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Suggesting Glulam as a sustainable and efficient substitute forconventional construction materials in Goan residences

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Abstract

Concrete, known for its versatility, quickly became a preferred alternative due to its durability and ease of use. Yet, despite its practical advantages, the environmental impact of concrete is significant. Its production process releases harmful emissions, contributing to environmental degradation, soil infertility, and even adverse health effects on its users. As architects, we have a responsibility to explore innovative building materials that not only leverage modern technology but also stay true to our cultural and ecological roots. Furthermore, concrete has inferior insulation properties compared to materials like timber, resulting in increased energy consumption for heating and cooling. This, in turn, contributes to higher carbon emissions throughout a building's lifecycle. While these factors relate to the physical characteristics of concrete, a more significant issue lies in its aesthetic impact. Concrete often diminishes the traditional charm of Goan architecture, which is deeply rooted in local materials that evoke a sense of comfort and warmth. The true identity of a traditional Goan home is derived from its use of natural materials that resonate with the local environment and culture—qualities that concrete fails to replicate. In this context, exploring sustainable alternatives like Glulam becomes essential, as they not only meet structural requirements but also enhance the aesthetic appeal and cultural relevance of Goan architecture.
Keywords—Glulam, sustainable, Goa, construction, timber

I. Introductiona.

Goa's Identity Through Traditional Building Materials A state rich in cultural heritage and history is often reflected through its architecture. The spatial planning, design elements, and, most importantly, building materials, shape the identity of a place. Goa, as a coastal state, has long relied on locally available materials, such as laterite stone and timber, thoughtfully considering its climate and geographical features. Traditional materials like laterite stone and timber from coconut and teakwood trees have been key in maintaining cooler interiors in Goa's humid conditions, offering structural stability and protection against heavy rains. However, despite their benefits, timber's high maintenance demands led many Goans to shift towards concrete for construction. B. The Impact of Concrete on Goa's Architectural Legacy
Concrete, known for its versatility, quickly became a preferred alternative due to its durability and ease of use. Yet, despite its practical advantages, the environmental impact of concrete is significant. Its production process releases harmful emissions, contributing to environmental degradation, soil infertility, and even adverse health effects on its users. As architects, we have a responsibility to explore innovative building materials that not only leverage modern technology but also stay true to our cultural and ecological roots. Furthermore, concrete has inferior insulation properties compared to materials like timber, resulting in increased energy consumption for heating and cooling. This, in turn, contributes to higher carbon emissions throughout a building's lifecycle. While these factors relate to the physical characteristics of concrete, a more significant issue lies in its aesthetic impact. Concrete often diminishes the traditional charm of Goan architecture, which is deeply rooted in local materials that evoke a sense of comfort and warmth. The true identity of a traditional Goan home is derived from its use of natural materials that resonate with the local environment and culture—qualities that concrete fails to replicate. In this context, exploring sustainable alternatives like Glulam becomes essential, as they not only meet structural requirements but also enhance the aesthetic appeal and cultural relevance of Goan architecture.

C. What is Glulam?

One such material is Glulam, short for glued laminated timber. Glulam is an engineered wood product made by bonding together layers of timber, known as laminates. It retains the aesthetic appeal of traditional timber while offering greater structural stability than steel. Compared to the energy-intensive production of concrete, Glulam beams require only a fraction of the energy, making them a more sustainable option. Additionally, Glulam boasts excellent fire

resistance and improved earthquake-resistant properties, making it an effective alternative to traditional timber in modern construction.

II. Data Collection

- 1. Glulam and the environment-Glulam products have a natural place in an Eco cycle society. The engineered wood is renewable and recyclable, while its manufacture is largely based on bio-energy.
- 2. Load bearing capacity-The process of manufacturing Glulam happens in a controlled environment which extends its scope to be a part of large structures. These sections are stronger and stiffer than solid wood, hence it can handle larger loads and can cause less deflection over the years
- 3. Thermal properties-In comparison with metal, wood has very small temperature movements. This means that the tensions in glulam due to temperature changes, seldom cause any inconvenience.
- 4. Moisture content-Wood should have less moisture content which is used for construction purposes other chances of mold growth can occur. Glulam (glued laminated timber) typically has a moisture content of 12–14% or less when it's manufactured. This is because the glulam manufacturing process uses dimension lumber that's usually dried to a moisture content of 16% or less. With further advancement, moisture content can be reduced to be used in a region where humidity levels are high
- 5. Glulam being recycled-Glulam can easily be recycled compared to concrete. This procedure will reduce the waste generation which is generally caused by construction materials. Increased landfills are one of the major causes of the construction industry

III. Case study

A. The Mass Timber Residence.

The Mass Timber Residence, a 6500 sqft project completed in 2023 by Delhi-based firm Artius in North Goa, exemplifies the use of sustainable building materials to address extreme climatic conditions. The design incorporates raw structural timber, Douglas fir, and Glulam (glued laminated timber), a modern construction material that ensures structural stability in a region facing high winds and is located in seismic zone III. The house uses a post-and-beam construction method, with Glulam columns and beams anchored to a concrete foundation and insulated with Rockwool for sound and heat efficiency. This project highlights Glulam's role in sustainable architecture, balancing environmental concerns with cultural and aesthetic values. It sets a precedent for future architectural developments, focusing on eco-friendly materials without compromising on design or functionality.

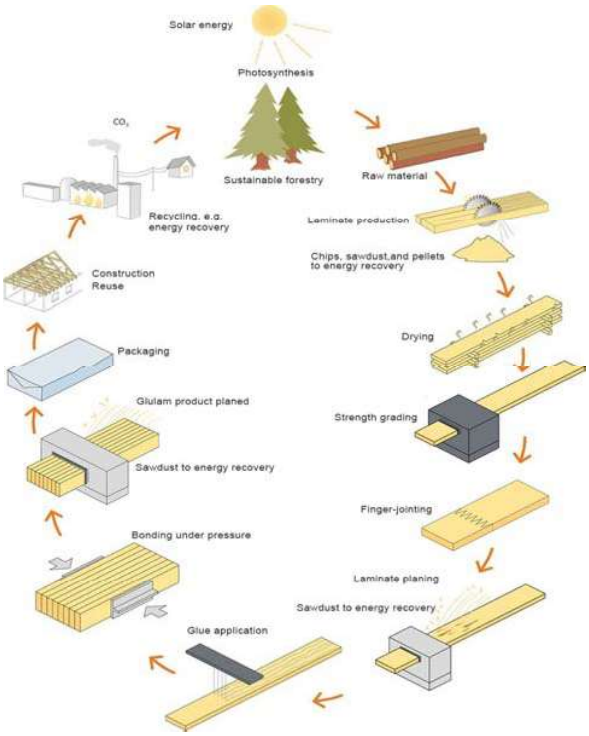

Fig. 1. Process of formation of Glulam. (*Source-Swedish wood manufacturing process of glulam*)

Fig.2,3.(Source: House constructed by the firm Artius in north Goa, Vagator,Elle décor)

Analysis

The Mass Timber Residence by Artius exemplifies the potential of Glulam as a sustainable and resilient building material, especially in challenging climates like Goa's. Structurally, Glulam outperforms traditional timber and steel, offering strength, stiffness, and lightweight properties ideal for withstanding high winds and seismic activity. Environmentally, it significantly reduces the carbon footprint compared to concrete, aligning with global trends in sustainable architecture. The integration of Rockwool insulation further enhances the building's

energy efficiency, making it more suited to Goa's tropical climate. Aesthetically, the project successfully merges traditional Goan architectural elements with modern design, maintaining cultural relevance while embracing innovation. This residence sets a strong precedent for future eco-friendly architectural projects, demonstrating that sustain ability and functionality can coexist without sacrificing design integrity or cultural identity.

V. Interviews

A. Comparative analysis-

Based on the interviews conducted a comparative analysis table based on the insights from Dean D'Cruz and Ar. Vinish Desai regarding timber use and the potential adoption of Glulam in Goan architecture is prepared. The table highlights similarities and differences, along with relevant quotes from both architects.

Aspect	Ar. Dean D'Cruz	Ar. Vinish Desai	Comparison
Types of Wood Used	"Typically, we use Matti for roofing and Sal for doors and windows. Occasionally, we use coconut rafters wherever possible."	"Teakwood, Jackfruit wood mostly for furniture. Local jungle wood for structural elements."	Both architects emphasize the use of locally available timber types, reflecting a preference for materials aligned with Goan culture.
Timber as Structural Material	"Only recycled wooden columns from old houses."	"Not much. The cost works out much higher than steel."	D'Cruz prioritizes sustainability through recycled timber, while Desai highlights a shift towards steel due to cost.
Timber Treatments	"Generally, a wood guard and linseed oil."	"Polish, oils, and synthetic coatings."	Both architects acknowledge the need for treatments to protect timber from humidity and damage, indicating a common concern regarding timber maintenance.
Timber Failure	"Occasionally, one experiences splitting of wood if not oiled, or termites if the member touches masonry surfaces untreated with pesticides."	"Contraction of non-seasoned timber... can cause joints to show gaps but not fail... timber requires attention and maintenance."	Both recognize that timber has vulnerabilities, such as splitting and contraction, requiring ongoing maintenance to ensure longevity.
Timber Composites	"Aware, but not easily available."	"No. I prefer the real material, or else don't use imitation."	Both architects have not adopted Glulam, indicating a local hesitance toward engineered timber products, although for different reasons (availability vs. preference).
Durability of Timber Joinery	"If well done, it holds— avoiding the use of nails, especially MS."	"Joints can show gaps. The size and extent of gaps increase with poor timber or seasoning quality."	D'Cruz emphasizes skilled craftsmanship for durability, while Desai highlights potential gaps due to timber quality.
Awareness and Adoption of Glulam	"Aware, but not easily available."	"Glulam is good as it evens out the shortcomings of timber... but it's known as an expensive material with procurement hassles."	Both architects acknowledge the advantages of Glulam but express concerns over its accessibility and cost.
Barriers to Glulam Adoption	"No known manufacturers locally. Glulam comes from far away, like Canada."	"Glulam is still not accessible and looked at as an alien material... cost is a major barrier."	Both cite logistical challenges and high costs as significant barriers to the adoption of Glulam in Goa.
Market Readiness for Glulam	"No, the wood generally comes from a far distance, e.g., Canada, and the Glulam sections, if available, come from far away from Goa."	"Steel rules the market at present."	Both architects' express skepticism about the current market readiness for Glulam, pointing to the dominance of steel as a more practical alternative.

Comparative analysis of views of Ar. Dean D'cruz, Ar. Vinish Desai Table-1. Source: Author

B Surveys

The Google form survey included a sample size of 5 participants, with 3 local practicing architects responding. The architects who participated in the survey are Ar. Fiona
Menezes, Ar. Girish Karnawat, and Bruce Fernandes. Based on the survey the following analysis has been done

- 1) Professional Background: Among the respondents, 33.3% identified as architectural engineers and design consultants, while 66.7%

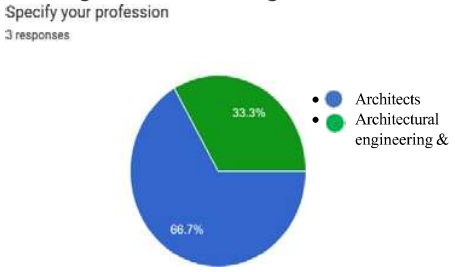

Fig 4. Source: Author

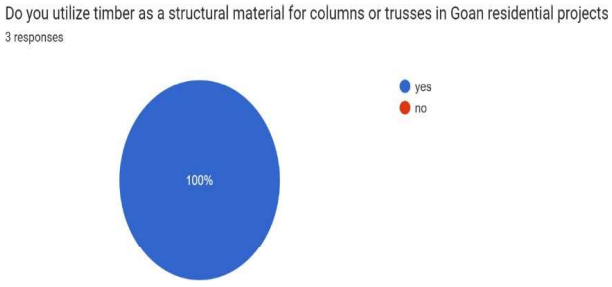

Fig 5. Source: Author

- 2) Timber Treatment: All respondents employed chemical treatments to protect timber from humidity and warping, highlighting a shared understanding of the challenges posed by Goa's

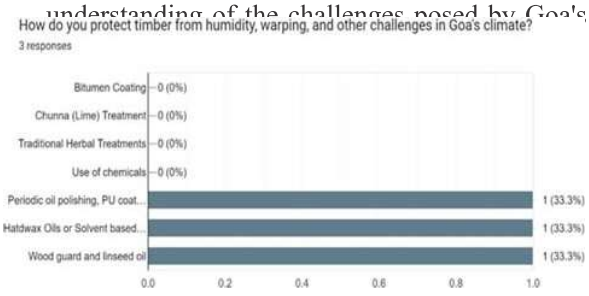

Fig 6. Source: Author

- 3) Hybrid Systems: The majority of architects indicated they have used hybrid steel-timber composite systems for enhanced durability, suggesting an openness to integrating materials.
- 4) Timber Failure: Responses regarding timber failure varied, with one architect reporting no issues, another suggesting a lifespan of up to 25 years, and a third noting potential problems due to inadequate treatment and pest exposure. This reflects the influence of maintenance on timber longevity in humid environments.
- 5) Knowledge of Timber Composites: All respondents were unaware of available timber composites, indicating a potential knowledge gap in the market.
- 6) Experience with Glulam: None of the architects had worked with Glulam, pointing to a lack of familiarity and experience with this engineered wood product.

V. Analysis

The interviews with Dean D'Cruz and Ar. Vinish Desai, along with a survey of three local architects, reveal a strong preference for traditional timber in Goan architecture, though concerns about its durability and maintenance in the region's humid climate were consistently raised. All of the architects use chemical treatments to protect timber from environmental factors, and many have adopted hybrid systems that combine timber with steel to improve durability. However, none of the respondents have worked with Glulam, indicating a lack of awareness and highlighting barriers to its adoption, including high costs, limited availability, and the absence of local manufacturers. While the architects acknowledge the potential advantages of engineered wood products, substantial challenges remain in integrating them into Goan construction practices.

VI. Inferences/ strategies

The analysis of interviews with local architects in Goa reveals a strong preference for traditional timber, valued for its cultural and aesthetic significance. However, significant barriers to adopting materials like Glulam persist, including concerns about higher costs, limited availability, and the challenges of integrating unfamiliar products into established design practices. Additionally, architects emphasize the need for improved treatment options for timber to address maintenance issues in Goa's humid climate.
To overcome these challenges, it is crucial to raise awareness of Glulam through educational workshops and successful case studies, collaborate with manufacturers to enhance local access and explore hybrid designs that combine traditional timber with Glulam. By adopting these strategies, the architectural community can foster sustainable practices while respecting Goan's construction heritage.

VII. Conclusion

In conclusion, the investigation of Glulam as a replacement for traditional timber in Goan architecture underscores its timely relevance and significance. While local architects recognize the sustainability and structural benefits of Glulam, concerns regarding cost, availability, and cultural compatibility remain key obstacles. Nevertheless, Glulam offers more than just a visual substitute for timber—it provides enhanced durability and a reduced environmental impact. By considering its physical properties and long-term ecological benefits, Glulam shows great potential for advancing sustainable architecture in Goa. A balance between tradition and innovation could lead to construction practices that both honour Goan heritage and adopt eco- friendly solutions.

VIII. Acknowledgment

I would like to express my sincere gratitude to all the architects and professionals who participated in this research. Their insights and experiences have been invaluable in shaping my understanding of Glulam and its potential within the Goan architectural landscape. I would also like to thank my academic advisor Ar. Shilpa Dhawale and Ar. Romeiro Silveira and peers for their continuous support and constructive feedback throughout this study. A special acknowledgment to Ar. Dean D'Cruz, Ar. Vinish Desai, Ar. Fiona Menezes, Ar. Girish Karnawat, and Bruce Fernandes. Their insights and experiences have been invaluable in shaping my understanding of Glulam and its potential within the Goan architectural landscape.

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