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ORIGINAL RESEARCH REVIEW

Performance of TALABLOCKS: Cement Hollow Block with *Ostreidei* Shell additive

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ABSTRACT

This study investigates the potential use of oyster shells (*Ostreidae*) as an additive in the production of hollow blocks to enhance their mechanical and physical properties. Specifically, it assessed the effects of oyster shell incorporation on compressive strength and water absorption performance. An experimental–descriptive research design was employed to establish cause-and-effect relationships while providing a detailed characterization of the material's behavior. The experiment was conducted at ParksHub Hollow Blocks, Purok Dita, Bobon, Mati City, Davao Oriental, and laboratory evaluation was performed at Triple M Material Testing Center, Tagum City. Observations and measurements were systematically recorded using a logbook, and data were analyzed using Analysis of Variance (ANOVA) to compare the performance of "Talablocks" (oyster shell–enhanced blocks) with commercial hollow blocks. Results revealed a significant increase in compressive strength for Talablocks compared with conventional hollow blocks, indicating the potential of oyster shell powder to enhance load-bearing capacity. Visual observations during and after compressive strength testing showed no noticeable cracking or abnormal failure patterns in Talablocks, suggesting that the added oyster shell powder did not induce brittleness. In contrast, water absorption did not differ significantly between the two block types, indicating that although oyster shell addition may slightly increase hydration, it does not compromise material integrity or crack resistance. These findings demonstrate that oyster shell waste can be repurposed as an effective, sustainable additive in construction materials, reducing waste and promoting environmentally responsible hollow block production.

Keywords: *Compressive strength, eco-friendly construction, oyster shell additive, sustainable building materials, waste utilization*

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INTRODUCTION

Oyster shells (*Ostreidae*) are primarily by-products of the seafood industry and are predominantly composed of calcium carbonate. They are recognized for their high calcium carbonate content, making them a valuable raw material for construction and building applications (Bellei et al., 2023). Beyond construction, oyster shells have been widely used as soil conditioners and liming agents in agriculture, as adsorbents for wastewater treatment, and as raw materials for producing calcium-based compounds in industrial and pharmaceutical applications (Topić Popović et al., 2023). However, despite their potential for reuse, most oyster shells are discarded, contributing to environmental pollution. An estimated 18 million tons of shellfish waste, including oyster shells, are illegally dumped into landfills or the ocean each year, creating significant ecological challenges (Topić Popović et al., 2023). In countries such as South Korea, where more than 300,000 tons of oyster shell waste are generated annually (Choi et al., 2023), studies indicate that recycling these shells as construction materials can substantially reduce waste while improving sustainability outcomes (Baek, 2021; Choi et al., 2024; Zhan et al., 2021).

Oyster farming represents a significant component of the Philippine aquaculture industry, particularly in coastal areas where it serves as a vital source of livelihood (Bureau of Fisheries and Aquatic Resources, 2024). Despite its economic importance, the disposal of empty shells remains a solid waste management challenge. At the same time, the construction industry faces increasing material costs and environmental pressures, particularly from high energy use and CO_2 emissions associated with cement production (Norona et al., 2021). In the Davao Region, known for its rich mollusk resources and aquaculture activities (Bersaldo et al., 2022), discarded oyster shells are an underutilized waste resource. Moreover, the construction sector in the region struggles with rising material expenses that affect infrastructure quality and environmental sustainability (Mendoza, 2022; Balucio and Abellanosa, 2023). These interlinked challenges underscore the need for innovative approaches such as recycling and integrating waste materials into construction processes to promote environmental and economic sustainability.

Despite several international and local studies that have explored the use of oyster shells as partial cement or fine aggregate substitutes in concrete, mortar, and masonry products (Bellei et al., 2023; Baek, 2021; Zhan et al., 2021), there remains a research gap in assessing their performance as an additive in hollow block production under tropical conditions. In the Philippine context, documented construction-related utilization of oyster shells has been reported only in selected areas outside the Davao Region, such as in the National Capital Region (Binag, 2018; Labador et al., 2024), with no published studies or applications identified locally, underscoring the need for region-specific evaluation of oyster shell–based construction materials. Most prior research has focused on concrete mixtures rather than on load-bearing block structures widely used in low-cost housing. Furthermore, limited data exist on the mechanical and absorption properties of locally sourced oyster shell admixtures in small-scale, community-level construction settings. Addressing this gap can provide region-specific insights into waste valorization and sustainable material innovation.

This study is therefore significant in promoting both environmental sustainability and resource efficiency. By transforming shellfish waste into functional construction materials, it supports circular-economy principles, reduces landfill waste, and offers a low-cost alternative to conventional cement additives. The relevance of this research extends to local government units, environmental policymakers, and the construction industry, all of which are striving to adopt green technologies that minimize waste and carbon emissions.

The novelty of this research lies in the development and assessment of “Talablocks,” an innovative hollow block formulation incorporating powdered oyster shells as a partial additive. Unlike previous studies focused on concrete mixtures, this work introduces a practical, locally sourced, and scalable approach that links aquaculture waste management with sustainable infrastructure development. Specifically, the study aims to evaluate the compressive strength and water absorption performance of Talablocks in comparison with commercial hollow blocks, determine whether oyster shell addition can serve as a sustainable and cost-effective alternative material for block production, and assess the feasibility of integrating shell waste recycling into environmentally responsible construction practices in the Davao Region.

By repurposing oyster shell waste into Talablocks, this study helps reduce environmental pollution by diverting shell waste from landfills and coastal dumping, thereby minimizing solid waste accumulation and associated ecological impacts (Topić Popović,et al., 2023). In addition, the use of oyster shell powder as a partial material substitute supports waste valorization, lowers reliance on conventional raw materials, and promotes sustainable construction practices aligned with the United Nations Sustainable Development Goals (SDGs), particularly SDG 9 (Industry, Innovation, and Infrastructure) and SDG 12 (Responsible Consumption and Production).

This study used an experimental-descriptive research design to determine the effects of oyster shell admixtures on the physical properties of hollow blocks. The design enabled both quantitative comparisons and qualitative observations of material behavior across varying compositions, providing a structured framework for analyzing compressive strength and water absorption. The experiment was carried out at ParksHub Hollow Blocks in Purok Dita, Bobon, Mati City, Davao Oriental, using oyster shells collected from Barangay Bagumbayan, Lupon, Davao Oriental. The finished products were tested at the Triple M Material Testing Center in Tagum City, Davao del Norte, an accredited centre for material quality testing. Production and curing took place from January to February 2025, encompassing preparation, molding, curing, and testing.

The materials included Ordinary Portland Cement (OPC), fine and coarse aggregates, potable water, and powdered oyster shells as the additive. Oyster shells (*Ostreidae*), chosen for their high calcium carbonate ($CaCO_3$) content, were thoroughly cleaned, air-dried, oven-dried at 105°C, crushed, and ground into a fine powder using a mechanical grinder. The powder was sieved with a 0.425 mm mesh for uniformity and stored in airtight containers.

Talablocks were produced following standard hollow block manufacturing procedures, with oyster shell powder incorporated as a partial cement substitute at 30.77-38.46% by *weight of cement* (see Figure 1). Two groups were prepared: commercial hollow blocks (control) and Talablocks with oyster-shell admixture at different percentages (see Table 1 below). The dry components were mixed until uniform, then water was gradually added to achieve proper consistency. Mixtures were molded into 40 cm × 20 cm × 10 cm blocks, compacted, leveled, and air-cured for 28 days under shaded conditions, following the standard curing period used in concrete and masonry testing to allow complete hydration and strength development.

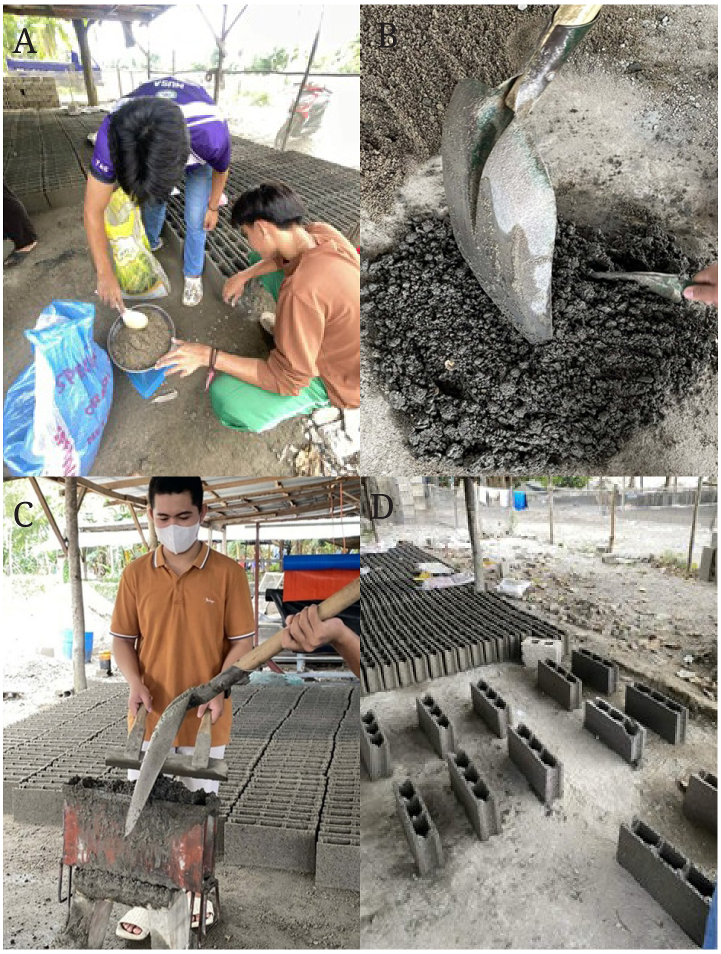

Figure 1. The step-by-step process of producing the Talablocks: (A) Weighing of components; (B) Mixing; (C) Molding; and, (D) Curing.

Table 1. Percentage composition of solid materials in hollow block treatments.

Treatment	Cement (%)	Coarse sand (%)	Powdered oyster shell (%)	Total solid mass (kg)
Treatment 1	30.77	38.46	30.77	6.5
Treatment 2	16.67	50.00	33.33	6.0
Treatment 3	15.38	46.15	38.46	6.5

After curing, the blocks underwent performance testing at the Triple M Material Testing Center. Compressive strength was tested in accordance with ASTM C140 using a universal testing machine to measure the maximum load before failure, expressed in megapascals (MPa). Water absorption was measured by comparing the dry and water-saturated weights of each sample after 24 hours of immersion, indicating the material's porosity and durability. These tests provided empirical data on how oyster shell addition influenced the mechanical and physical properties of the blocks relative to commercial standards.

Data on compressive strength and water absorption were analyzed using Analysis of Variance (ANOVA) at a 0.05 significance level, with IBM SPSS Statistics 28 used to determine statistical differences between the two groups. Ethical and environmental considerations were observed throughout the study. Only post-consumer oyster shells were collected with permission from local aquaculture operators, ensuring no harm to live organisms. All laboratory and field activities followed safety and waste management protocols. The research supports the United Nations Sustainable Development Goals (SDGs) 9 and 12 by promoting sustainable material innovation and responsible production through the reuse of shellfish waste.

The compressive strength results, shown in Figure 2(A), indicate a marked improvement in the mechanical performance of the Talablocks treatments relative to commercial hollow blocks. Commercial hollow blocks, composed solely of conventional cement–aggregate mixtures, exhibited the lowest mean compressive strength (178.71 psi). In contrast, Talablocks incorporating oyster shell powder as a cement additive demonstrated higher compressive strengths of 768.34 psi, 262.34 psi, and 403.89 psi for Treatments 1, 2, and 3, respectively, highlighting the strengthening effect of the calcium carbonate–rich oyster shell component. These results demonstrate that oyster shells can effectively enhance block strength, likely due to their high calcium carbonate content, which contributes to matrix densification and improved cementitious bonding (Bellei et al., 2023; Zhan et al., 2021).

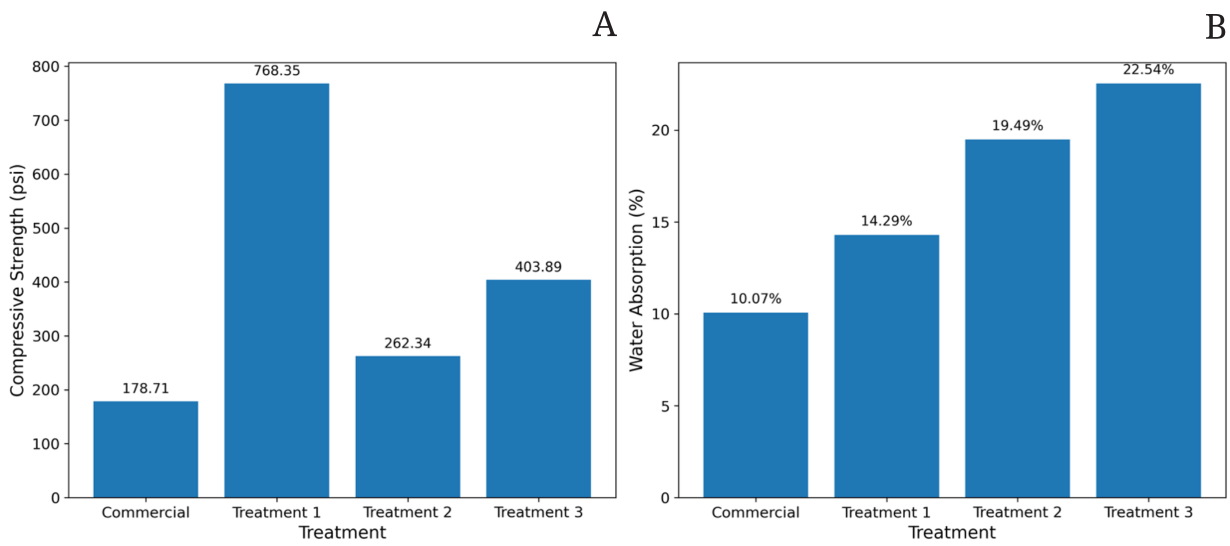

Figure 2. Mechanical and water absorption performance among the Talablocks treatments relative to commercial hollow blocks. (A) Compressive strength expressed in pounds per square inch (psi); (B) Percentage water absorption of the different treatments.

These findings align with those of Yao and Sharan (2024), who reported that substituting fine aggregates with oyster shell powder led to notable improvements in the compressive strength of concrete mixes. Similarly, Bunyamin and Mukhlis (2020) found that even partial substitution of cement with oyster shell ash significantly increased the compressive strength of test specimens compared with controls. In this study, the increase in strength may be attributed to the pozzolanic reactivity of oyster shell calcium oxide, which helps microfill voids within the matrix and enhances the interfacial bond between cement and aggregates.

The ANOVA results (Table 2) confirm that these strength differences are statistically significant, with an F-value of 10.54 exceeding the critical value of 4.07 and a p-value < 0.001. This indicates that the treatment effects are meaningful and not due to random variation. The results support earlier studies by Kathiria and Suthar (2022), which proposed that oyster shell–based concretes can achieve comparable or even superior strength to traditional materials while offering sustainability benefits.

Table 2. Analysis of variance on the compressive strength.

Groups	Average	Variance	*F*-value	*P*-value	F crit
Commercial	178.71	581.61	10.54	<0.001	4.07
Treatment 1	768.35	6627.87			
Treatment 2	262.34	4106.45			
Treatment 3	403.89	65930.31			

However, consistent with Olaniyi and Abiodun (2024) and Anosike (2022), the relatively low compressive strength of commercially produced blocks highlights ongoing deficiencies in block manufacturing quality standards. This underscores the potential of Talablocks as a more sustainable and mechanically resilient alternative for construction in resource-limited and coastal areas.

The average water absorption results are presented in Figure 2 (B), showing values of 10.07% for commercial blocks and 14.29%, 19.49%, and 22.54% for Treatments 1, 2, and 3, respectively. Although adding oyster shell powder improved compressive strength, it also increased water absorption. The higher porosity in oyster shell–modified blocks can be attributed to the powder's fine texture and its effect on capillary action within the cement matrix, resulting in greater moisture retention (Bellei et al., 2023b; Kwon and Wang, 2024).

Despite the elevated absorption rates, ANOVA results (Table 3) revealed no statistically significant differences among the treatments (F = 2.10, p = 0.18), indicating that while trends exist, the observed variations may not be strong enough to be considered conclusive. These findings are consistent with Cha et al. (2023) and Olofinnade et al. (2023), who both reported that while oyster shell incorporation can enhance compressive strength, it tends to increase water absorption due to microstructural changes in the concrete mix. The increased absorption, though not ideal for structural durability, remains manageable within acceptable limits when used in non-load-bearing or interior applications.

Table 3. Analysis of variance on the water consumption

Groups	Average	Variance	*F*-value	*P*-value	F crit
Commercial	10.07	0.01	2.10	0.18	4.07
Treatment 1	14.29	0.51			
Treatment 2	19.48	113.26			
Treatment 3	22.54	60.74			

Furthermore, Kwon and Wang (2024) emphasized that oyster shell powder increases hydration levels, thereby increasing water-binding capacity and reaction rates in cement composites. When finely ground, the larger surface area of shell powder can trap more water molecules, leading to elevated absorption values. This trade-off between mechanical enhancement and moisture sensitivity suggests that optimal blending ratios should be explored to balance strength and porosity.

The results collectively affirm that oyster shell–based Talablocks exhibit superior compressive strength compared with commercial hollow blocks while maintaining water absorption levels within workable limits. These findings substantiate the viability of oyster shells as sustainable construction additives that enhance mechanical properties without compromising usability.

In the context of environmental and economic sustainability, integrating oyster shell waste into construction materials offers dual benefits: it diverts waste from landfills and reduces reliance on conventional raw materials. Beyond hollow block production, oyster shell powder can be used as a partial substitute for cement or fine aggregates in concrete and mortar, as a filler to enhance particle packing, in lime-based binders, pavement blocks, and bricks, and in soil stabilization applications, and as a component of eco-cement and lightweight construction materials. The outcomes of this study thus align with global efforts to promote circular economy practices in the construction sector by promoting the reuse of aquaculture waste across multiple construction applications (Zhan et al., 2021; Bellei et al., 2023b).

The findings demonstrate that Talablocks represent a technically viable and environmentally responsive alternative to conventional hollow blocks, particularly in coastal and resource-constrained settings. The significant gains in compressive strength, coupled with manageable water absorption, confirm that oyster shell powder can serve not merely as a waste filler but also as a performance-enhancing additive when appropriately proportioned. These results underscore the value of locally sourced shellfish waste as a strategic input for sustainable construction, effectively linking aquaculture by-product management with infrastructure development. By validating the structural potential of oyster shell–modified blocks under controlled laboratory conditions, this study provides a strong foundation for scaling up production and advancing circular economy practices in the Davao Region and comparable tropical contexts.

To further strengthen the applicability of these findings, continued optimization of mix proportions, curing conditions, and particle size distribution is recommended to maximize mechanical performance while minimizing water absorption. Field trials and long-term durability assessments should be undertaken to confirm laboratory-scale results under real-world environmental and loading conditions. In addition, future investigations may expand beyond oyster shells to include other abundant shellfish wastes in Davao Oriental, such as *Strombus urceus* and *Placuna placenta* (Angsinco-Jimenez and Jumawan-Nanual, 2002), *Canarium urceus* (Ibañez and Dedal, 2024), and *Pegophysema philippiana* (Bersaldo and Avenido, 2021; Gil et al., 2023). Exploring these locally available materials may further enhance the sustainability, scalability, and regional relevance of shell-based construction technologies.

CONCLUSION

This study demonstrated the feasibility of repurposing oyster shell waste as an additive for hollow block production. The incorporation of powdered oyster shells (Talablocks) significantly improved the compressive strength of the blocks compared with commercially produced hollow blocks, confirming the role of calcium carbonate in enhancing cementitious bonding and structural integrity. ANOVA results showed a highly significant difference ($p < 0.001$), indicating that the strength improvements were statistically reliable and consistent with earlier studies reporting the reinforcing capacity of oyster shell derivatives as partial substitutes for cement or fine aggregates. Water absorption values increased slightly in the treated blocks; however, the differences were not statistically significant and remained within acceptable limits for non-load-bearing and interior construction applications. This increase in moisture retention may be attributed to the fine particle size and porous structure of powdered oyster shells, reflecting a manageable balance between improved strength and increased porosity. Hence, the findings confirm that oyster shell waste is a viable and eco-efficient construction material that supports sustainable building practices by reducing aquaculture waste, conserving natural resources, and lowering reliance on conventional materials. This study contributes to the growing evidence on sustainable construction materials. It demonstrates the potential of aquaculture by-products to produce cost-effective, durable building materials suitable for tropical regions such as Davao Oriental.

RECOMMENDATIONS

- Optimize the oyster shell powder mix ratios to maximize compressive strength while minimizing water absorption.
- Conduct long-term durability and performance tests under varying environmental and loading conditions to assess field applicability; and,
- Encourage collaboration between local government units, aquaculture producers, and construction stakeholders to institutionalize oyster shell recycling within sustainable construction programs.

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AUTHOR CONTRIBUTIONS

M.J.H.R, and P.K.R.A: Conceptualization; M.J.H.R, P.K.R.A, and N.B, P.N.C: Introduction; P.N.C, M.J.H.R, N.A.B, J.P.M.R, P.K.R.A, P.J.B.G, F.N.T.S, Y.D.M, and J.E.P.P: Methodology; M.J.H.R, N.A.B, J. P. M. R, P.K.R.A, P.J.B.G, F.N.T.S, Y.D.M, and J.E.P: Data Gathering,; P.N.C, M.J.H.R and N.A.B: Analysis; P.J.B.G: Software; M.J.H.R, P.K.R.A, N.A.B, P.N.C: Review and Editing; M.J.H.R, J.P.M.R,

P.K.R.A, P.J.B.G, F.N.T.S, Y.D.M, and J.E.P.P: Funding Acquisition. All authors have read and agreed to the publication of this manuscript.

DECLARATION

Informed consent statement

This review study did not involve any human participation or data collection. All data were analyzed from the previously published study and available sources. No ethical approval or informed consent was required for this research.

Conflict of interest

The authors have no conflict of interest in the result of the study.

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