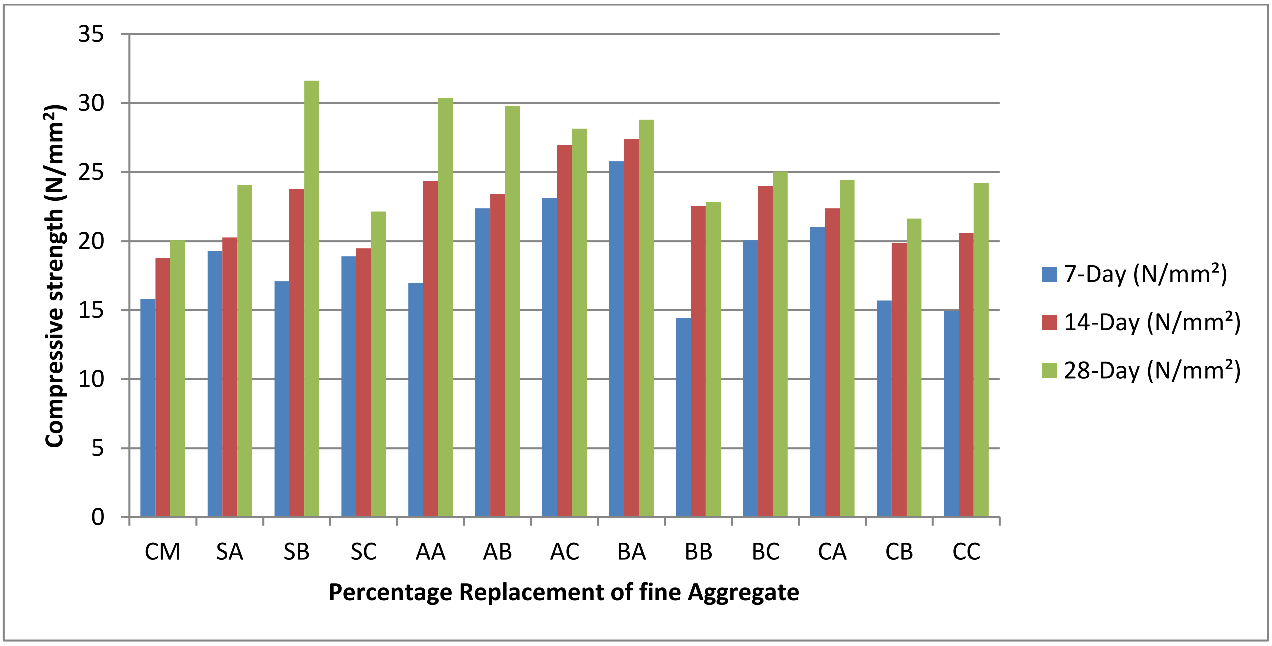

Figure 1: Effect of Conplast SP430 on Compressive Strength of Oyster Shell Concrete

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the experimental results, the following conclusions are drawn:

1. The inclusion of Conplast SP430 significantly improved the workability of OS concrete. A maximum slump of 500 mm was obtained at 20% OS + 0.5% SP.

2. Partial replacement of fine aggregate with OS up to 15% improved compressive strength. Mix BA [15% OS, 0% SP] recorded 28.81 N/mm² at 28 days.

3. The synergistic effect of 5% OS + 0.5% SP [SB] produced the optimum 28-day compressive strength of 31.63 N/mm².

4. Higher SP dosage of 1.0% at 15% and 20% OS replacement led to reduced strength.

The study demonstrates that waste oyster shell can be effectively utilized as partial fine aggregate replacement with Conplast SP430 to produce sustainable concrete with enhanced properties.

Recommendations

1. A combination of 5% OS replacement and 0.5% Conplast SP430 is recommended for structural lightweight concrete.

2. Further research should investigate the durability properties and microstructure of OS concrete with SP.

3. Policy makers should promote the utilization of OS waste in construction to reduce environmental impact.

REFERENCES

1. ASTM international, (2019). ASTM C494/C494M-19 Standard specification for chemical admixtures for concrete. West Conshohocken, PA: ASTM.
2. British Standards Institution, (1992). BS 882:1992 Specification for aggregates from natural sources for concrete. London: BSI.
3. British Standards Institution, (1995). BS 812-2:1995 Testing aggregates. Methods for determination of density. London: BSI.
4. British Standards Institution. (2019). BS EN 12350-2:2019 Testing fresh concrete. Slump test (British Standard). BSI.
5. British Standards Institution. (2019). BS EN 12390-3:2019 Testing hardened concrete. Compressive strength of test specimens (British Standard). BSI.
6. Dhir, R. K., & Hewlett, P. C. (2020). Concrete technology (3rd ed.). Elsevier.
7. Hay, M. E., & Pennings, S. C. (2019). Oyster shell structure and function. Journal of Shellfish Research, 38(2), 215–228.
8. Hossain, M. M., Karim, M. R., Hossain, M. K., Islam, M. N., & Zain, M. F. M. (2020). Durability of mortar and concrete made up of shell aggregate: A comprehensive review. Construction and Building Materials, 257, 119507.
9. Kumar, P., Patel, S., & Singh, R. (2019). Effect of superplasticizer dosage on the mechanical properties of concrete containing waste materials. Materials Today: Proceedings, 22, 1450–1456.
10. Lutz, R. A., & Vrijenhoek, R. C. (2020). Composition and microstructure of bivalve shells. Marine Biology, 167(4), 45.
11. Shah, S. P., & Li, V. C. (2022). Mechanisms of superplasticizers in cementitious systems. Cement and Concrete Research, 152, 106692.
12. Siddique, R., Kaur, K., & Kahlon, R. (2019). Properties of concrete made with oyster shell aggregate and superplasticizer. Construction and Building Materials, 200, 420–430.
13. Soutsos, M., & Millard, S. (2020). Concrete technology and design (2nd ed.). CRC Press.
14. Standards Organisation of Nigeria, (2018). NIS 444-1:2018 Cement - Part 1: Composition, specifications and conformity criteria for common cements. Abuja: SON.
15. Surendra, P., & Gang, X. (2022). High-performance concrete with chemical admixtures. Journal of Materials in Civil Engineering, 34(5), 04022045.