Design and Feasibility Study of a Floating Structure –A Review

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***Abstract*—Rapid urban growth, shortage of land in coastal areas, and rising sea levels due to climate change have increased the need for alternative construction solutions. Floating structures have emerged as a promising option, as they make use of water surfaces while reducing pressure on land resources. This paper presents a review of various studies on floating structures, focusing on their design principles, material selection, and feasibility in coastal regions. Different types of floating systems and foundation materials such as EPS, PVC pipes, plastic drums, and lightweight concrete are discussed based on previous research. The review also highlights key factors affecting the performance of floating structures, including buoyancy, stability, durability, and cost. From the analysis of existing studies, it is observed that lightweight and advanced materials improve the efficiency and stability of floating structures while also reducing overall cost. Floating construction is found to be a suitable and sustainable solution for areas affected by flooding and land scarcity. Overall, the paper shows that floating structures have strong potential for future development, especially in coastal and flood-prone regions, provided proper design and material selection are considered.**

***Index Terms*—Floating structures, buoyancy, coastal development, material selection, EPS (Expanded Polystyrene), PVC pipes, lightweight concrete, structural stability, sustainable construction, climate change adaptation.**

I. INTRODUCTION

A large portion of the Earth's surface is covered with water, and many major cities are located near coastal regions. In recent years, challenges such as rapid urban growth, shortage of land, and rising water levels due to climate change have created serious concerns for future development. Coastal areas are especially vulnerable to flooding and sea-level rise, which makes conventional construction methods less reliable in the long term. To address these issues, alternative construction approaches are being explored, and floating structures have gained attention as a practical solution. Floating buildings are designed to remain stable on water by using the principle of buoyancy. Unlike fixed structures, they can adjust to changes in water levels, which makes them suitable for flood-prone and coastal regions.

Many researchers have studied different aspects of floating structures, including design methods, material selection, and construction techniques. Various types of floating systems and foundation materials, such as EPS, PVC pipes, plastic drums, and lightweight concrete, have been analyzed in different environmental conditions. These studies highlight the importance of stability, durability, and cost-effectiveness in the successful implementation of floating structures. This paper presents a review of existing research on floating structures, focusing on their design, materials, and overall feasibility. The aim is to understand current developments and identify suitable approaches for future applications in coastal and water-based environments.

II. LITERATURE REVIEW

Recent studies on floating structures show that they are gaining importance as a solution to problems such as flooding, land shortage, and rising sea levels.

Suchanda Banerjee (2025) studied the design and feasibility of floating structures with a focus on architectural and structural aspects. The research considered different parameters such as buoyant systems, material behavior, construction methods, and service integration. The study also reviewed various types of floating buildings, including residential units, public spaces, and mixed-use platforms in different water environments like lakes, rivers, and coastal regions.

Vivek Patva (2023) presented design concepts for floating structures in coastal areas of Goa. The study emphasized floating architecture as a sustainable solution to sea-level rise and land subsidence. A systematic approach was followed, including site analysis, case studies, and design development. The research highlighted the importance of planning and location-specific design for successful implementation.

G. Hema Sai (2022) discussed floating houses as an effective response to climate change. The study explained the basic principle of buoyancy and classified floating houses into different types. It also highlighted important design requirements such as stability, material selection, and structural safety. The use of lightweight, corrosion-resistant, and recyclable materials was recommended for better performance.

Xinhao Wang and Shi-Yuvu (2021) compared floating houses with houseboats as alternative housing options in coastal regions. The study pointed out that floating houses are more suitable for permanent living due to better stability and larger usable space, whereas houseboats are mainly used for temporary or recreational purposes.

H. P. Adi et al. (2020) analyzed the feasibility of floating houses using plastic barrels as the floating base. The study included load calculations, buoyancy analysis, and cost estimation for a residential unit in flood-prone coastal areas. The results showed that such systems are economical and can provide sufficient stability when properly designed.

Emilin Sara Varkey (2019) presented the design of a floating residential structure based on the pontoon system. The study highlighted several advantages of floating structures, such as minimal environmental disturbance, quick construction, and resistance to seismic forces. It also confirmed that floating buildings can be a reliable solution for areas affected by rising water levels.

Prihatmaji and Nugraha (2019) studied the use of EPS as a floating foundation for houses in water-based regions like Banjarmasin. They presented a two-storey floating house of about 150 m², inspired by traditional lanting houses. The study highlighted that EPS is lightweight, durable, and resistant to water and environmental effects. It also showed that EPS pontoons provide better stability, durability, and ease of construction compared to local materials, making them a reliable choice for floating foundations.

Asrasal et al. (2018) analyzed a floating house design using PVC pipes as the foundation in water-dominated regions. The study included stability analysis, connection details, and cost evaluation for an 8 m × 10 m structure.The results showed that the buoyant force (648,793 N) was higher than the total load, ensuring stability with a safety factor of 1.2. The system was found to be safe, economical, and suitable for use as a floating foundation with proper design and connections.

Son Haji et al. (2018) compared plastic drums, Styrofoam, and bamboo as floating foundation materials for a 99 m² house. All materials provided sufficient buoyancy, but plastic drums were found to be the most economical, lightweight, and practical option for low-cost floating structures.

Dasila and Semwal (2017) discussed the concept of self-sustaining floating architecture. Their study focused on the use of renewable energy sources such as solar, wind, and geothermal energy to make floating structures independent and energy-efficient. They also highlighted the advantage of mobility, as floating structures can be relocated when required. This flexibility allows such structures to adapt to changing environmental and social needs.

Svitlana Shekhorkina (2015) explained the basic design principles of low-rise floating residential buildings. The study described floating buildings as a combination of traditional building systems and marine structures. It emphasized the importance of stability, load considerations, and design standards based on shipbuilding codes. The research aimed to develop a systematic approach for designing safe and reliable floating houses.

Ambica and Venkatraman (2015) presented a conceptual design of a floating house suitable for areas with fluctuating water levels. The design was inspired by floating houses in the Netherlands. The study included analysis using STAAD Pro software and considered factors such as lateral forces, stability, and foundation behavior. The proposed structure used lightweight materials to reduce overall load and improve performance.

Svitlana Shekhorkina (2015) included detailed analysis of loads and structural behavior of floating buildings. The study considered different types of loads such as dead load, live load, wind load, and water pressure. A finite element model was used to analyze stress and structural safety. The results showed that the structure met required safety standards, indicating that such designs can be successfully implemented.

Changho (2015) studied floating houses designed for flood-prone areas, particularly in New Orleans. The research focused on resilient housing solutions that can rise with increasing water levels. The structure used a lightweight base with a protective outer layer and was guided by vertical supports to prevent drifting. The study highlighted different types of floating housing systems, including floating, amphibious, and floatable houses.

Shahryar Habibi (2015) emphasized the importance of sustainability in floating structures. The study suggested that floating buildings can be designed to generate their own energy using wave, solar, and wind power. This makes them environmentally friendly and reduces dependence on conventional energy sources.

Ishaque et al. (2014) presented a low-cost floating house design using steel drums as the floating base. The study included detailed load calculations considering occupants, stored materials, and structural weight. Stability analysis showed that the structure could safely withstand wind forces and remain stable under different conditions. The study also highlighted that using locally available materials can significantly reduce construction cost, making floating housing more affordable.

Zheng and Dai (2025) presented a review and graph analysis of Very Large Floating Structures (VLFS) for ocean space utilization. The study discussed the development history, important milestones, and applications of large floating platforms such as floating airports, ports, and offshore living spaces. It highlighted that research is increasingly focused on hydroelastic behavior, dynamic response, and environmental interaction of floating systems.

Ahmed A. El-Shihy (2024) proposed a new systematic approach for modular floating cities. The study focused on expandable floating platforms and their configuration using an analytical framework. The research emphasized efficient space utilization, interlocking modular systems, and long-term urban resilience against sea-level rise, making it highly relevant for future floating residential developments.

Habibi et al. (2025) reviewed floating modular energy islands and very large floating systems for sustainable marine infrastructure. The study explored material selection, construction technologies, and life-cycle performance. It concluded that floating modular systems can support multi-purpose use such as housing, renewable energy, and transport facilities.

Ghonim et al. (2026) carried out a systematic literature review on the structural aspects of floating photovoltaic systems. The study examined floating platforms, mooring systems, and connection mechanisms under wave and wind actions. It identified long-term durability and extreme condition performance as major research gaps.

Koondhar et al. (2026) reviewed floating renewable energy technologies including floating solar, offshore wind, and wave energy systems. The study provided a comparative assessment of structural performance, cost, sustainability, and scalability, which supports the broader applicability of floating structures in modern infrastructure development.

Lee et al. (2021) studied the structural behavior of modular floating platforms for residential applications. Their research focused on the use of modular concrete pontoons connected through flexible joints. The study found that modular floating systems provide better adaptability, easier transportation, and improved stability under varying water conditions, making them suitable for large floating residential development.

Kim and Park (2020) investigated the use of lightweight concrete in floating structures to improve buoyancy and reduce dead load. Their analysis showed that lightweight concrete reduces the self-weight of the platform while maintaining sufficient strength and durability. This makes it an effective material for floating residential construction in coastal regions.

Chen et al. (2019) examined the environmental impact of floating urban infrastructure. The study highlighted that floating structures can reduce land reclamation and preserve coastal ecosystems when eco-friendly materials are used. It also suggested integrating renewable energy systems into floating platforms to improve sustainability.

Nguyen and Tran (2020) analyzed floating housing systems in flood-prone regions of Southeast Asia. Their study concluded that floating houses provide an effective adaptation strategy against seasonal flooding. The use of locally available lightweight materials was found to reduce construction cost and improve the feasibility of such structures in low-income communities.

Habibi and Rahman (2021) reviewed the role of floating architecture in climate-resilient urban development. Their work emphasized that floating structures can serve as a long-term solution for urban expansion in coastal cities affected by sea-level rise. The study also highlighted the importance of proper mooring systems and lightweight materials for ensuring safety and performance.

Zhao et al. (2022) studied the performance of floating structures under wave action. The research showed that floating platforms designed with proper stability calculations and flexible mooring arrangements can safely withstand dynamic wave forces. This makes floating systems suitable for coastal environments with moderate wave conditions.

III. COMPARATIVE ANALYSIS OF FLOATING STRUCTURES

Various studies on floating structures highlight differences in design approaches, materials used, cost, and overall performance. A comparison of these studies helps in understanding the most suitable options for practical applications.

One of the key aspects compared in the literature is the type of floating foundation material. Materials such as Expanded Polystyrene (EPS), PVC pipes, plastic drums, Styrofoam, and bamboo have been widely studied. EPS-based systems are found to be highly durable, lightweight, and resistant to water and environmental effects, making them suitable for long-term applications. PVC pipe-based systems also provide good buoyancy and stability, but they require proper connection detailing to ensure safety. Plastic drums are considered economical and easy to install, making them suitable for low-cost housing, although their durability may be lower compared to advanced materials. Bamboo and Styrofoam are also used in some regions, but they are generally less reliable for long-term structural performance.

Another important factor is structural stability. Most studies show that stability depends on the balance between the total load and the buoyant force. Advanced materials like EPS and lightweight concrete help in reducing the overall weight of the structure, which improves stability and safety. In comparison, heavier conventional materials require a larger floating base to maintain equilibrium.

Cost is also a major consideration in floating construction. Research indicates that low-cost materials such as plastic drums and bamboo are more affordable, but may require frequent maintenance. On the other hand, advanced materials involve a higher initial cost but provide better durability and long-term performance, which can reduce maintenance expenses over time.

Environmental impact is another important aspect discussed in the studies. Floating structures generally have less impact on land compared to traditional construction methods. Materials like EPS and lightweight concrete are preferred due to their recyclability and resistance to environmental degradation. However, proper waste management and material selection are necessary to minimize any negative effects on aquatic ecosystems.

Overall, the comparison of different studies shows that advanced lightweight materials offer better performance in terms of stability, durability, and efficiency, while conventional materials may be suitable for low-cost and temporary applications. The selection of materials and design approach should depend on site conditions, cost considerations, and intended use of the structure.

IV. CONCLUSION

This paper reviewed various studies on floating structures to understand their design approaches, material selection, and overall feasibility in water-based environments. From the literature, it is clear that floating structures have developed from small residential units to more advanced systems such as modular platforms and large-scale floating infrastructure.

The studies highlight that the performance of floating structures mainly depends on proper balance between load and buoyant force, along with suitable material selection. Lightweight and durable materials such as EPS, lightweight concrete, and modular systems have shown better results in terms of stability, efficiency, and long-term performance. In comparison, conventional and locally available materials are more economical but may have limitations in durability and maintenance.

Different research works also emphasize that floating structures can effectively adapt to changing water levels, making them suitable for coastal and flood-prone regions. In addition, the integration of renewable energy systems and sustainable materials further improves their environmental performance.

Overall, the review indicates that floating structures are a promising solution for future development in areas affected by land scarcity and climate change. However, further research is still required in areas such as long-term durability, advanced mooring systems, and large-scale implementation to make these systems more reliable and widely applicable.

V. FUTURE SCOPE

The review of existing studies shows that floating structures have strong potential for further development in the coming years. However, there are several areas where additional research and improvement are required.

Future work can focus on the development of large-scale floating communities or cities with integrated infrastructure such as transportation, water supply, and waste management systems. This can help address the problem of land scarcity in densely populated coastal regions.

There is also significant scope for integrating renewable energy systems such as solar panels, wind turbines, and wave energy devices into floating structures. This can make them more self-sufficient and environmentally sustainable.

Further research is needed in the field of advanced materials, including lightweight composites, recycled materials, and high-performance concrete, to improve durability, reduce maintenance, and increase the lifespan of floating structures.

Another important area is the improvement of mooring and anchoring systems to ensure stability under extreme environmental conditions such as high waves, strong winds, and cyclones. Long-term performance studies and real-life implementation data are also required to better understand the behavior of floating structures over time.

Overall, continued research and technological advancements can make floating structures a more reliable and widely accepted solution for future coastal and water-based development.

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