Abstract

The thesis strives to provide a road map to utilise the fly ash as a viable particulate reinforcement to polyurethane foam (PUF). The work also supports that the understanding the deformation mechanism of the components (face sheet and core) and sandwich composite under different loading condition i.e., compression, shear, bending and indentation, will gives perspective to design a sandwich composite.

In the current study, Silane coupling agent is employed to facilitate adhesion between an organic matrix and an inorganic filler. Thereafter, the shear test has been conducted on treated and untreated fly ash (FA) reinforced PUF core. The findings suggest that the stress carrying capacity of the silane treated FA-PUF outperform the untreated FA-PUF. Thus, the results depict that the FA as particulate reinforcement can be a sustainable option.

Now, the effect of varying FA wt. % inclusion in PUF core has been studies under compression and shear. ASTM C365/C365M and ASTM C273/C273M-16 has been used for compression and shear test respectively. The results shows that the polyurethane foam's shear modulus was improved from 14% to 39% depending on the weight percentage of fly ash inclusion to the neat PUF. While under compression the 20% FA-PUF's modulus is more than twice of the neat PUF.

Later, the glass fiber reinforced polymer (GFRP) and carbon fiber reinforced polymer (CFRP) laminated face sheet has been fabricated and tested according to D3039/D3039M-17 for its tensile strength and modulus. The finding reports that the stiffness of the CFRP laminates is more than 3 time of GFRP.

Now, the sandwich composites were manufactured using GFRP/CFRP face sheet in combination with neat and FA-PUF core. The 3 Point test was conducted according to ASTM C393/C393M-16 to understand the deformation behaviour with varying wt. % of

FA-PUF on GFRP/CFRP sandwich composite. The results shows that CFRP sandwich composites performs better than the GFRP sandwich composites.

After performing the conventional mechanical testing, indentation resistance or response to localised stress is elaborately studied for both bare core and sandwich composite. At first the core alone is taken under consideration, here the effect of indenter geometry (flat-circular, hemispherical and conical) and inclusion of varying FA wt.% to PUF has been studied. The study shows the positive response to the reinforcement, owing to the fact, that the rigidity of the PUF increases with FA reinforcement. After indentation the cross-sectional cut of the damaged PUF core is analysed for the deformation behaviour and to corroborate the variation in performance due to reinforcement and indenter's geometry during indentation test.

At last, the indentation resistance of the sandwich composite has been conducted. The effect of face sheets, FA reinforcement and indenter's nose tip profile is taken under consideration. The CFRP sandwich composite performs better than the GFRP sandwich composite due to the stiff face sheet which provide better resistance against indentation. The study also concluded that the least resistance is offered in case of conical indenter and highest resistance offered by flat-circular indenter, while hemispherical lie in between these two indenters. The effect FA reinforced PUF core GFRP/CFRP sandwich composites are also analysed under different indenter's nose profile.

The improvement in mechanical properties of PUF foam core by employing a low-cost thermal power plant industry by-product fly ash seems to be an attractive alternative for future structural applications. This also has the advantage of reducing environmental hazards and corrosive pollution.