



# Flexural Behaviour of Sandwich Composite Panels Fabricated Through Different Vacuum Bagging Techniques

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Multiple bag technique, Glass  
fabric/epoxy face sheets,  
Three-point bending test,  
Flexural properties.

## Abstract

The experimental investigation here focuses on the fabrication of sandwich panels using a single hot vacuum bag, modified vacuum bag, multiple bag and a single hot vacuum bag with platen compression techniques. The present vacuum bagging system cannot be used to prepare sandwich structures when the pressure needs to exceed one bar for bonding considerations. In order to avoid this issue, a new methodology that follows a modified and then a multiple bag technique is proposed to fabricate sandwich panels with high temperature curing of epoxies. Sandwich composites with glass fabric-epoxy face sheet as skin material and a low density thermoset unfilled rigid foam-Polyisocyanurate (PIR-100kg/cu.m), as core material, are considered here. Specimens are tested for flexure for varied spans and at a constant skin to core weight ratio. The flexural strength, rigidity and shear properties are evaluated from the observations to find the influence of the core and span to depth ratios on the respective properties of the sandwich composites.

The work had been presented at an international conference **Fatigue Durability India 2015**, 28-30th May 2015, IN TATA AUDITORIUM, Indian Institute of Science, Bangalore.

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## Introduction

A composite material can be defined [1] as a combination of two or more materials that results in better properties than those of the individual constituents. The two main constituents of a composite material are reinforcement and a matrix. The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part. The reinforcing phase provides the strength and stiffness which may be harder, stronger, and stiffer than the matrix. A sandwich-structured composites [2] are a special class of composite materials, fabricated by attaching two thin but stiff skins to a lightweight, but thick core. These materials have increasingly been used in a variety of industrial applications such as [3] marine, automobile industry, aeronautics, and aerospace as it is convenient for designers to design for specific requirements with precision and work with the desired characteristics, due to high strength to weight ratios. Polyisocyanurate (PIR) [5] foams represent the system of choice to produce Glass fabric-faced sandwich panels, providing energy efficiency and compliance to severe fire safety requirements.

The manufacturing techniques are also seen to contribute [6] toward performance of the composite. Vishakh et. al. [2] and Surya Teja Varma [4] have investigated the flexural properties of foam core glass epoxy sandwich composites, followed room temperature vacuum bagging technique. Menta [6] developed a non-autoclave vacuum bag process using atmospheric pressure alone that eliminates the need for external pressure normally supplied by an autoclave or a press is an attractive method for composite fabrication. In order to protect against bag or seal failure, part lay-ups are sometimes 'double bagged'. Double bagging [7] [8] involves placing a first, inner bag over the lay-up which is then sealed to the

tool base. A second, outer bag is placed over the inner bag and is also sealed to the tool base. The various flexural properties of sandwich specimens such as flexural strength, flexural strength per unit width, bending strength per unit width, bending stress, shear strain were obtained under 3 point bending [9][10] to find the sandwich beam flexural and shear stiffness.

## Experimental

### Approach of Investigation

The present investigation deals about fabrication of sandwich panels using four different techniques. A Thermo set rigid unfilled polyisocyanurate foam (PIR) of density 100kg/m<sup>3</sup> is used as core and glass/epoxy as the skin material. The skin to core weight ratio is maintained at 4:1 with volume fraction of 0.3 in the skin for the fibre, and the beams were tested for flexure.

**Table 1: Materials Considered For Fabrication**

Material	Name
Skin Reinforcement	E - Glass Fabric-Plain Weave
Core	PIR-100 kg/m <sup>3</sup>
Resin	LY556
Hardener	EH200

**Table 2: Material Properties of Core**

Properties	PIR-100
Elastic Modulus(M Pa)	14.6 MPa
Poisson's Ratio	0.29

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**Reza Vaziri,Asemi Nakai,Bryn  
Crawford ,Tatsuro Kosaka,Suong Hoa**

## **Flexural Behaviour Of Sandwich Composite Panels Fabricated:**

**Hybrid Fiber Composites** Anish Khan, Sanjay Mavinkere Rangappa, Mohammad Jawaid, Suchart Siengchin, Abdullah M. Asiri, 2020-07-02 Fiber reinforced composites are exceptionally versatile materials whose properties can be tuned to exhibit a variety of favorable properties such as high tensile strength and resistance against wear or chemical and thermal influences. Consequently, these materials are widely used in various industrial fields such as the aircraft, marine, and automobile industry. After an overview of the general structures and properties of hybrid fiber composites, the book focuses on the manufacturing and processing of these materials and their mechanical performance, including the elucidation of failure mechanisms. A comprehensive chapter on the modeling of hybrid fiber composites from micromechanical properties to macro scale material behavior is followed by a review of applications of these materials in structural engineering, packaging, and the automotive and aerospace industries. *Processing and Fabrication of Advanced Materials, XVII: Part 8: Polymer-based composites and nano composites: Volume Two*, 2009. Papers presented at the Seventeenth International Symposium on Processing and Fabrication of Advanced Materials XVII held at New Delhi during 15-17 December 2008. Sandwich Composites Senthilkumar Krishnasamy, Chandrasekar Muthukumar, Senthil Muthu Kumar Thiagamani, Sanjay Mavinkere Rangappa, Suchart Siengchin, 2022-01-25 A composite sandwich panel is a hybrid material made up of constituents such as a face sheet, a core, and adhesive film for bonding the face sheet and core together. Advances in materials have provided designers with several choices for developing sandwich structures with advanced functionalities. The selection of a material in the sandwich construction is based on the cost, availability, strength requirements, ease of manufacturing, machinability, and post-manufacturing process requirements. *Sandwich Composites: Fabrication and Characterization* provides insights into composite sandwich panels based on the material aspects, mechanical properties, defect characterization, and secondary processes after the fabrication, such as drilling and repair. **FEATURES** Outlines existing fabrication methods and various materials aspects. Examines composite sandwich panels made of different face sheets and core materials. Covers the response of composite sandwich panels to static and dynamic loads. Describes parameters governing the drilling process and repair procedures. Discusses the applications of composite sandwich panels in various fields. Explores the role of 3D printing in the fabrication of composite sandwich panels. Due to the wide scope of the topics covered, this book is suitable for researchers and scholars in the research and development of composite sandwich panels. This book can also be used as a reference by professionals and engineers interested in understanding the factors governing the material properties, material response, and the failure behavior under various mechanical loads. **Handbook of Composites from Renewable Materials, Design and Manufacturing** Vijay Kumar Thakur, Manju Kumari Thakur, Michael R. Kessler, 2017-03-03 This unique multidisciplinary 8 volume set focuses on the emerging issues concerning synthesis, characterization, design, manufacturing, and various other aspects of composite materials from renewable materials and provides a shared platform for both researcher and industry.

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*Biocomposites for Lightweight Sandwich Structures* M.Y.M. Zuhri,S. M. Sapuan,2024-12-19 Biocomposites for Lightweight Sandwich Structures Engineering Properties and Applications highlights how the relationship between biocomposites and sandwich structures can provide a unique combination of superior properties that can be optimized for environmentally friendly lightweight applications It introduces current performance of biocomposites sandwich structure applications machining and manufacturing methods energy absorbing capabilities and strengthening techniques of structures as well as potential challenges and future perspectives on performance improvement Provides latest research on biocomposites and use in lightweight engineering applications Explores the suitability of core designs using biocomposites and related environmentally friendly materials Includes recent manufacturing technologies and important performance criteria of sustainable materials for lightweight structures Discusses existing commercial materials and those that are currently under research and development This comprehensive reference will be of interest to materials mechanical and aerospace engineers and those working in related fields interested in development of materials for lightweight designs

**ACMSM25** Chien Ming Wang,Johnny C.M. Ho,Sritawat Kitipornchai,2019-09-03 This book presents articles from The Australasian Conference on the

Mechanics of Structures and Materials ACMSM25 held in Brisbane December 2018 celebrating the 50th anniversary of the conference First held in Sydney in 1967 it is one of the longest running conferences of its kind taking place every 2 3 years in Australia or New Zealand Bringing together international experts and leaders to disseminate recent research findings in the fields of structural mechanics civil engineering and materials it offers a forum for participants from around the world to review discuss and present the latest developments in the broad discipline of mechanics and materials in civil engineering

ICCS21 Antonio J.M. Ferreira, Francesco Tornabene, Nicholas Fantuzzi, Erasmo Viola, 2018-07-23 It is well known that the topic of composite materials affects many engineering fields such as civil mechanical aerospace automotive and chemical In the last decades in fact a huge number of scientific papers concerning these peculiar constituents has been published Analogously the industrial progress has been extremely noticeable The study of composite materials in general is a challenging activity since the advancements both in the academia and in the industry provide continually new sparks to develop innovative ideas and applications The communication the sharing and the exchange of views can surely help the works of many researchers This aspect represents the main purpose of this Conference which aims to collect high level contributions on the development and the application of composite materials The establishment of this 21st edition of International Conference on Composite Structures has appeared appropriate to continue what has been begun during the previous editions ICCS wants to be an occasion for many researchers from each part of the globe to meet and discuss about the recent advancements regarding the use of composite structures sandwich panels nanotechnology bio composites delamination and fracture experimental methods manufacturing and other countless topics that have filled many sessions during this conference As a proof of this event which has taken place in Bologna Italy selected plenary and key note lectures have been collected in the present book *Mechanics of Structures and Materials XXIV* Hong Hao, Chunwei

Zhang, 2019-08-08 Mechanics of Structures and Materials Advancements and Challenges is a collection of peer reviewed papers presented at the 24th Australasian Conference on the Mechanics of Structures and Materials ACMSM24 Curtin University Perth Western Australia 6 9 December 2016 The contributions from academics researchers and practising engineers from Australasian Asia pacific region and around the world cover a wide range of topics including Structural mechanics Computational mechanics Reinforced and prestressed concrete structures Steel structures Composite structures Civil engineering materials Fire engineering Coastal and offshore structures Dynamic analysis of structures Structural health monitoring and damage identification Structural reliability analysis and design Structural optimization Fracture and damage mechanics Soil mechanics and foundation engineering Pavement materials and technology Shock and impact loading Earthquake loading Traffic and other man made loadings Wave and wind loading Thermal effects Design codes Mechanics of Structures and Materials Advancements and Challenges will be of interest to academics and professionals involved in Structural Engineering and Materials Science **The Indian Textile Journal** Sorabji M. Rutnagur, 2013 8th

*International Conference on Advanced Composite Materials in Bridges and Structures* Brahim Benmokrane, Khaled Mohamed, Ahmed Farghaly, Hamdy Mohamed, 2022-09-26 This book comprises the proceedings of the 8th International Conference on Advanced Composite Materials in Bridges and Structures ACMBS 2021. The contents of this volume focus on recent technological advances in the field of material behavior, seismic performance, fire resistance, structural health monitoring, sustainability, rehabilitation of structures, etc. The contents cover latest advances especially in applications in reinforced concrete, wood masonry and steel structures, field application, bond development and splice length of FRB bars, structural shapes and fully composite bars, etc. This volume will prove a valuable resource for those in academia and industry.

**3rd fib Congress Washington USA** FIB - International Federation for Structural Concrete, 2010-06-01

**Proceedings of MPCPE 2024** Nikolai Vatin, Svetlana Roschina, Saurav Dixit, 2024-12-27 This book gathers selected contributions in the field of civil and structural engineering as presented by international researchers and engineers at the International Conference on Materials Physics Building Structures and Technologies in Construction Industrial and Production Engineering MPCPE held in Vladimir, Russia, on April 22-25, 2024. The book covers a wide range of topics including the theory and design of capital construction facilities, engineering and hydraulic structures, development of innovative solutions in the field of modeling and testing of reinforced concrete, metal and wooden structures, as well as composite structures based on them, investigation of complex dynamic effects on construction objects and many others. Intended for professional builders, designers and researchers. The contributions, which were selected by means of a rigorous international peer review process, highlight numerous exciting ideas that will spur novel research directions and foster multidisciplinary collaborations.

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