International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 8, August - 2014

Estimation of Compression Strength On Hybrid Composite Corrugated Sandwich Coupons

G. Guru Saiprasad[1],PG Student,
Department of Mechanical Engineering,Madanapalle Institute of Technology & Science, Madanapalle. Andhra Pradesh., INDIA.

Dr. G. Harinath Gowd[2], Professor,
Department of Mechanical Engineering, Madanapalle Institute of Technology & Science, Madanapalle. Andhra Pradesh.,

G. Guru Mahesh[3], Assistant Professor,
Department of Mechanical Engineering, Madanapalle Institute of Technology & Science, Madanapalle. Andhra Pradesh., INDIA

R. MANU[4],Assistant Professor,
Department of Mechanical Engineering, Madanapalle Institute of Technology & Science, Madanapalle. Andhra Pradesh., INDIA

***Abstract*—The compressive load carrying behavior of hybrid composite corrugated sandwich coupons is investigated to explore a new kind of lightweight structures, these structures are able to resist the load and capable of energy absorption in automobiles, like transportationvehicles. The coupons are reinforced with three different hybridizations of fiber materials, namely, hybridization of GFRP WR350 and Kevlar29 fibers, hybridization of GFRP WR350 and Jute, hybridization of Kevlar29 and Jute fibers and matrix is used as epoxy. Hand layup method is used for fabrication of cores and face sheets and thenby using of epoxy both cores and face sheets are coupled based on the same material combinations.Then compression test is conducted on hybrid composite sandwich coupons for finding the load carrying capacity, by using Universal Testing Machine (UTM) having a capacity of 60KN**.

Keywords –Buckle; Compression; Corrugated composite coupon; Hybrid; Light weight;Strength.

2. INTRODUCTION & LITERATURE SURVEY

Hybrid composites are newly developed structural materials and are more advanced composites compared to conventional composites [1]. The conventional composites are normally made up of only one kind of fiber but hybrid composites have one matrix phase and a single reinforcement phase or single matrix phase and multiple reinforcement phases or multiple matrix phases and multiple reinforcement phases. In principle several fiber reinforcements incorporated in a hybrid system but it is more likely that combination of only two fibers would be most use [2]. Hybrid composites have unique features that can be used to meet various design requirements in a more economical way than the conventional composites. This is because expensive fibers like graphite and boron can be partially replaced by less expensive fibers such as glass and kevlar [3].

Some of specific benefits of hybrids over conventional composites are:

a. Reduced weight and cost.
b. Balanced stiffnessand strength,balanced thermal distortion stabilityand balanced bending membrane mechanical properties.
c. Improved impact resistance,fatigue resistance and crack resistance properties.

Subsequently Sandwich boards are broadly utilized as aircraft wing and body structures etc. Moreover, the sandwich boards or panels have space in the core gives the competence to coordinate different functionalities, for example,energy storage, actuators, and sensorsoffering different applications in the aviation, military, auto and common framework. In the current circumstance, weight reduction is the principle measure in auto commercial ventures. Improving the fuel effectiveness and lessening the ecological load of transport vehicles like, railways and automobiles by Lightweight structure.

Jin Zhang [4], in this research they are explored on composite ridged coupons produced using, carbon fiber, glass fiber and combination of glass: carbon (50:50) reinforcement, with different material combinations, core angles, bond length and with or without form inserts. Then, the coupons are investigated under three point bending test and compression test. After testing's they are concluded that, the coupon with the carbon fiber face sheet having a lower bending strength compare to hybridization of glass: carbon (50:50) face sheet. The angle of corrugation for core 45 degrees is resisting the high failure load of 28KN. By inserting the form in the coupons increase the crush force efficiency up to 30-50%. Improve the specific bending strength of coupons with increasing core-sheet thickness and corrugation angle. While the coupons having lower specific bending strength with increasing in bond length.

R.m. Rejab [5], in this paper they are explored composite ridged sandwich boards in both tentatively and numerically by taking triangle profile as the core and having 45 degrees corrugation angle. The types of materials are chosen for investigating and they arecarbon fiber reinforced plastic (CPRF), glass fiber reinforced plastic (GPRF), and aluminum alloy. By using of hot press mould

technique panels are fabricated, after the fabrication experiments are conducted on each coupon with compression testing machine and FEM is also done by using ABAQUS. The results revealed that GPRF and CPRF panels shows a brittle manner and delamination and debonding occurred in cores while in testing and aluminum alloy shows a behavior of elastic buckling and plastic deformation takes place. The analytical models are also shows approximately same results.

V. Diwakar Reddy [6], metallic sandwich boards welded by laser be equipped for prescribe 30-50 % weight diminishment compare to conventional structures, the interest for greater, speeder and low weight moving vehicles, for example, trucks, prepares, ships and transports has expanded the essentialness of productive structural arrangements. In this research they are mainly focused on open type metalliccore sandwich panels and panel parameters are optimized based on bending strength by utilizing Taguchi optimization technique. The panel was investigated in both analytically and experimentally. After getting the optimum parameters of the panel, panel is modeled in Pro-E and then analyzed with 5KN by using ANSYS software. And it is observed that the maximum Von-missies stress, shear stress, and deflections are 22.161Mpa, 11.882Mpa and 0.009mm and also panel is fabricated with same parameters by using three point bending test with a load of 15KN. And it is observed that the maximum Von-missies stress, shear stress, and deflections are 15.769Mpa, 8.7741Mpa and 0.017551mm. Finally, they concluded that the maximum load endured by the panel is three times more than the considered load and panel is recommended up to 10KN.

3. 2. MODELING OF COMPOSITE CORRUGATED SANDWITCH COUPON

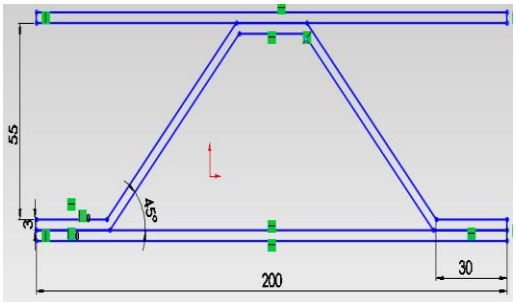

Figure.1,Geometry of the corrugated sandwich coupon.

Corrugated Mould design: The corrugatedmould design was designed by utilizing the CATIA

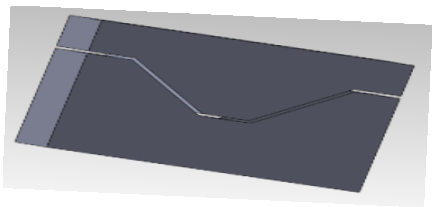

Figure.2,Three Dimensional Model Of Corrugated Mouldsoftware.

TABLE1. Design specifications of composite coupon.

S. No	Design parameters	Dimensions (mm)
1	Adhesion Length, L_1	30
2	Adhesion Length, L_2	30
3	Adhesion Length, L_3	30
4	Height of core, H	54
5	Thickness of face sheets, t_1,t_2	3
6	Angle of corrugation in degrees	45

4. FABRICATION OF COMPOSITE CORRUGATED SANDWITCH COUPONS

In the process of fabrications composite corrugated sandwich coupons we follow two steps this are

A. Chemical treatment of jute fiber

B. Hand layup method

A. *Chemical treatment of jute fiber*

Jute fibers are chemically treated in the sodium hydroxide flakes (Noah), which are mixed in the water with an estimated proportion of 10:100 and stirred systematically and jute fibers are soaked in that solution for 12-15 hours and dried out in the shadow up to 2 days. After the treatment we are seen, shrinkage of the fibers takes place. A significant effect on the fiber structure takes place due to the shrinkage of the fiber structure and, as a result, on the mechanical properties of the fibers. The improved mechanical properties are young's modules of the fibers increases nearly 30 to 50 percentage and Fibers attain the properties of stiffness and smoothness.

B. *Hand lay-up method*

This method is also known as open mould shaping method as shown in fig. It was oldest method and simplest way of making composite laminates. In this process successive layers of matrix and reinforcement are manually applied to an open mould for the fabrication of composite laminates. This method is generally used for fabricating large size of parts but in low production quantity, and the applications of this method for fabricating of boat hulls, turbine blades and swimming pools etc.

4. MATERIALS AND FABRICATION PROCESS

The corrugated composite sandwich coupons were fabricated by using three types of fibers frequently used in aerospace and heavytransportation vehicle applications, these being aKevlar-29, GFRP woven roving (WR350) and Jute fibers. But in the process of fabrication, combinations of materials are used for getting good results and finally three coupons are fabricated. The manufactureprocess included fabrication ofcores, faces sheets, and thenassembled by using epoxy resin LY556 with a hardener HY951.

A. *Preparation of face sheets*

The face sheets are fabricated by using a flat mould made with MS sheets. The mould was manufactured by using welding process and having a channel section is shown in fig 3. It having a two parts top and bottom, the laminates are laid in bottom plate and top plate is used for distribute he weight uniformly throughout the laminate.

Figure.3,Flat mould for face sheets preparation.

TABLE 2 Characteristics of the composite corrugated face sheets.

S.No	Combination of materials	Number. of piles	No.Of Laminates	Thickness (mm)	Length & width of laminates(mm)
1	GPRF & Kevlar29 fibers	4-4	2	3	210 x 130
2	GPRF & Jute fibers	2-2	2	3	210 x 130
3	Kevlar29 & jute fibers	2-2	2	3	210 x 130

The hybrid laminates are made of, reinforcement as reinforced with hybridization of GFRP woven roving (WR350)and jute fibers, GFRP woven roving (WR350) and Kevlar29 fibers, Kevlar29 and jute fibers and matrix as Epoxy resin LY556 with a hardener HY951 was selected which is a room temperature curing matrix. When the surface of the mold and the top plate of bottom surface are smoothened, the releasing moiler film is place on the mold which acts as a releasing agent, so that the final laminate does not adhere to the mold. The fiber fabric having required shape was placed on the surface of the moiler film, then by using brush the resin was uniformly applied, after first layer an another fiber material is set on top it which will be the second layer and anotherlayer of resin coat was applied on the surface of it. Likewise, an alternate layer of fabrics material is laid. After fulfillment of every last one of layers the releasing moiler film is put on the final layerthen, the top mold plate is put on it. This mold with overlay is kept around 8-10 hours in a room temperature for curing, and then the hybrid face sheets are removed from the mould. Hybrid composite face sheets of different material combinations are shown in

Figure. 4, Hybrid face sheets after fabrication.

B. *Preparationof core laminates*

The cores are fabricated by using wooden corrugated mouldbefore the fabrication process a moiller film which acts as a releasing agent and stackedthe first layer of the laminate to prevent the stickingbetween the laminate and the mould is shown in fig 5.

Figure.5, Corrugation mould with staked moiler film.

TABLE 3 Characteristics of the composite corrugated core

S.No	Combination of materials	No. Of piles(Alternative way)	No. Of Laminates	Thickness (mm)	Angle of corrugation in degrees
1	GPRF & Kevlar29 fibers	4-4	1	3	45
2	GPRF & Jute fibers	2-2	1	3	45
3	Kevlar29 & jute fibers	2-2	1	3	45

In the fabrication of cores, same process is carried out up to laying of layers on moiler film than before curing the wet laminate just remove it from the moiler film and placed it in the corrugated mould, then the load is placed on mould for better stacking. Finally, by using adhesives both cores and face sheets are joined.

Figure. 6, Final hybrid composite corrugated sandwich coupons.

5. COMPRESSION TESTING

Hybrid corrugated composite coupons are investigated by Compression test by using Universal testing Machine (UTM) having capability of 60KN. Load is applied gradually on the coupons and the coupon is fitted in between two MS sheets having a thickness of 2cm for uniform distribution of the load. The load was applied on the coupons until fracture. The arrangement of coupons for testing is demonstrated in fig7.

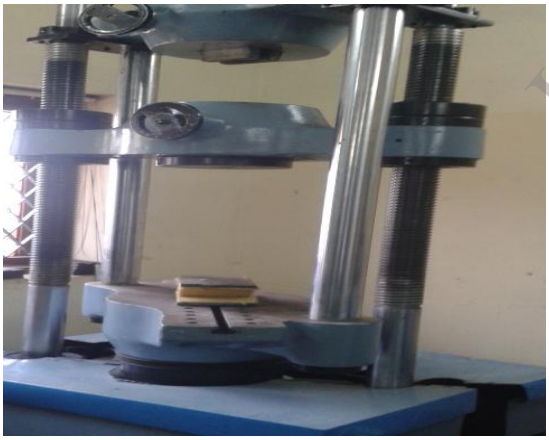

Figure. 7, Experimental set up for hybrid composite coupons under Universal Testing Machine.

6. RESULT AND DISCUSSION

TABLE 4. Compressive Strength & Displacement values

S.No	Hybrid composite coupon	Compression strength (KN)	Displacement (mm)
1	GPRF & Kevlar29 fibers	27.8	8.0
2	GPRF & Jute fibers	28.3	3.2
3	Kevlar29 & jute fibers	17.8	11.2

After the completion of fabrication, Compression testing is performed on the hybrid corrugated core sandwich coupon showed that there were significant differences **i**n the conduct of the three coupons and their reactions are in this way considered independently below**.**

A. *Compression response of GFRP WR 350 and Jute fibers coupon;*

The load-displacement graph for the GFRP woven rovingWR350 and jute fibers corrugated sandwich coupon under gone broad compressive forces as shown in fig 8.

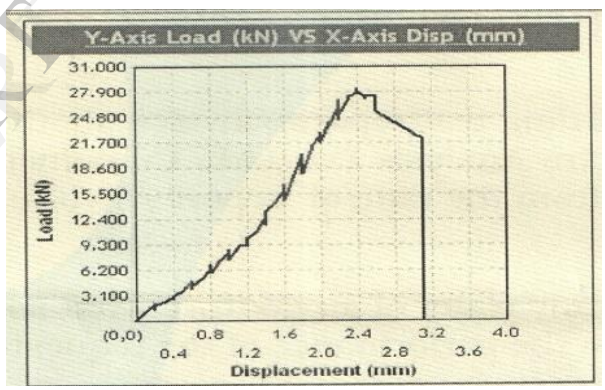

Figure. 8,load-displacement plot for GFRP and jute fibers coupon.

The load increases steadilywith the displacement up to the highest peak load. Then after the wall of core begins, to buckle,the load has abruptly decreased. After buckling, failure of the fiber breakage was observed and core wall has suddenly breakage takes placewas clearly visible at maximum displacements shown in fig 9.

Fig.9, Core wall breakage due to buckling.

B. *Compression response of GFRP WR350 and Kevlar29 fibres coupon*

A typical Stress-Strain graph following a compression test on a, Kevlar29 and GFRP WR350fibers composite corrugated core sandwich coupon is presented in fig10.

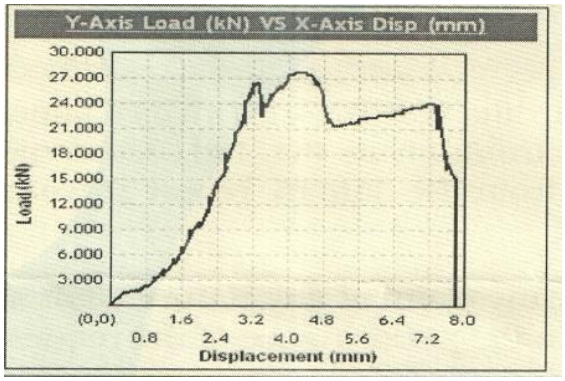

Fig. 10, load-displacement graph for GFRP and kevlar coupon.

The coupon accordingly reacted in a non-linear fashion up to the first peak load as indicated in diagram. At that point, as from the plot there was a sudden fall in load, the reason may be an air gap between face sheets and core occurred in joining process, and the load progressively increased to the second peak stage. We have seen that, load was reduced due to the effect of the buckling in the wall of the core at the joint of face sheet. And thenload increases slightly with displacement. Finally, fracture occurs at same spot i.e. where buckling was appearingas shown in fig 11.

Fig.11, Fibre breakage and delamination after process.

C. *Compression response of Kevlar29 and Jute fibres coupon*

A typical load-displacement trace following a compression test on a Kevlar29 and Jute fibers composite sandwich coupon is presented in fig 12.

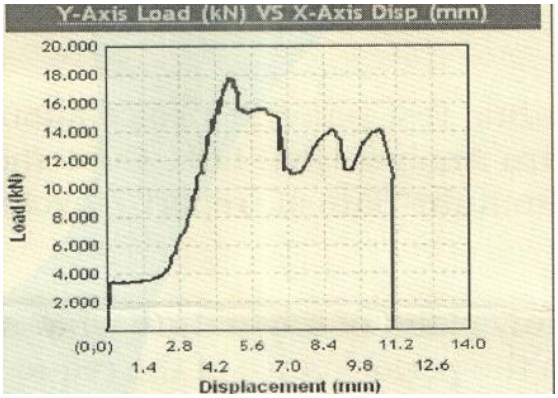

Fig. 12, load-displacement graph for GFRP and kevlar29 coupon.

Fig.13, delaminating and debonding at an edge of core Afterprocess.

From the plot we can observe that the initial rise in load was observed. Later the load was almost constant but the displacement was increasing the reason was the face sheets are not parallel to each other. Later the coupon responded linearly up to the first peek and delamination of the plies has taken place so the drop in load was observed. The bucking has taken place the displacement increased with load as almost constant. The increased in displacement the load has increased and decreased the reason for this is the buckling of the core plies, later failure has taken place in the core wall and debonding taken place between the core and the face sheets as shown in fig 13.

7. CONCLUSION

The hybrid composite corrugated sandwich coupons are fabricated by using the Hand Layup method using different combinations like GPRF, Kevlar & jute. The coupons are reinforced with three different hybridizations of fiber materials, namely, hybridization of GFRP WR350 and Kevlar29 fibers, hybridization of GFRP WR350 and Jute, hybridization of Kevlar29 and Jute fibers and matrix is used as epoxy.Later they are subjected to compressive test for finding the compressive load carrying behavior. The results are presented in the form of graphs.

REFRENCES

[1] C. C. Chamis and R.F Lark, "Hybrid Composites-State-Of-Art review: Analysis, Design, Application and Fabrication," Lewis Research Center.

[2] Gururaja M N and A N Hari Rao, "A Review on Recent Application and Future Prospectus of Hybrid Composites," International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Vol. 1, issue. 6, January 2012.

[3] S. Banerjee and B. V sankar, "Mechanical Properties of Hybrid Composites using Finite Element Method Based Micromechanics,"

[4] jin Zhang, Peter Supernak, Simon Mueller-Alander, and chun H. Wang, "Improving the bending strength and energy abortion of corrugated sandwich composite structure," Elsevier, Materials and Design 52, pp.767-773, May 2013.

[5] M. R. M. Rejab and W. J. Cantwell, "The mechanical behaviour of corrugated- core sandwich panels," Elsevier, Composites: Part B 47, pp.267-277, November 2012.

[6] V. Diwakar Reddy, A. Gopichand, G. Nirupama and G.Krishnaiah, "Design and fabrication of corrugated sandwich panel using Taguchi method," international journal of design and Manufacturing Technology (IJDMET) ISSN 0976-7002, Vol. 4, Issue 2, pp.01-13, may-August 2013.