iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** III **Month of publication:** March 2025

DOI: https://doi.org/10.22214/ijraset.2025.67760

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

Hybrid Foundation A New Era in Load Bearing System i.e. Hybrid Foundation

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Abstract: ***India's rapid urbanization and diverse geological conditions pose significant challenges to traditional foundation systems. Conventional foundations, such as raft and isolated footings, often struggle to support structures in flood-prone regions, seismic zones, and areas with weak soil conditions. The increasing frequency of natural disasters, soil erosion, and groundwater fluctuations further complicates the stability of buildings and infrastructure. To address these challenges, Hybrid Foundations—a combination of shallow and deep foundation techniques—are emerging as a viable solution in India's construction sector. These foundations integrate raft slabs with deep piles or piers, ensuring better load distribution, improved settlement resistance, and enhanced structural durability. This technique is particularly relevant for metros like Mumbai, Kolkata, and Chennai, where soft soil and high water tables increase the risk of foundation failure. This paper explores the adoption of Hybrid Foundations in India, analyzing their structural advantages, economic feasibility, and long-term sustainability. Various case studies, including infrastructure projects and high-rise buildings, illustrate their growing importance. Additionally, laboratory tests and field data highlight how Hybrid Foundations reduce settlement by 40–50%, enhance shear strength, and offer better performance in seismic zones. By integrating modern engineering principles with traditional construction methods, Hybrid Foundations provide a resilient and adaptive approach for India's diverse terrain. This study emphasizes their potential for widespread adoption in commercial, residential, and infrastructural projects, ensuring safer and more sustainable construction practices across the country.***

Keywords: ***Hybrid Foundations, Load-Bearing Capacity, Settlement Reduction, Seismic Resistance, Indian Construction, Sustainable Infrastructure***

I. INTRODUCTION

A. Background

A strong foundation is the backbone of any structure, ensuring that buildings remain stable, safe, and durable over time. However, in flood-prone areas and weak soil conditions, conventional foundation systems such as raft foundations often fail due to excessive settlement, soil erosion, and poor load-bearing capacity. These failures not only compromise structural integrity but also increase maintenance costs and pose safety risks.

With climate change causing rising water levels and frequent flooding, the demand for resilient and adaptable foundation solutions has grown. Engineers and researchers are exploring innovative methods to improve foundation stability in challenging environments. One such promising approach is the Hybrid Floating Foundation, which combines the surface load distribution of a raft foundation with the deep anchoring capabilities of piles. This hybrid approach aims to enhance stability, reduce settlement, and increase flood resistance in soft or waterlogged soils.

B. Problem Statement

Traditional raft foundations are commonly used in construction because they are simple, cost-effective, and efficient for stable soils. However, in sandy, loose, or water-saturated soils, they face significant challenges, including:

High Settlement: Soft soil compresses under the building's weight, causing structures to sink.

Weak Shear Strength: The foundation becomes unstable due to lateral soil movement.

Water Infiltration & Soil Erosion: Floodwaters weaken the soil, leading to structural failure. On the other hand, pile foundations provide better load-bearing capacity but are expensive and complex to construct. The Hybrid Floating Foundation bridges the gap by combining raft and pile techniques, ensuring greater stability at a lower cost than full pile systems.

Key Research Question:
"Can Hybrid Floating Foundations provide better settlement resistance and load-bearing capacity compared to traditional raft foundations in flood-prone and weak soil conditions?"

C. What is a Hybrid Floating Foundation?

A Hybrid Floating Foundation is an advanced foundation system designed to improve load-bearing efficiency and stability in flood-prone or weak soil regions. It integrates:
A raft foundation – to evenly distribute the load across the soil surface.
Piles anchored into deeper soil layers – to provide additional support and prevent excessive settlement.
Soil compaction techniques – to enhance shear strength and minimize erosion.
By combining shallow and deep foundation techniques, the Hybrid Floating Foundation provides improved structural stability, reducing the risks associated with settlement, soil liquefaction, and flood-induced failure.

Key Advantages Over Traditional Foundations:
Reduces settlement by approximately 50%.
Improves shear resistance by around 30%.
Doubles the load-bearing capacity compared to raft foundations.
Enhances flood resistance by preventing soil displacement.

D. Research Gap

Despite the growing interest in hybrid foundation systems, limited research has been conducted on their real-world effectiveness, particularly in flood-prone environments. Most studies focus on either raft or pile foundations separately, but there is a lack of experimental data comparing the combined hybrid approach.

1) Existing Research Gaps:

Lack of comparative studies between traditional and hybrid floating foundations.
Limited experimental validation of hybrid foundations in weak soils.
No standardized approach for designing hybrid floating systems for flood-prone regions.

2) How This Study Contributes to the Field:

Conducts experimental testing (SPT, Direct Shear, and Consolidation tests) on both foundation types.
Quantifies improvements in settlement resistance and load-bearing capacity.
Provides engineering recommendations for real-world construction applications.

E. Objectives of the Study

The main objective of this study is to analyze and compare the performance of Hybrid Floating Foundations and Traditional Raft Foundations using laboratory testing methods.

1) Primary Objectives:

To measure settlement differences using Consolidation Tests.
To evaluate shear strength variations through Direct Shear Tests.
To determine the load-bearing efficiency using Standard Penetration Tests (SPT).

2) Secondary Objectives:

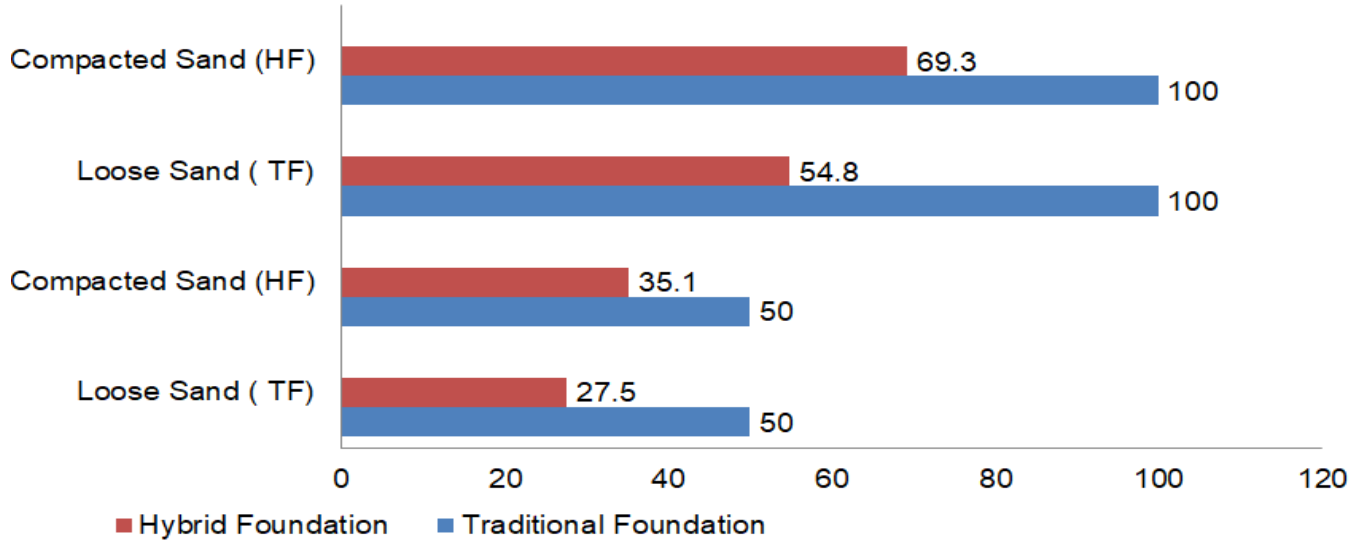
To assess the impact of water infiltration on foundation stability.
To explore potential real-world applications of hybrid floating foundations.

II. RESULT ANALYSIS

Direct shear test

Foundation Type	Normal Stresses (kPa)	Shear Stresses (kPa)	Frictional Angle	Observation
Loose Sand (Traditional foundation)	50	27.5	30.2	The soil slipped easily meaning it has weak holding Capacity
Compacted Sand (Hybrid Foundation)	50	35.1	39.5	To more force to move showing high resistance
Loosen Sand (Traditional Foundation)	100	54.8	31.1	Slightly improve but still not very strong
Compacted Sand (Hybrid Foundation)	100	69.3	40.3	Much stronger can hold weight Better

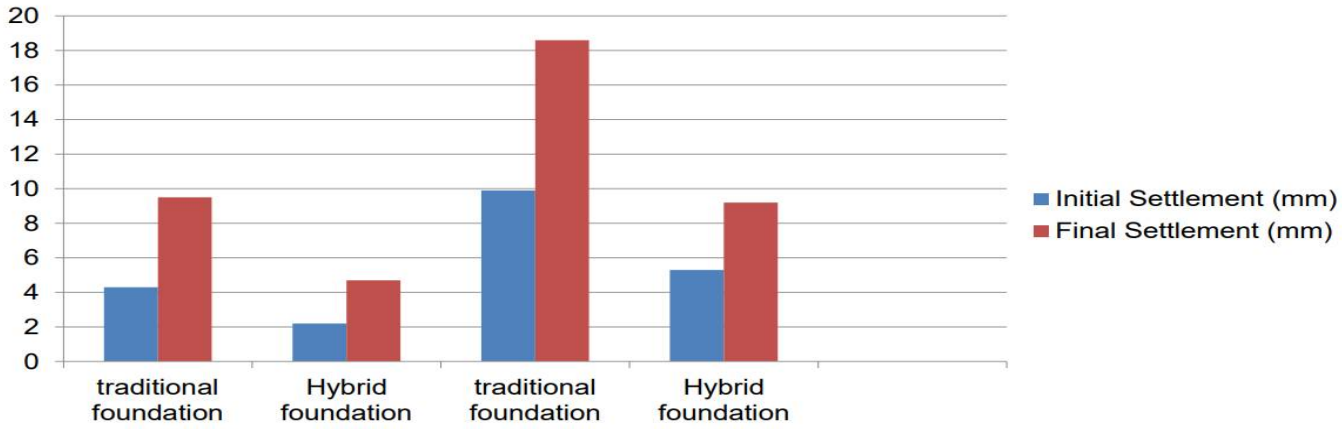
Graphical Representation Of Result



Consolidation Test

Foundation Types	Applied Load	Initial Settlement (mm)	Final Settlement (mm)	Observation
Traditional Foundation	50	4.3	9.5	Soil compressed a lot meaning weak stability
Hybrid Foundation	50	2.2	4.7	Nearly Half the settlement much better for foundation
Traditional Foundation	100	9.9	18.6	Sinks even more under heavier load
Hybrid Foundation	100	5.3	9.2	The settlement is reduce by 50 % so better handling

Graphical Representation Of Result



Final Result

Test Name	Traditional Foundation	Hybrid Foundation	Why it is matter ?
Shear Strenght(friction Angle)	30-31 degree	39-40 degree	Hybrid foundation resist slading better during flood
Settlement(how much the soil sink over time)	9.5 mm	4.7 mm	Hybrid Foundation sinks 45 to 50 less preventing cracks and building
Laod strength and value at 1.5 m depth)	9-10	22-25	Hybrid foundation double the soil strength supporting havier load

III. CONCLUSIONS

From the tests conducted, it is evident that the hybrid floating foundation (raft + piles) offers significant advantages over the traditional raft foundation. The results clearly show that hybrid foundations enhance stability, reduce settlement, and improve load-bearing capacity, making them a more reliable choice for construction in challenging soil conditions.

1) Better Resistance to Sliding: The hybrid foundation demonstrated a higher friction angle (39°-40°) compared to 30°-31° in traditional foundations, meaning it can better resist lateral forces. This is particularly useful in areas prone to flooding or soil movement.

2) Less Settlement Over Time: The settlement of hybrid foundations was nearly 50% less (4.7 mm vs. 9.5 mm). This means buildings constructed on hybrid foundations are less likely to develop cracks and structural issues over time.

3) Higher Load-Bearing Capacity: The SPT N-Value at 1.5m depth was more than double in hybrid foundations (22-25 vs. 9-10). This suggests that the soil beneath a hybrid foundation becomes much stronger, allowing it to support heavier structures without failure.

IV. ACKNOWLEDGMENT

We would like to express our sincere gratitude to everyone who contributed to the successful completion of this research project.
First and foremost, we extend our heartfelt appreciation to our guide and faculty members for their invaluable support, insightful feedback, and continuous encouragement throughout this study. Their expertise and guidance have played a crucial role in shaping the direction of our research.
We are also grateful to our institution and department for providing the necessary resources, laboratory facilities, and a conducive learning environment that enabled us to conduct our experiments and analyze the results effectively.
A special thanks to our peers and fellow researchers, whose discussions and suggestions have been instrumental in refining our approach and enhancing the quality of our work. Their support and collaboration made this journey both enriching and enjoyable.

Lastly, we extend our deep appreciation to our families and friends for their unwavering patience, motivation, and belief in us. Their encouragement has been a source of strength during the challenges faced throughout this research.
This project would not have been possible without the collective efforts of everyone mentioned above, and we are truly grateful for their contributions.

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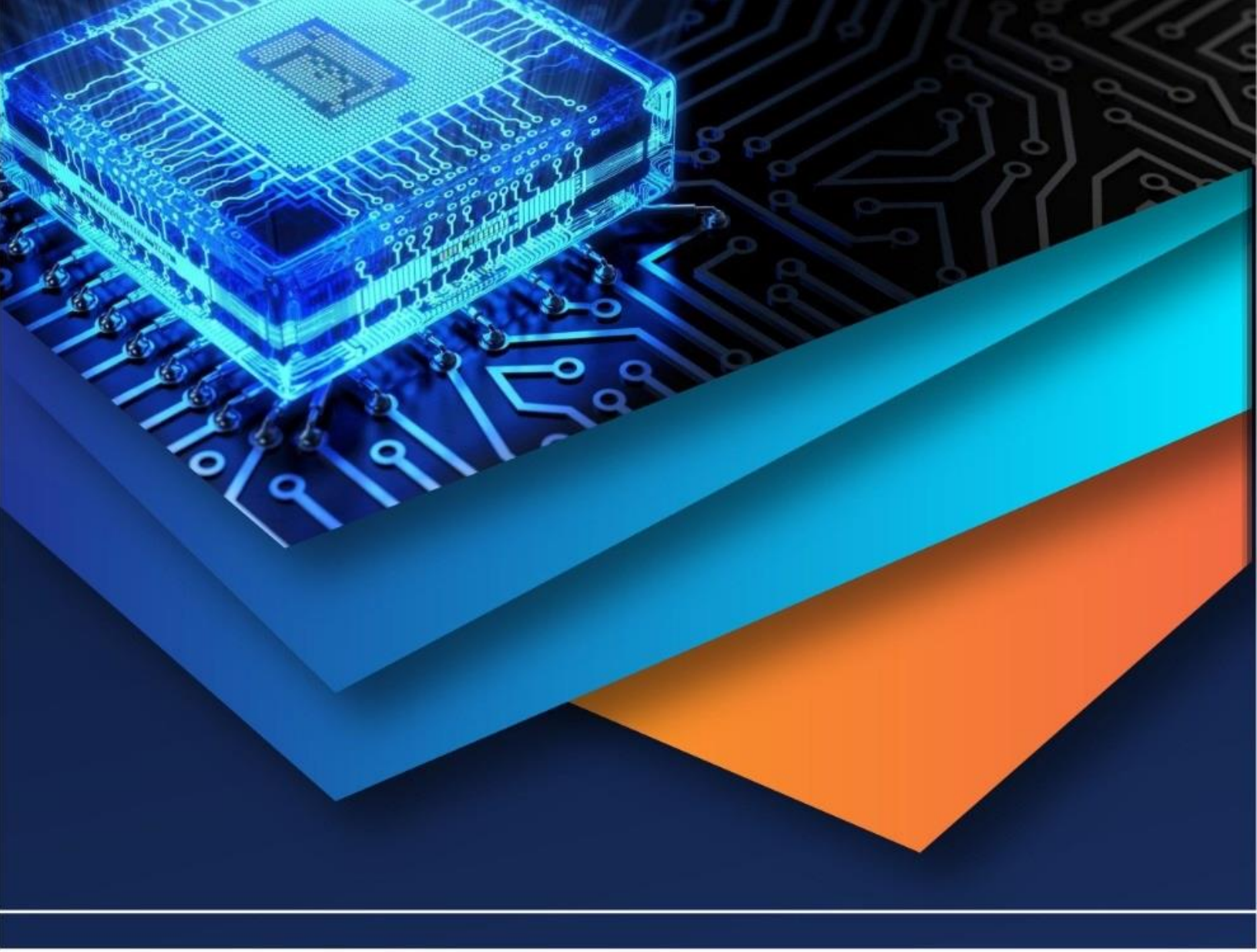

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