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A Comparative Study on the Use of GFRG Panels and RCC in Multi-Storey Buildings Using ETABS

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ABSTRACT

This study conducts a comparative analysis of GFRG (Glass Fiber Reinforced Gypsum) panels and Reinforced Concrete (RCC) regarding their structural performance in multi-storey buildings, employing ETABS software. GFRG panels are increasingly recognized as a sustainable and cost-effective substitute for traditional RCC construction materials. The analysis evaluates critical structural parameters including load-bearing capacity, seismic resilience, and overall stability across diverse design scenarios. Through simulations in ETABS, the study contrasts the behavior of buildings constructed with GFRG panels versus RCC, highlighting respective advantages and limitations. The findings provide insights into the feasibility and performance characteristics of GFRG panels in contemporary construction methods, with implications for sustainable building design and structural engineering practices.

Keywords: - GFRG, RCC, ETAB, Multi Storey Building, Construction.

I. INTRODUCTION

In contemporary construction practices, the selection of building materials holds significant sway over the structural integrity, sustainability, and cost-effectiveness of projects. Among the alternatives gaining prominence, Glass Fiber Reinforced Gypsum (GFRG) panels are emerging as a compelling substitute for traditional materials like Reinforced Concrete (RCC), particularly in multi-storey buildings. This introduction delves into the nuanced advantages and considerations associated with choosing between GFRG panels and RCC.

GFRG panels are crafted from gypsum plaster reinforced with glass fibers, combining lightweight properties with robust structural capabilities. This composition facilitates easier handling during construction, potentially lowering overall project costs by reducing transportation and labor expenses. Moreover, the rapid installation capabilities of GFRG panels expedite construction timelines compared to the more labor-intensive processes involved with RCC.

Conversely, RCC has long been favored for its exceptional strength and durability, attributes critical in multi-storey constructions where load-bearing capacity and seismic resilience are paramount. RCC's ability to withstand substantial loads and adverse environmental conditions has established it as a cornerstone of modern construction practices, albeit at a higher cost in terms of materials and labor compared to alternatives such as GFRG panels.

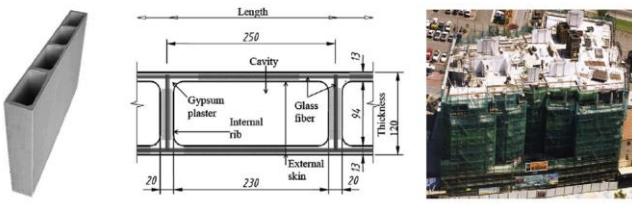

Figure 1. Structural view of GFRG Panel

The primary objective of this comparative analysis is to meticulously evaluate the structural performance of GFRG panels versus RCC in multi-storey buildings. This evaluation encompasses critical factors such as load-bearing capacity, seismic resilience, sustainability considerations, and overall cost-effectiveness. Leveraging advanced analytical tools like ETABS software, the study aims to offer comprehensive insights into the feasibility and potential implications of adopting GFRG panels as a viable construction material in contemporary building design and engineering methodologies.

II. GLASS FIBER REINFORCED GYPSUM (GFRG)

Glass Fiber Reinforced Gypsum (GFRG) represents a significant innovation in construction materials, blending the structural benefits of gypsum with the reinforcing properties of glass fibers. This introduction explores the fundamental characteristics, applications, and advantages that have propelled GFRG into the forefront of modern building practices.

GFRG is composed of high-strength gypsum plaster reinforced with continuous strands of glass fibers. This combination imbues the material with exceptional strength-to-weight ratio, making it significantly lighter than traditional building materials like concrete while maintaining robust structural integrity. The incorporation of glass fibers enhances GFRG's tensile and flexural strength, making it suitable for a variety of architectural and structural applications.

The versatility of GFRG extends to its moldability, allowing for intricate designs and architectural details that are not easily achievable with conventional materials. Its inherent fire-resistant properties further enhance its appeal in building codes where fire safety is a primary concern. Moreover, GFRG panels are known for their rapid installation capabilities, contributing to faster construction timelines and reduced labor costs compared to traditional methods.

In architectural applications, GFRG finds use in interior partitions, ceilings, decorative elements, and even load-bearing structures in some cases. Its ability to be molded into complex shapes and its lightweight nature make it ideal for prefabricated components that can be easily transported and assembled on-site.

GFRG panels find diverse applications across various building types and structural configurations due to their unique properties and versatility in construction. Here's a detailed exploration of how GFRG panels can be applied:

Light Load-Bearing Walls in Low-Rise Buildings: GFRG panels are often used as light load-bearing walls in single or two-storey buildings. These panels serve multiple purposes:

Insulating Material: GFRG panels can act as efficient insulators, helping to maintain thermal comfort within the building envelope.

Sandwich Panels: They can be configured as sandwich panels with materials like polyurethane or lightweight concrete. This configuration enhances structural stability while offering thermal and acoustic insulation properties.

Non-Load-Bearing Core: In some applications, GFRG panels are used without bearing significant structural loads, serving primarily as partitions or cladding elements.

Multi-Storey Timber-Framed Structures:

Within timber-framed buildings, GFRG panels serve several functions:

Wall Coverings: GFRG panels can be applied as durable wall coverings, providing both aesthetic appeal and functional benefits such as soundproofing and fire resistance.

Sports Facilities and Commercial Structures: They are suitable for covering walls in sports facilities or commercial buildings due to their robustness and ability to withstand wear and tear.

Horizontal Slabs or Floors: GFRG panels can be employed as horizontal slabs or floors in various configurations:

Bacteria and Reinforced Cement Mortar (T-Beam Effect): This method involves using GFRG panels as the structural base, reinforced with cement mortar to create a composite slab. This approach enhances load-bearing capacity and structural integrity.

Composite Walls or Safety Walls: GFRG panels are utilized in constructing composite walls or safety barriers where high durability and impact resistance are required.

Each application leverages GFRG's lightweight nature, moldability, and inherent strength, making it a versatile choice for modern construction projects aiming for sustainability, efficiency, and design flexibility. As advancements in materials science continue, GFRG panels are expected to expand their role further in innovative building solutions.

GFRG panels offer a range of advantages that make them an attractive choice for construction projects. Here's a detailed exploration of the benefits of using GFRG panels:

Quicker Construction:

GFRG panels enable rapid construction, significantly reducing project timelines. Conventional structures, which typically take six to eight months to complete, can be erected in just one month using GFRG panels. This accelerated construction process enhances project efficiency and reduces labor costs.

Economical:

GFRG panels contribute to cost savings through reduced material usage. Compared to traditional construction methods, GFRG panels reduce the consumption of steel by 35%, sand by 76%, and cement by nearly 50%. These reductions translate to lower material procurement costs and contribute to overall project affordability.

Fire Resistant:

GFRG panels exhibit excellent fire resistance properties. When subjected to fire, GFRG panels release moisture equivalent to 15–25% of their weight, effectively lowering surface temperatures and minimizing fire damage. This characteristic enhances building safety and reduces the spread of flames during fire incidents.

Earthquake Resistant:

GFRG panels can serve as effective shear walls, enhancing a structure's resistance to seismic forces. Studies have demonstrated that buildings constructed with GFRG panels can withstand the effects of earthquakes, particularly in regions prone to seismic activity such as the fifth seismic zone.

Thermal Insulation:

GFRG panels contribute to maintaining comfortable indoor temperatures by offering superior thermal insulation. Compared to conventional building materials, GFRG panels help reduce building temperatures by up to 4°C, enhancing occupant comfort and energy efficiency.

Strength and Durability:

GFRG panels exhibit exceptional strength and durability, surpassing that of traditional building materials. Gypsum, the primary component of GFRG panels, is renowned for its strength and dimensional stability, ensuring long-term structural integrity and resilience against environmental factors.

Water Resistant:

GFRG panels are inherently resistant to water damage. During the manufacturing process, specific chemicals are added to the gypsum mixture to enhance its water resistance properties. This feature makes GFRG panels suitable for applications where exposure to moisture is a concern.

Increased Carpet Area:

Structures constructed with GFRG panels offer a larger carpet area compared to conventional buildings. This is due to the thinner profile of GFRG panels, which typically measure.

III. LITERATURE REVIEW

Chandru et al., 2023 [1]

In India, the rising costs of construction and limited access to affordable housing have spurred interest in alternative building materials like Glass Fiber Reinforced Gypsum (GFRG) panels. Compared to traditional Reinforced Cement Concrete (RCC) construction, GFRG panels offer faster build times, cost savings, and enhanced environmental sustainability. This study employs software tools such as AutoCAD, SketchUp, STAAD Pro, MS Excel, and MS Project to compare the construction processes of RCC and GFRG, highlighting the advantages of GFRG structures. Despite the gradual adoption of panel construction methods, public awareness remains low. The project aims to increase awareness of panel systems for affordable housing by educating stakeholders through planning, design, analysis, and resource allocation stages, ultimately aiming to address housing needs among economically disadvantaged populations.

Sobhi et al., 2022 [2]

This research emphasizes the significance of structural considerations in landscape design, supported by higher Structural Strength Index (SSI) and Secondary Structural Strength Index (SSSI) scores. The study underscores the impact of SSI on the behavior of nearby building structures during seismic events, highlighting its critical role in seismic analysis and lateral load processes. The findings recommend integrating SSI into engineering practices to enhance structural integrity and mitigate seismic risks effectively.

Koyandea et al., 2021 [3]

This study compares the performance, cost, and planning analysis of conventional RCC and GFRG buildings under seismic loading conditions. GFRG buildings demonstrate superior performance in seismic analysis due to their reduced weight compared to RCC, resulting in up to 20% lower base shear forces. Cost analysis reveals direct and indirect savings of 20–30% with GFRG compared to RCC, attributed to faster installation times and reduced material usage. The study concludes that GFRG designs offer advantages in seismic resilience, cost-effectiveness, and construction efficiency, particularly beneficial for economically challenged areas.

Cayci et al., 2021 [4]

This study investigates the interaction between soil and structure through the evaluation of impact effects on general construction structures. Using various building models and ground motion data, the research highlights how impact effects influence structural behavior, particularly in terms of displacement and damage mechanisms. It identifies the critical role of soil-structure interaction models in predicting and mitigating structural responses to seismic loads, emphasizing the importance of integrating these factors into engineering design practices.

Archan et al., 2021 [5]

Focusing on multi-storey Reinforced Concrete (RC) structures, this study examines seismic vulnerabilities arising from irregular mass and stiffness distributions. Through dynamic analyses using ETABS software and compliance with Indian seismic codes (IS 1893-2002), the research evaluates structural responses across different seismic zones. Results show that designs compliant with seismic standards exhibit reduced lateral displacement and storey drift, highlighting the importance of seismic design considerations in mitigating earthquake risks for multi-story RC buildings.

Pankaj Kumar, 2021 [6]

Addressing settlement issues and utilizing sustainable materials, this study explores the use of GFRG panels filled with M20 grade concrete and fly ash aggregate. The research demonstrates that GFRG panels, constructed from lightweight concrete mixed with fly ash, offer enhanced electrical and seismic resistance while reducing concrete weight by 27.5% compared to conventional methods. This approach not only addresses housing demands sustainably but also mitigates environmental impacts by utilizing fly ash as a recycled material in construction.

IV. CONCLUSIONS

In modern construction, the choice of materials profoundly affects structural integrity, sustainability, and cost-efficiency. Glass Fiber Reinforced Gypsum (GFRG) panels are emerging as a promising alternative to Reinforced Cement Concrete (RCC) in multi-storey buildings. GFRG panels, reinforced with glass fibers in gypsum plaster, offer lightweight strength, rapid installation, and superior fire resistance, earthquake resilience, and thermal insulation. While RCC remains robust for heavy loads and seismic conditions, GFRG panels provide up to 20% lower base shear forces and 20–30% cost savings due to reduced materials and faster construction. Promoting GFRG adoption through research and advanced tools like ETABS software can enhance its role in sustainable, efficient construction practices, addressing housing needs and environmental concerns.

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