EDUZONE: International Peer Reviewed/Refereed Multidisciplinary Journal (EIPRMJ), ISSN: 2319-5045
Volume 7, Issue 2, July-December, 2018, Impact Factor: 5.147, Available online at: www.eduzonejournal.com

Analysis and Design of Composite Structures in Structural Engineering

Amarjeet Singh

M. Tech Scholar, Kalinga University Raipur, Chattisgarh

ABSTRACT

A composite structure is a composition that is a mixture of multiple materials and acts as a single unit. This composite action is stronger than single materials strength and it is mostly used in structural engineering. From a structural point of view this is a single unit which provides greater strength to the structure. Here in this part the analysis and the design pattern have been built for the composite structure of the composition of structural engineering. Where this file has been made for the methodological implementation of the structural components with the advancement of the composites. Here in that context it involves the chosen materials and the other concept of the structural engineering for the determination of the strength and the toughness of applied model structure. So, here in this context the structure has been built using the materials steel, concrete and masonry for the steel concrete composite structure

Keywords: Composite materials, Heat insulation, Secondary analysis, Hybrid composite, reinforced construction, Construction industry, Lightweight structures.

INTRODUCTION

The report is based on the designing of composite structures in the field of structural engineering. The structures that are built with different materials such as timber, concrete, and steel are called composite. Basically, composite structures are made of different materials instead of using one particular material. Due to this reason, these structures have a lot of advantages as well as disadvantages. The steel-concrete composite structure is the most common and widely used which is the combination of concrete and steel. In this structure, the concrete resist the compaction load, and the steel resists the tensile load that occurs on the structure. This report elaborates on several attributes of designing composite structures that start with methodologies and materials used for making composite structures. The result and discussion section is done with a secondary analysis of test results. The final section is a recommendation that can develop the existing composite structures and future scope.

REVIEW OF LITERATURE

According to Scardaoni *et al.* 2022, composite materials can allow modifying the properties of the materials, in order to provide benefits. Half-breed composites can be utilized in a large number of primary applications, including scaffolds, structures, and modern designs. In the construction industry, composite designs are utilized broadly in the planning of buildings, bridges, and other massive civil structures. Structural engineers have a lot of options for designing innovative, high-performance structures in a variety of industries of the vast scope of composite structure design.

According to Wang *et al.* 2020, the tasks of optimization of the composite structures are complex to do. Composite designs are utilized in foundation ventures like pipelines, burrows, and holding walls. They offer better solidness and consumption opposition contrasted with customary materials like steel and cement. Composite materials are ideal for use in these applications because they are complex and have a high strength-to-weight ratio. These applications require efficiency and weight which can be utilized for several lightweight constructions.

MATERIALS AND METHODOLOGY

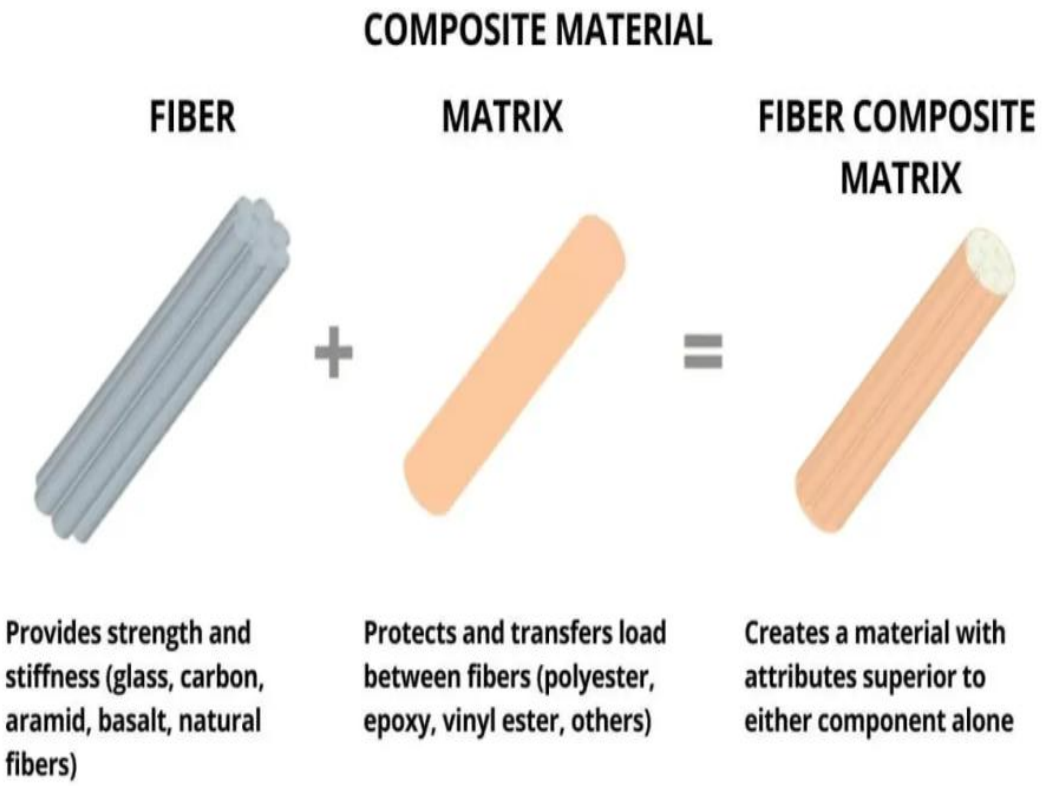
Materials

The material used to design composite structures typically consist of two or more distinct materials that are combined in a way that maximizes their respective strengths (Li, Z. *et al*, 2021.). The materials that are used to design composite

structures can be very different from one application to the next, but the following are some common materials that are used in composite structures:

Fibers: These are normally produced using materials like carbon, glass, aramid, or basalt. Filaments give strength and solidness to the composite material.

Fillers: In order to enhance properties like thermal conductivity, electrical conductivity, or wear resistance, these are frequently incorporated into the matrix.



(Source: https://i0.wp.com/midwestcomposites.com)

Figure 1: Composite Materials

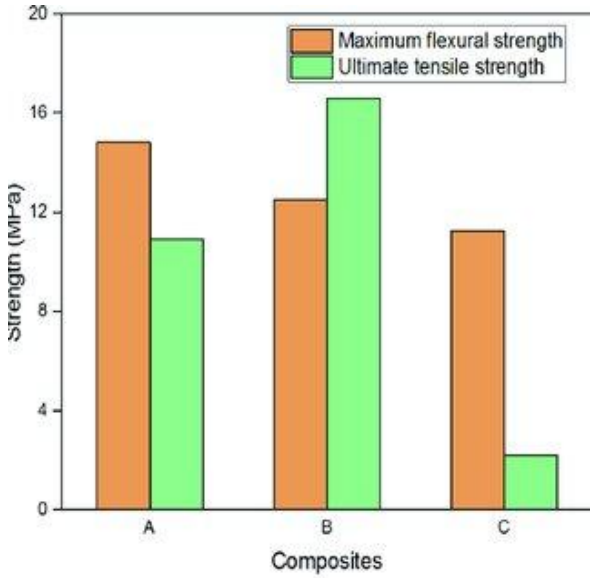
Adhesives: The composite material is joined to other materials or components by means of these (Shakeri, M. *et al*, 2019.). Adhesives can be very strong and long-lasting, but they need to be chosen carefully to be compatible with the other materials in the composite structure.[***Refer to Appendix 1***]

Matrix: The substance that surrounds and holds the fibers together is this. Typically, it is a polymer like polyester or epoxy, but it can also be metal or ceramic. The matrix aids in the even distribution of loads and transfers stresses between fibers.

METHODOLOGY

This section holds information about the methodologies utilized for the designing of composite structures.

Selection of materials: The most vital phase in planning composite designs is choosing the suitable materials to be utilized in the development of the construction (Neuhäusler, J. *et al*, 2019). This involves selecting the composite materials that best meet the project's requirements, such as carbon fiber-reinforced polymer (CFRP), fiber-reinforced polymer (FRP), or glass fiber-reinforced polymer (GFRP).



(Source: https://www.researchgate.net)

Figure 2: Comparison of Tensile and Flexural Strength of Composite Material

Criteria for Design: The kind of application, the loading conditions, the environmental factors, and the requirements for durability will all play a role in determining the design criteria for composite structures (Yang, J. *et al*, 2020.). This will include characterizing the primary presentation, strength, solidness, and exhaustion opposition of the composite design.

Modeling of Structures: Software tools that make use of analytical or finite element analysis (FEA) can be used to model the composite structure. The composite structure's structural behavior under specific loading conditions is determined through the modeling process.

Optimization of Design: By adjusting the structural geometry and the properties of the materials, the optimization process aims to increase the performance of the composite structure and decrease the costs of the materials (Lu, X.Z. *et al*, 2022). The manufacturing process's practicality and any constraints imposed by the environment should also be taken into account during the optimization process.

Manufacturing: The layup of the composite material, curing, and post-curing processes are all part of the manufacturing procedure for composite structures (Huang, Y. *et al*, 2021.). The chosen material, the structural design, and the required quality standards will all have an impact on the manufacturing procedure.

Testing Process: Testing must be carried out after the composite structure has been produced to ensure that it satisfies the design specifications (Rajan, G. *et al*, 2019.). Testing will include the utilization of damaging and non-horrendous strategies to assess the mechanical properties and the underlying honesty of the composite design.

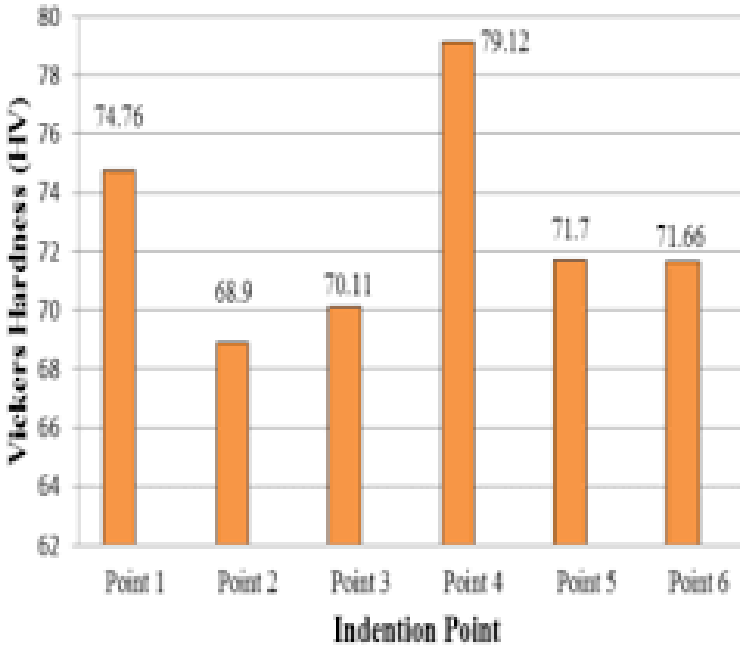
Certification: In conclusion, certification of the composite structure is required to guarantee compliance with regulatory requirements and industry standards. Acquiring certification from independent testing and certification organizations will be necessary for this.
Choosing the right materials, defining the design criteria, modeling the structure, optimizing the design, manufacturing, testing, and certification are all part of the process of designing composite structures.

RESULTS AND DISCUSSION

As the secondary analysis is considered for this report, the result and discussion part is performed by elaborating on several composite components and the usage of those components.

High-rise buildings: As tall buildings have to deal with high wind speed, the usage of composite structures in these buildings is a very useful method (De Rosa, S.et al, 2019.). The main composite structures used here are stee-concrete

composite components. Due to its capacity to withstand significant seismic and wind loads, composite structures are utilized in high-rise buildings.



(Source: https://encrypted-tbn0.gstatic.com)

Figure 3: Hardness assessment of Composite material

Another important usage of composite material in buildings is the insulation of the rooms. Specific composite materials are used to improve insulation in the room walls which maintains the temperature of the room (Rajan, G.et al, 2019). The usage of composite materials such as fibers or light timbers in buildings can also reduce energy consumption and provide cost efficiency.

Bridges: Another sector where composite structures are used is Bridges. The decks of the bridges, the beams, and the cables that are used for the tensile force, all the components are made from the composite structures. The materials used to make these types of structures are fiberglass and carbon fiber. These materials offer high solidarity to-weight proportions, strength, and protection from consumption.[***Refer to Appendix 2***]

Infrastructures and Facilities Regarding Sports: The sports arena consists of huge structures like a stadium and a concrete pitch which consists of several composite materials (Lee, J.M. *et al*, 2020). The composite structures can offer high solidarity to-weight proportions, which can be gainful for huge designs that need to help weighty burdens. These attributes are very important to build an arena regarding sports as the safety of the participants depends on the materials of the structures.

CONCLUSION AND FUTURE SCOPE

Future scope

The extent of planning composite designs in primary designing is very broad and covers a wide scope of uses across numerous enterprises. A composite structure is made up of two or more materials that have different chemical and physical properties and are combined to make a new material that is stronger, lighter, and lasts longer than its individual parts.

Composite structures are frequently used in construction applications, such as the design of bridges, buildings, and other infrastructure projects, in the field of civil engineering. Fiber-reinforced polymers (FRPs) and other composite materials are frequently used in place of conventional building materials like steel and concrete to reduce weight, increase durability, and enhance overall performance.

RECOMMENDATIONS

Composites Made of Fiber-Reinforced Polymer (FRP): FRP composites are made by consolidating a polymer network with supporting strands like fiberglass, carbon fiber, or aramid. Because they are corrosion-resistant, lightweight, and long-lasting, these materials are ideal for a variety of structural applications. Reinforcing concrete structures, strengthening bridges, and serving as building structural components are all possible applications for FRP composites.

Panels Sandwiched: Sandwich boards comprise two external layers of an unbending material, for example, metal or fiber-built-up plastic, with a lightweight center material in the middle between. Sandwich boards offer astounding solidarity to-weight proportions, making them ideal for use in walls, rooftops, and floors of structures.

Composite Lumber: Wood fibers are combined with a polymer resin to create composite timber. Because it resists rot, insects, and weathering, this material is an excellent substitute for traditional wood. Decking, fencing, and other outdoor structures can all be constructed of composite timber.

Composites Made of Hybrid Materials: By combining two or more distinct types of composite materials, hybrid composites are produced. For instance, a mixture composite could consolidate carbon fiber and fiberglass to accomplish an equilibrium of solidarity, firmness, and cost viability.

CONCLUSION

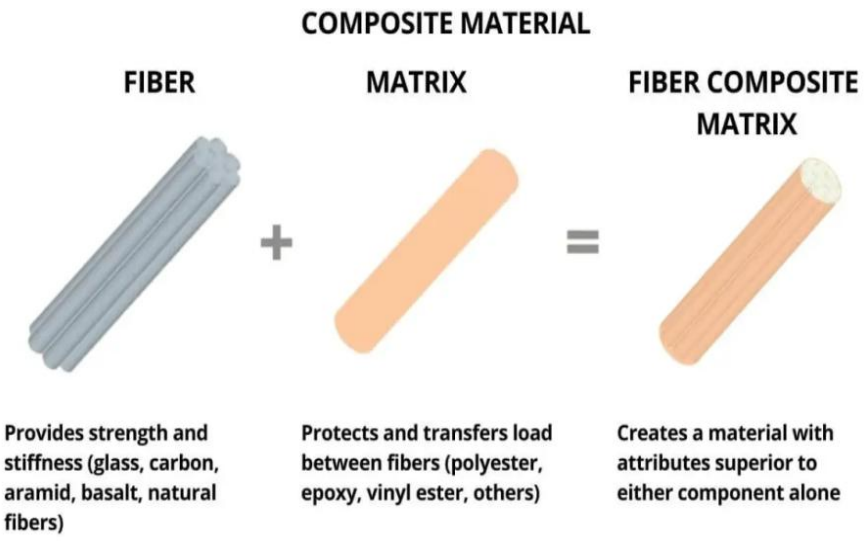
This section holds brief information about the actions performed throughout this report. The main purpose of this study is to determine the designing process of composite structures in the construction industry. The literature review elaborates thoughts of several researchers on this topic. The methodology section elaborates on several methods of composite structures and the discussion part states several uses of composite design.

REFERENCES

[1]. Wang, L., Ni, B., Wang, X. and Li, Z., 2021. Reliability-based topology optimization for heterogeneous composite structures under interval and convex mixed uncertainties. *Applied Mathematical Modelling*, *99*, pp.628-652.
[2]. Nikbakht, S., Kamarian, S. and Shakeri, M., 2019. A review on optimization of composite structures Part II: Functionally graded materials. *Composite Structures*, *214*, pp.83-102.
[3]. Neuhäusler, J., 2019. *Design of Composite Structures in the Early Phase* (Doctoral dissertation, Hochschulefür Angewandte Wissens chaften München).
[4]. Zhao, S., Zhao, Z., Yang, Z., Ke, L., Kitipornchai, S. and Yang, J., 2020. Functionally graded graphene reinforced composite structures: A review. *Engineering Structures*, *210*, p.110339.
[5]. Fei, Y.F., Tian, Y., Huang, Y.L. and Lu, X.Z., 2022. Influence of damping models on dynamic analyses of a base-isolated composite structure under earthquakes and environmental vibrations [J]. *Engineering Mechanics*, *39*(03), pp.201-211.
[6]. Nsengiyumva, W., Zhong, S., Lin, J., Zhang, Q., Zhong, J. and Huang, Y., 2021. Advances, limitations and prospects of nondestructive testing and evaluation of thick composites and sandwich structures: A state-of-the-art review. *Composite Structures*, *256*, p.112951.
[7]. Casaburo, A., Petrone, G., Franco, F. and De Rosa, S., 2019. A review of similitude methods for structural engineering. *Applied Mechanics Reviews*, *71*(3).
[8]. Oromiehie, E., Prusty, B.G., Compston, P. and Rajan, G., 2019. Automated fibre placement based composite structures: Review on the defects, impacts and inspections techniques. *Composite Structures*, *224*, p.110987.
[9]. Wang, H. and Lee, J.M., 2020. Recent advances in structural engineering of MXeneelectrocatalysts. *Journal of Materials Chemistry A*, *8*(21), pp.10604-10624.
[10]. Scardaoni, M.P., Izzi, M.I., Montemurro, M., Panettieri, E., Cipolla, V. and Binante, V., 2022. Multi-scale deterministic optimisation of blended composite structures: case study of a box-wing. *Thin-Walled Structures*, *170*, p.108521.
[11]. Wang, Z. and Sobey, A., 2020. A comparative review between Genetic Algorithm use in composite optimization and the state-of-the-art in evolutionary computation. *Composite Structures*, *233*, p.111739.

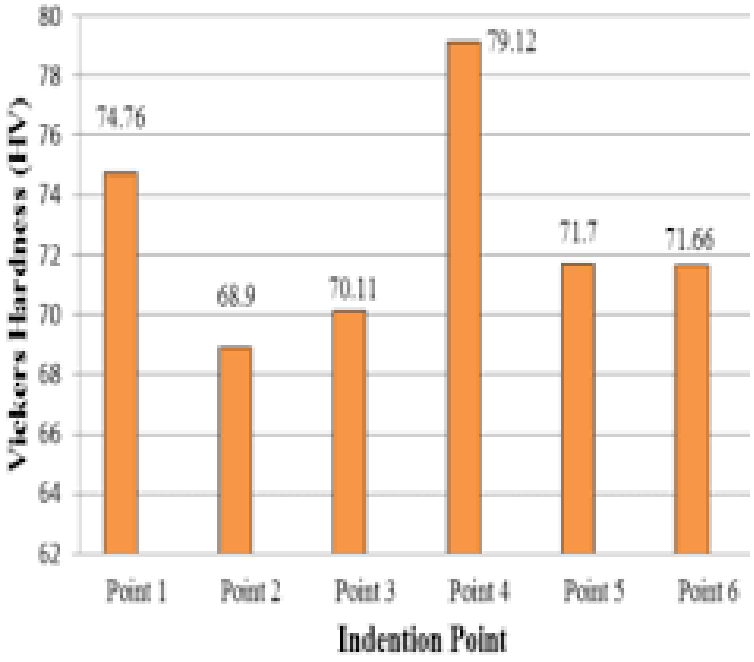
Appendices

Appendix 1: Composite Materials



(Source: https://i0.wp.com/midwestcomposites.com)

Appendix 2: Hardness assessment of Composite material



(Source: https://encrypted-tbn0.gstatic.com)