
Sujith Bobba, UPM, Kembangan, Malaysia
https://orcid.org/0000-0002-1633-1299
Z Leman, UPM, Kembangan, Malaysia
SM Sapuan, UPM, Kembangan, Malaysia
ES Zainudin, UPM, Kembangan, Malaysia

ABSTRACT

This article investigates the effects of impact and compressive behaviors of impacted E-glass/epoxy and S-glass/epoxy composite elbow pipe joints. In a bid to measure the transverse impact and residual compressive strength, the composite elbow pipe joints were subjected to impact test at room temperature, followed by the axial compression test. Moreover, various impact energy levels of 10, 12.5, and 15 J were utilized to test the elbow pipe joints using an instrumented impact testing machine at room temperature. Results indicated that the force–deflection behavior and failure mechanism was more than impact energy with the type of material used. Compressive strength commonly decreases with the increase in the impact energy and the type of material used.

KEYWORDS

E-Glass/Epoxy, Elbow Pipe Joints, Force–Deflection Behaviour, Residual Compressive Strength, S-Glass/Epoxy, Transverse Impact

1. INTRODUCTION

In recent times, glass/epoxy composite pipe has been the preferred choice of both researchers and industrial experts for multiple purposes. These pipes have a broad-based usage, such as in fluid flow pipelines in geothermal energy, and waste water pipelines purposes including beneath ground and below water applications, due to their intensity-to-weight and rigidity-to-weight ratios, heat endurance, and corrosion endurance. Sometimes, composite pipes may be exposed to environmental conditions

DOI: 10.4018/IJMMME.2019070102

Copyright © 2019, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.
that can cause remarkable decline in their mechanical properties. More so, failure mechanisms such as fracture in the fibers, in the matrix and in the fiber-matrix interface in tension, compression and shear are unpredictable and require comprehensive analysis.

Even though it is well known that composite structures are rarely flat in practice, most of the research investigations have focused on plate and beam structures, while relatively few investigations have been conducted on composite shell structures. Also, the impact behaviours of straight composite pipes or tubes have been studied. However, impact behaviours of bent composite pipes or tubes are yet to be studied. In other words, research was only performed on straight pipe lines which laminar rather than those which are turbulent where the impact and pressure levels are higher. Quite a number of investigations have been conducted to determine the impact behavior of composite tubes. Deniz EM et al. (2011) carried out an experimental study and discussed the effects of the tube diameter and the impact energy level on the impact and compression after impact behaviours of 3 filament-wound glass/epoxy composite tubes. In a similar study to the above, Deniz et al. (2013) investigated the effects of seawater and impact loading on the impact behavior and compressive strength of impacted glass/epoxy composite pipes. Zhou et al. (2000) compared the impact damage limits for the thick E-glass/polyester laminates and S-glass/phenolic laminates and concluded that the impact resistance was considerably elated to rate of impact for E-glass polyester laminates and S-glass phenolic laminates, respectively and lastly the consequences on the design of the laminates with regard to shear- out resistance was more in E-glass polyester laminates than in S-Glass phenolic laminates. Khalid (2001) conducted a practical and statistical analysis on the axial crushing behaviour of hybrid composite pipes. An evaluation was performed between the finite element method and the practical results. As an outcome, it was predicted that carbon fiber reinforced tubes can withstand more loads when compared to glass and cotton fibers. Xu et al. (2009) studied the global and local bulking behaviours of the cylindrical shells under axial compression impact loads, from their findings, they discovered that the critical bulking load was affected by the given radial inertia, which tends to increase the critical loads on the samples when subjected to compression. Elsewhere, Abdewi et al. (2008) performed experimental examinations on three geometrical kinds of radial corrugated composite tubes exposed to axial and lateral compressive loadings and found out that the radial corrugated tubes exhibited an effective and stable energy absorption character under axial compression load. The cylindrical shells bulking with crack phenomenon was studied by Estekanchi et al. (1999). Fan et al. (2013) have performed axial compression tests on triangular tubes to calculate the tubes plastic deformation and energy absorption. These tests conducted by the researchers were not performed completely and the values were not recorded as expected. Alijawi et al. (2004) and his co-researchers conducted study both numerically and experimentally on the energy absorption of square steel tubes and found out that the maximum failure load is found to reduce about 10% when the tubes are filled with foam. The researchers developed an exclusive database for creating finite element kinds of cylindrical shells according to crack extent and fiber positioning. The effects of the analysis were exhibited in parametric state when it appeared to be suitable. Sensitivity of the buckling load to the crack extent and orientation has been examined also. The established materials, which are being interchanged by the composite materials, have distinct impact features and the standards are well defined but when it comes to laminated composites, it is more susceptible to have or predict impact damages which are regularly internal and easy to observe visually by Abrate (1998).

Implementation of E-glass material is quite common but as per the research perspective, S-glass composite with proposed epoxy resin has been used in the preparation of the pipe joints and analysis between the two E-glass and S-glass composite pipe joints have been performed.

**2. MATERIAL**

E-glass and S-glass/epoxy elbow pipe joints were produced by hand layup process as shown in Figure 1 below at Win-Fung fiberglass Sdn. Bhd, Malaysia. The laying of the dry E-glass and S-glass fabric
Development of an Optimization Framework for Parameter Identification and Shape Optimization Problems in Engineering
[www.igi-global.com/article/development-optimization-framework-parameter-identification/51375?camid=4v1a](www.igi-global.com/article/development-optimization-framework-parameter-identification/51375?camid=4v1a)

Design and Feasibility Test of an Indigenous Motorized Wheel for Manual Wheelchair
[www.igi-global.com/article/design-and-feasibility-test-of-an-indigenous-motorized-wheel-for-manual-wheelchair/231658?camid=4v1a](www.igi-global.com/article/design-and-feasibility-test-of-an-indigenous-motorized-wheel-for-manual-wheelchair/231658?camid=4v1a)