CRASH TEST ANALYSIS OF IMPACT BARRIER USING HONEY COMB TEXTILE AND OTHER GEOMETRY'S BY USING COMPOSITES

P.Naresh[1]*, A.V.Hari Babu [2], S.Ramesh Babu[3], M.Sudhakar Reddy[4] , Dr.P.Malli Karjuna Reddy[5]

***Corresponding Author**:*

1 .*P Naresh, Asst professor in ME DEPT,* AVR&SVR College of Engg&Tech, Nandyal.

2. *A.V.Hari Babu, HOD OF ME DEPT,* AVR&SVR College of Engg&Tech, Nandyal.

3. *S.Ramesh Kumar Babu, Asst Professor in ME DEPT,* AVR&SVR College of Engg&Tech, Nandyal.

4 .*M.Sudhakar Reddy, Asst Professor in ME DEPT,* AVR&SVR College of Engg&Tech, Nandyal

5. *Dr.P.Malli Karjuna Reddy, Professor and Principal of* AVR&SVR College of Engg&Tech, Nandyal.

mail:*poppathi@gmail.com*

ABSTRACT

Textile honeycomb composites, with an array of hexagonal cells in the cross section, is a type of textile composites having the advantage of being light weight and energy absorbent over the solid composite materials. The aim of this project is to investigate the influence of the geometric parameters on textile honeycomb composites on their mechanical performances under low velocity impact, which can be used to help designer control over the textile honeycomb composites.

The 3D honeycomb fabrics are successfully manufactured and converted into textile honeycomb composites. It was found through the finite element analysis (FEA) that changes in geometric and structural parameters of the textile honeycombcomposites have noted influences on the energy absorption, force attenuation and damage process of the structure.

This project carries the comparision betweenhoneycomb,hexagonal,box,trianguler and cross trianguler composite shapes for optimized inner core design based on FEA based impact analysis to rectify the delamination problems occoring in hony comb technology due to impacts (even small impacts).

Key Words

Composite Materials, 3DModeling (Solid works), FEA,

1. INTRODUCTION

1.1 Overview

The Washington State Department of Transportation (WSDOT) uses traffic barriers to reduce the overall severity of collisions that occur when a vehicle leaves the traveled way. Consider whether a barrier is preferable to the recovery area it replaces. In some cases, installation of a traffic barrier may result in more collisions, as it presents an object that can be struck. Barriers are designed so that such encounters might be less severe and not lead to secondary or tertiary collisions. However, when impacts occur, traffic barriers are not guaranteed to redirect vehicles without injury to the occupants or additional collisions. Barrier performance is affected by the characteristics of the types of vehicles that collide with them. For example, motor vehicles with large tires and high centers of gravity are commonplace on our highways and they are designed to mount obstacles. Therefore, they are at greater risk of mounting barriers or of not being decelerated and redirected as conventional vehicles would be.

When barriers are crash-tested, it is impossible to replicate the innumerable variations in highway conditions. Therefore, barriers are crash-tested under standardized conditions. These standard conditions were previously documented in National Cooperative Highway Research Program (NCHRP) Report 350. These guidelines have been updated and are now presented in the Manual for Assessing Safety Hardware (MASH).

Barriers are not placed with the assumption that the system will restrain or redirect all vehicles in all conditions. They are placed with the assumption that under normal conditions, they might provide an improved safety condition for most collisions. Consequently, barriers should not be used unless an improved safety situation is likely. No matter how well a barrier system is designed, optimal performance is dependent on drivers' proper use, maintenance, and operation of their vehicles and the proper use of vehicle restraint systems.

At the time of installation, the ultimate choice of barrier type and placement is made by gaining an understanding of site and traffic conditions, having a thorough understanding of and using the criteria presented in Chapters 1600 and 1610, and using engineering judgment.

1.2 Present work

This thesis gives an overall view of Honeycomb structures and the role of these structures in vehicles. The aim is to find out an alternative structure for hexagonal honey comb structure and to find a optimal solution for delamination of frame of honeycomb structures which improves the strength of the structure and eliminates or decreases the delimitation problem and decreases the maintenance costs.

1.3. Barrier Design

When selecting a barrier, consider the flexibility, cost, and maintainability of the system. It is generally desirable to use the most flexible system possible to minimize damage to the impacting vehicle and injury to the vehicle's occupant(s). However, since no rigid systems sustain more damage during an impact, the exposure of maintenance crews to traffic might be increased with the more frequent need for repairs.

Maintenance costs for concrete barrier are lower than for other barrier types. In addition, deterioration due to weather and vehicle impacts is less than most other barrier systems.

Unanchored precast concrete barrier can usually be realigned or repaired when moved from its alignment. However, heavy equipment may be necessary to reposition or replace barrier segments. Therefore, in medians, consider the shoulder width and the traffic volume when determining the acceptability of unanchored precast concrete barrier versus rigid concrete barrier.

Drainage, alignment, and drifting snow or sand are considerations that can influence the selection of barrier type. Beam guardrail and concrete barrier can contribute to snow drifts. Consider long-term maintenance costs associated with snow removal at locations prone to snow drifting. Slope flattening is recommended when the safety benefit justifies the additional cost to eliminate the need for the barrier. Cable barrier is not an obstruction to drifting snow and can be used if slope flattening is not feasible.

With some systems, such as concrete and beam guardrail, additional shoulder widening or slope flattening is common. However, selection of these types of barriers is sometimes limited due to the substantial environmental permitting and highway reconstruction needs. Permits issued under the SEPA and NEPA processes may lead to the use of a barrier design such as cable barrier, which has fewer potential environmental impacts and costs.

Fig.1.3. Frame Structure of a Fore Wheel Drive

1.3.1. Barrier Deflections

Expect all barriers except rigid barriers (such as concrete bridge rails) to deflect when hit by an errant vehicle. The amount of deflection is primarily dependent on the stiffness of the system. However, vehicle speed, angle of impact, and weight also affect the amount of barrier deflection. For flexible and semi rigid roadside barriers, the deflection distance is designed to help prevent the impacting vehicle from striking the object being shielded. For unrestrained rigid systems (unanchored precast concrete barrier), the deflection distance is designed to help prevent the barrier from being knocked over the side of a drop-off or steep fill slope.

In median installations, design systems such that the anticipated deflection will not enter the lane of opposing traffic using deflection values that were determined from crash tests. When evaluating new barrier installations, consider the impacts where significant traffic closures are necessary to accomplish maintenance. Use a rigid system where deflection cannot be tolerated, such as in narrow medians or at the edge of bridge decks or other vertical drop-off areas. Runs of rigid concrete barrier can be cast in place or extruded with appropriate footings.

In some locations where deflection distance is limited, anchor precast concrete barrier. Unless the anchoring system has been designed to function as a rigid barrier, some movement can be expected and repairs may be more expensive. Use of an anchored or other deflecting barrier on top of a retaining wall without deflection distance provided requires approval.

The deflection distances for cable and beam guardrail are the minimum measurements from the face of the barrier to the fixed feature. The deflection distance for unanchored concrete barrier is the minimum measurement from the back edge of the barrier to the drop-off or slope break.

1.3.2. Terminals and Anchors

A guardrail anchor is needed at the end of a run of guardrail to develop tensile strength throughout its length. In addition, when the end of the guardrail is subject to head-on impacts, a crash-tested guardrail terminal is needed (see the Standard Plans).

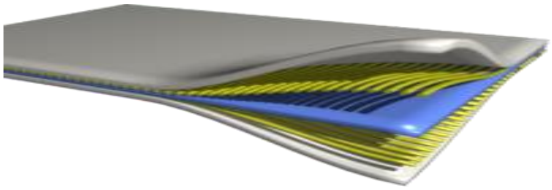
1.3.3. Buried Terminal (BT)

A buried terminal is designed to terminate the guardrail by burying the end in a back slope. The BT is the preferred terminal because it eliminates the exposed end of the guardrail. The BT uses a Type 2 anchor to develop the tensile strength in the guardrail. The back slope needed to install a

BT is to be 3H:1V or steeper and at least 4 feet in height above the roadway. The entire BT can be used within the length of need for back slopes of 1H: 1V or steeper if the barrier remains at full height in relation to the roadway shoulder to the point where the barrier enters the back slope. For back slopes between 1H:1V and 3H:1V, design the length of need beginning at the point where the W-beam remains at full height in relation to the roadway shoulder—usually beginning at the point where the barrier crosses the ditch line. If the back slope is flatter than 1H: 1V, provide a minimum 20-foot-wide by 75-foot-long distance behind the barrier and between the beginning length of need point at the terminal end to the mitigated object to be protected. For new BT installations, use the Buried Terminal Type 2. Note: Previously, another BT option (the Buried Terminal Type 1) was an available choice. For existing situations, it is acceptable to leave this option in service as long as height requirements and other previous design criteria can still be met.

2. Composite material

For the specific carbon and glass fiber based composite materials often referred to loosely as 'composites 'Composites are formed by combining materials together to form an overall structure that is better than the individual components



Composite materials (also called composition materials or shortened to composites) are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional materials.

Typical engineered composite materials include:

- Composite building materials such as cements, concrete
- Reinforced plastics such as fiber-reinforced polymer
- Metal Composites
- Ceramic Composites (composite ceramic and metal matrices)

Composite materials are generally used for buildings, bridges and structures such as boat hulls, swimming pool panels, race car bodies, shower stalls, bathtubs, and storage tanks, imitation granite and cultured marble sinks and countertops. The most advanced examples perform routinely on spacecraft in demanding environments.

2.1 Composite Advantages

HIGH STRENGTH TO WEIGHT RATIO	CORROSION RESISTANCE
WEAR RESISTANCE	STIFNESS
FATIGUE LIFE	TEMPERATURE DEPENDENT BEHAVIOUR
THERMAL INSULATION	THERMAL CONDUCTIVITY
ACOUSTICAL INSULATION	LOW-ELECTRICAL CONDUCTIVITY
VISUAL ATTRACTIVENESS	RADIO TRANSLUCENT

2.2. EPOXY SOLUTION:

To add in a layer of glass, or alternatively make sure to pepper with microspheres to provide enough insulation to prevent galvanic corrosion and delamination.

Four compounds were used to improve adhesion between carbon fibers and an epoxy matrix. Triglycidylisocyanurate (TGIC) and 3-glycidoxy-propyl-triethoxysilane (EPS) contained reactive epoxy groups, while N-(3-trimethoxysilane-propyl) ethylene diamine (AMS) a primary and a secondary amino group. The fourth coupling agent was 4, 4'diphenylmethane-diisocianate (MDI). The interaction of the fiber and the coupling agents was studied by dissolution experiments. Chemical reactions taking place on the surface of the fiber were followed by FTIR spectroscopy. Interfacial shear stress determined by fragmentation was used for the characterization of matrix/fiber adhesion. Besides coupling to the surface, EPS, AMS and MDI formed a polymer layer on the surface, but TGIC also entered into secondary reactions during the treatment. Both the type and the amount of the coupling agent affect strongly interfacial adhesion, which is determined by the thickness and properties of the formed coupling agent layer. The combination of dissolution experiments with the fragmentation test yields valuable information about the processes taking place on the surface of the fiber; facilitate the selection of the best coupling agent, as well as the development of surface treatment technology.

3. About Honeycomb structures

Honeycomb structures are natural or man-made structures that have the geometry of a honeycomb to allow the minimization of the amount of used material to reach minimal weight and minimal material cost. The geometry of honeycomb structures can vary widely but the common feature of all such structures is an array of hollow cells formed between thin vertical walls. The cells are often columnar and hexagonal in shape. A honeycomb shaped structure provides a material with minimal density and relative high out-of-plane compression properties and out-of-plane shear properties.

Man-made honeycomb structural materials are commonly made by layering a honeycomb material between two thin layers that provide strength in tension. This forms a plate-like assembly. Honeycomb materials are widely used where flat or slightly curved surfaces are needed and their high strength-to-weight ratio is valuable. They are widely used in the aerospace industry for this reason, and honeycomb materials in aluminum, fiberglass and advanced composite materials have been featured in aircraft and rockets since the 1950s. They can also be found in many other fields, from packaging materials in the form of paper-based honeycomb cardboard, to sporting goods like skis and snowboards.

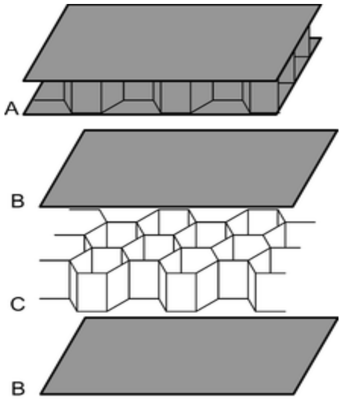


Fig 3.1. A composite sandwich panel (A) with honeycomb core (C) and face sheets (B)

3.2 Applications

- They are widely used in the aerospace industry,
- From packaging materials in the form of paper-based honeycomb cardboard, to sporting goods like skis and snowboards.
- Used as front barriers in heavy vehicles.
- Used in Automobile industries.

3.3 Advantages

- Very low weight
- High stiffness
- Durability
- Production cost savings

4. Problem Description

4.1. The Main Objectives

This project gives better shape for textile composite impact barriers by analyzing results using FEM based software COMSOL for impact analysis on honey comb box type and triangular and hexagonal models, Solid Works software to model 3D models of honeycomb structures. This is going to help in finding out an alternative geometric shape which can be used as a replacement to the traditional hexagonal honeycomb structure and which can help in reducing the delimitation problem of honeycomb structure.

- Selection of different geometric structures for better inner cores
- Selection of different materials (composite fibers).
- Use of solid Works to prepare 3D models.
- Use of COSMOS to perform analysis.
- Comparison of results of different geometric structures with traditional hexagonal honeycomb structure.
- To provide a best suitable alternative for traditional hexagonal honeycomb structure.

4.2. Types of Materials Used and their Properties

ALUMINIUM ALLOY

Name	1060 Alloy
Yield strength	2.75742e+007N/m^2
Tensile strength	6.89356e+007N/m^2
Elastic modulus	6.9e+010 N/m^2
Poisson Ratio	0.33
Mass density	2700 kg/m^3
Shear Modulus	2.7e+010 N/m^2
Thermal Expansion	2.4e-005 /Kelvin

S2_GLASS

Name	S2_Glass Fiber
Yield strength	4.89e+009 N/m^2
Tensile strength	4.89e+009 N/m^2
Elastic modulus	8.69e+011 N/m^2
Poisson Ratio	0.23
Mass density	2460 kg/m^3
Shear Modulus	3.189e+008 N/m^2

E_GLASS FIBER

Name	E-Glass fiber
Yield strength	1.725e+009 N/m^2
Tensile strength	1.725e+009 N/m^2
Elastic modulus	7.24e+010 N/m^2
Poisson Ratio	0.2
Mass density	2600 kg/m^3
Shear Modulus	3e+010 N/m^2
Compressive strength	4.15e+008 N/m^2

5. Modeling of Traditional hexagonal cross-sectioned impact barrier Honeycomb Structure using Solid Works

This impact barrier is used for 10 to 16 ton capacity trucks; it is placed in front of bumper and is connected with chassis of the vehicle

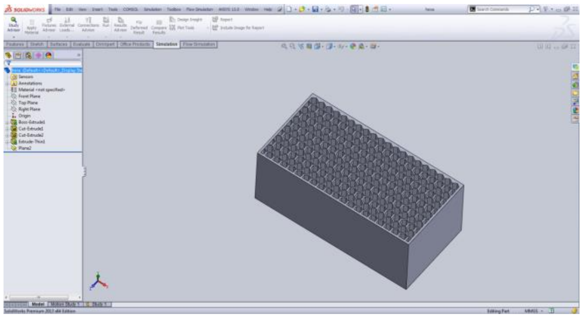


Fig.1. Traditional hexagonal cross-sectioned impact barrier Honeycomb Structure

Created using extrudes and cut operations with individual sketches in solid works

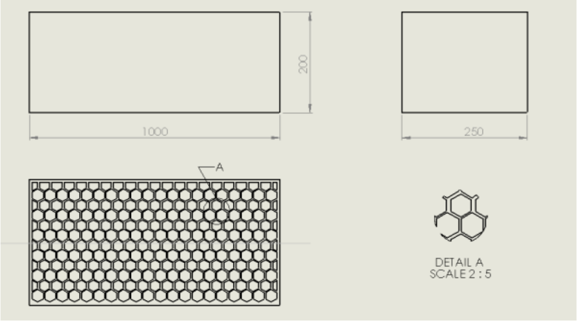


Fig.2. Drafting of hexagonal cross-sectioned impact barrier

The above shape is the traditional structure of impact barrier

Modeling of Square cross-sectioned impact barrier Honeycomb Structure using Solid Works

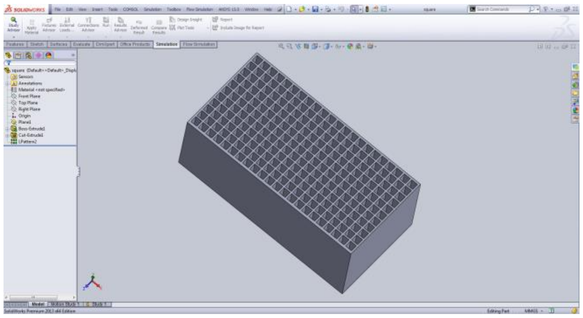


Fig.3. Square cross-sectioned impact barrier

Created using extrudes and cut operations with individual sketches in solid works.

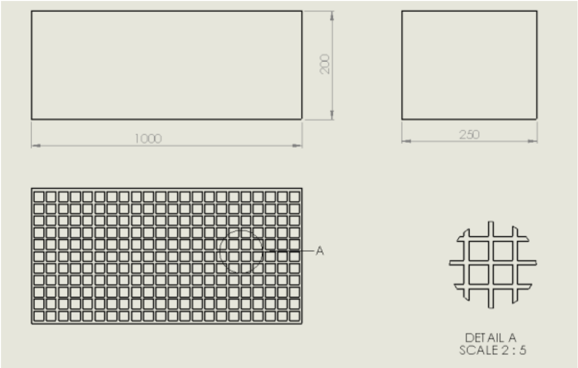


Fig.4. Drafting of square cross-sectioned impact barrier

The above images shows the new geometry shape

Modeling of Triangular cross-sectioned impact barrier Honeycomb Structure using Solid Works

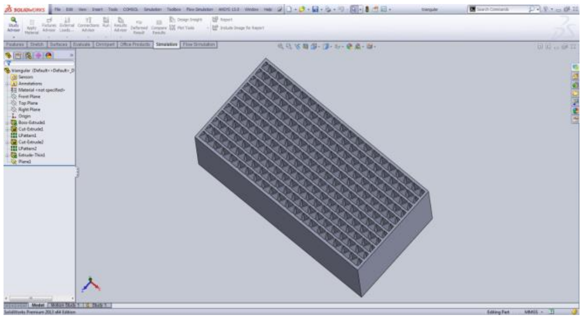


Fig.5. Triangular cross-sectioned impact barrier

Created using extrudes and cut operations with individual sketches in solid works

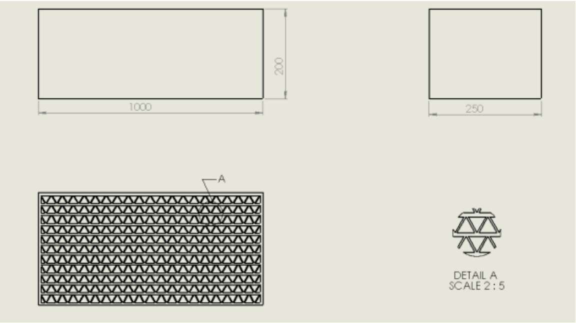


Fig.6. Drafting of triangular cross-sectioned impact barrier

The above images shows the new geometry shape

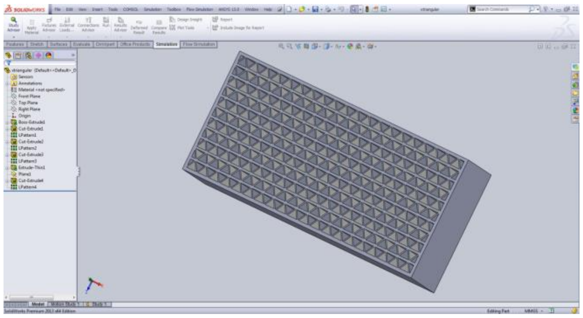


Fig.7. Cross-triangular cross-sectioned impact barrier

Created using extrude and cut operations with individual sketches in solid works

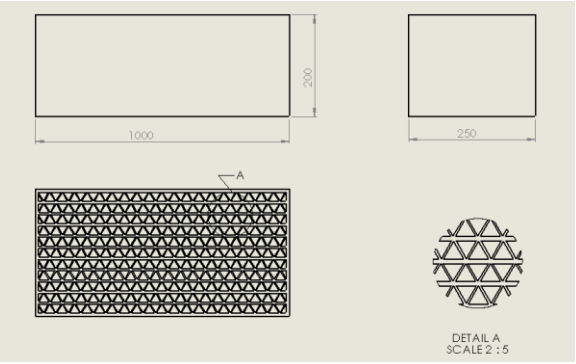


Fig.8. Drafting of cross-triangular cross-sectioned impact barrier

The above images shows the new geometry shape

6. LOAD CONDITIONS:

When barriers are crash-tested, it is impossible to replicate the innumerable variations in highway conditions. Therefore, barriers are crash-tested under standardized conditions. These standard conditions were previously documented in National Cooperative Highway Research Program (NCHRP) Report 350. These guidelines have been updated and are now presented in the Manual for Assessing Safety Hardware (MASH).

As per the above discussion we are going to conduct analysis at speed of

250 kmph = 69.44M/S

Impact Analysis of Hexagonal E-Glass Structure

HEXGONAL (E-Glass)

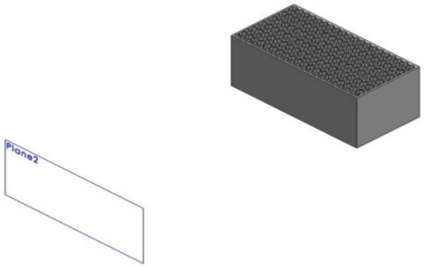


Fig.9. Solid model of Hexagonal E-Glass Structure

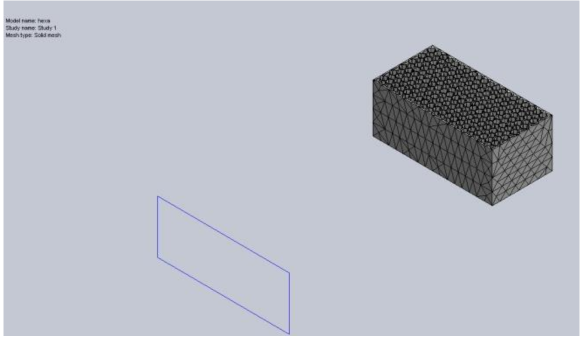


Fig.10 Meshed model of Hexagonal E-Glass Structure

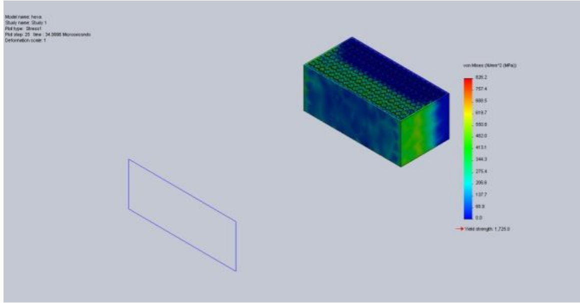


Fig.11 Von misses stress value,Min = 2.17743e-006 N/mm^2 (MPa), Max = 826.247 N/mm^2 (MPa)

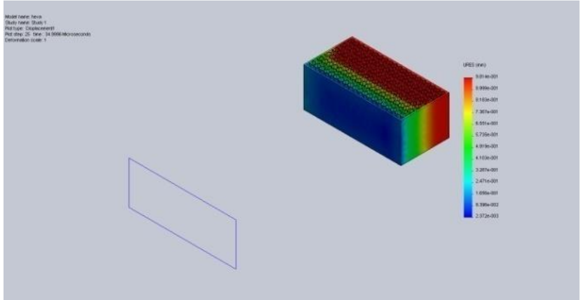


Fig.12 Displacement value, min = 0.0023725 mm, max = 0.98144 mm

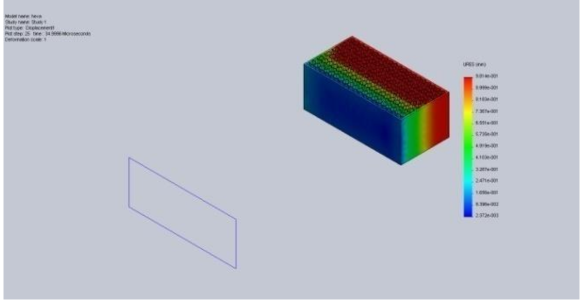


Fig.17Strain value, min = 5.60678e-012, max = 0.0107664

Impact Analysis of Hexagonal S2-Glass Structure

HEXGONAL (S2-Glass)

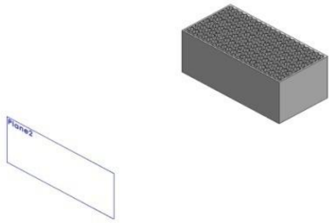


Fig.13 solid model of Hexagonal S2-Glass

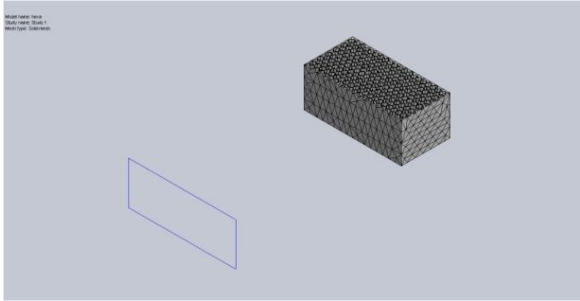


Fig.14 Meshed model of Hexagonal S2-Glass

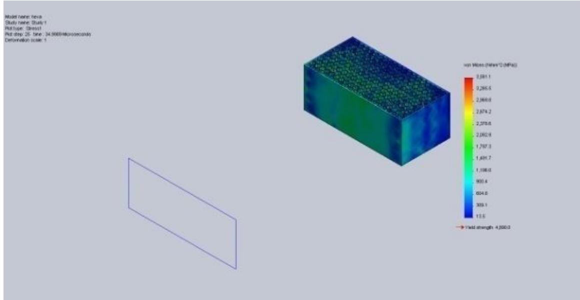


Fig.15 Von misses stress value, min = 13.5071 N/mm^2 (MPa), max = 3561.1 N/mm^2 (MPa)

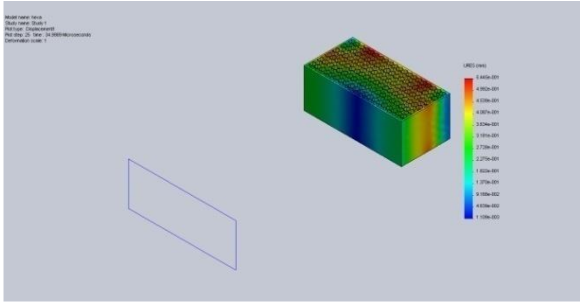


Fig.16 Displacement value, min = 0.00110866 mm, max = 0.544516 mm

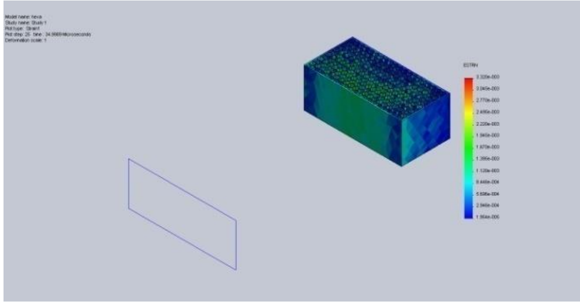


Fig.17 Strain value, min = 1.95364e-005, max = 0.00331992

Impact Analysis of Hexagonal Aluminum Structure

Hexagonal (aluminum)

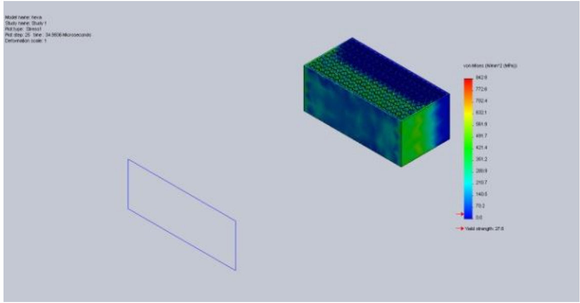


Fig.18 Von misses stress value, min = 2.47172e-006 N/mm^2,Max = 842.841 N/mm^2

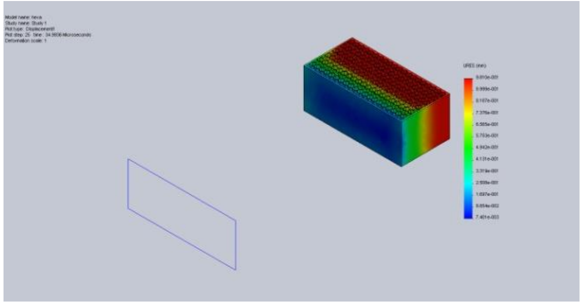


Fig.19 Displacement value, min = 0.00740097 mm, max = 0.981015 mm

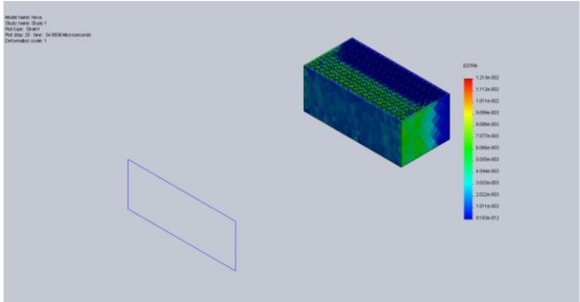


Fig.20 Strain value, min = 9.1829e-012, max = 0.0121315

Impact Analysis of SQUARE E-Glass Structure

SQUARE (E-Glass)

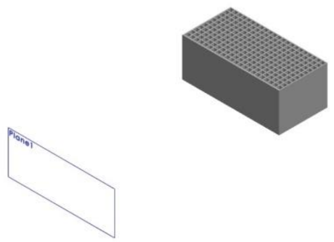


Fig.21 Solid model of SQUARE E-Glass

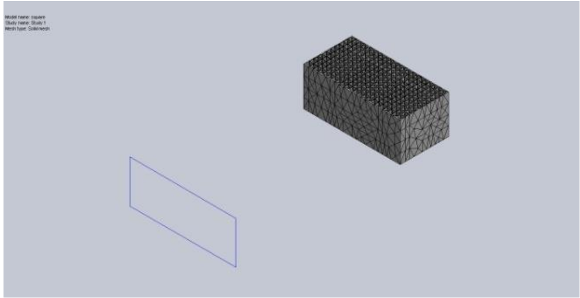


Fig.22 meshed model of SQUARE (e-glass)

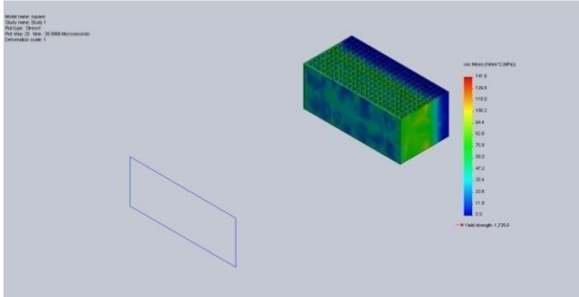


Fig.23 Von misses stress value, min = 0.000828085 N/mm^2, max = 141.632 N/mm^2(MPa)

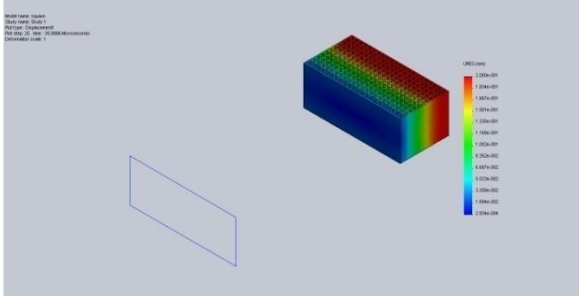


Fig.24 Displacement value, min = 0.000293423 mm,max = 0.200035 mm

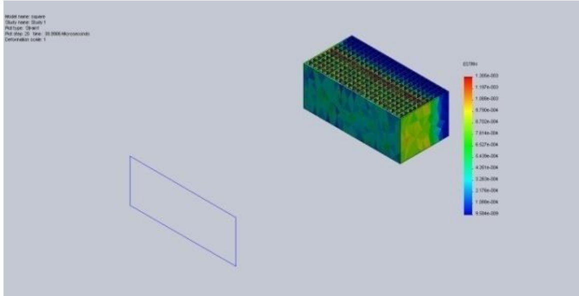


Fig.25 Strain value, min = 9.58421e-009, max = 0.00130533

Impact Analysis of SQUARE S2-Glass Structure

SQUARE (s2-glass)

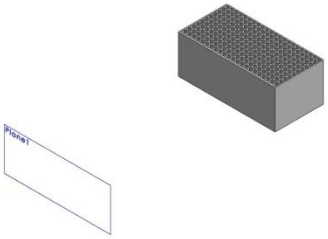


Fig.26 solid model of SQUARE S2-Glass

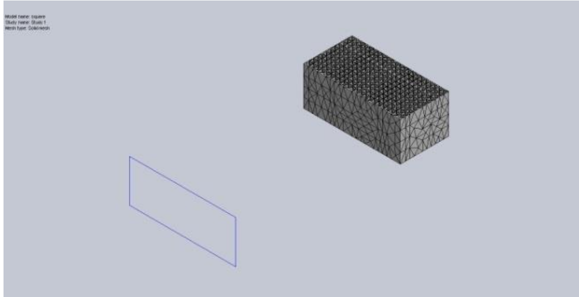


Fig.27 Meshed model of SQUARE S2-Glass

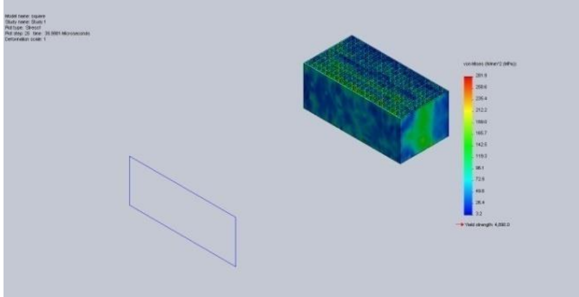


Fig.28 Von misses stress value, Min = 3.19176 N/mm^2 (MPa), Max = 281.863 N/mm^2(MPa)

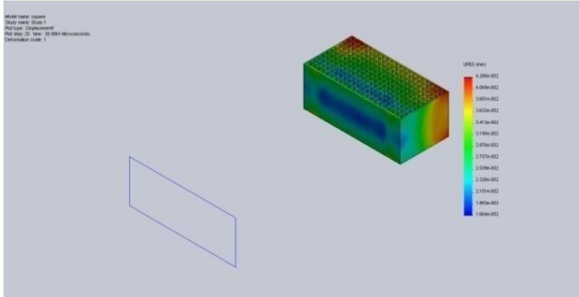


Fig.29 displacement value, Min = 0.0166425 mm,Max = 0.0428777 mm

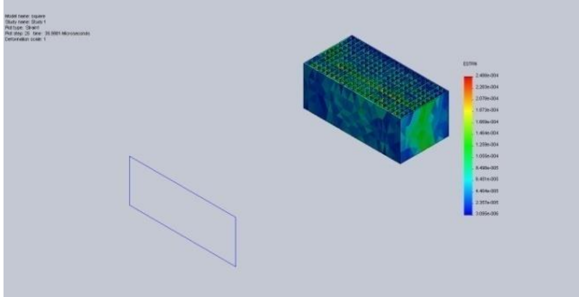


Fig.30 Strain value, min = 3.09523e-006, max = 0.000248751

Impact Analysis of SQUARE Aluminum Structure

Square (aluminum)

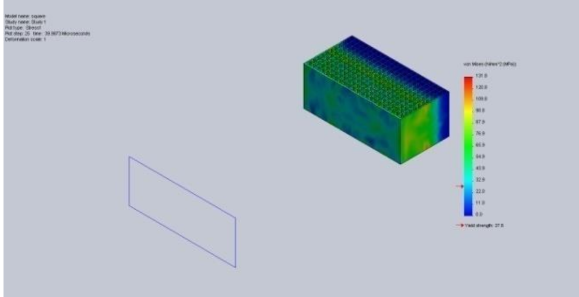


Fig.31 Von misses stress value, Min = 0.00132973N/mm^2,Max=131.796 N/mm^2

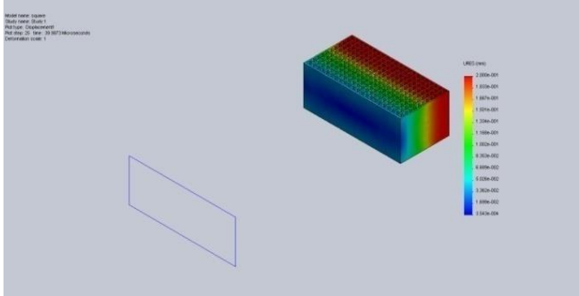


Fig.32 Displacement value, Min = 0.000354302 mm, Max = 0.199973 mm

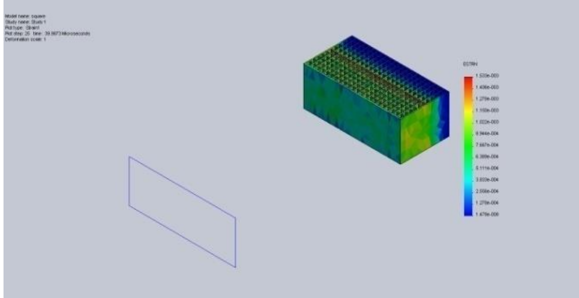


Fig.33 Displacement value, Min = 1.47839e-008, Max = 0.0015333

Impact Analysis of TRIANGULERE-Glass Structure

TRIANGULER (e-glass)

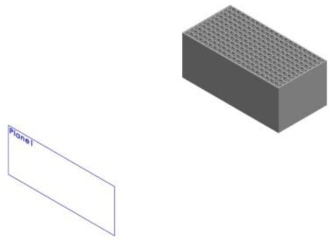


Fig.34 the above image shows the solid model of TRIANGULER-E-Glass

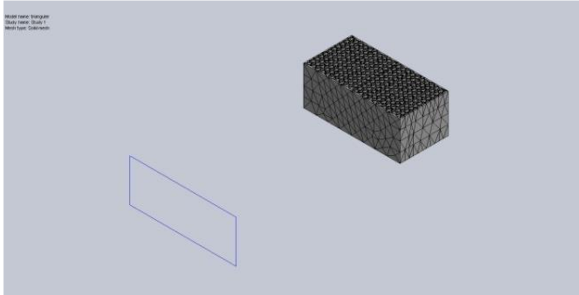


Fig.35 Meshed model TRIANGULER-E-Glass

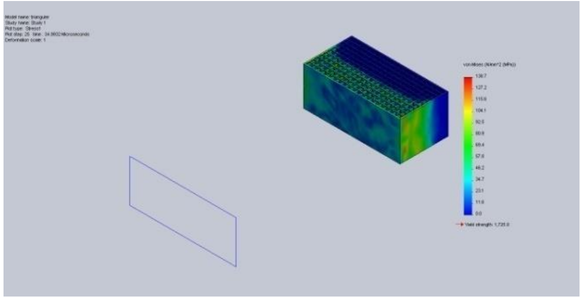


Fig.36 The above image shows the Von misses stress value, min = 6.60734e-005 N/mm^2, max = 138.738 N/mm^2 (MPa)

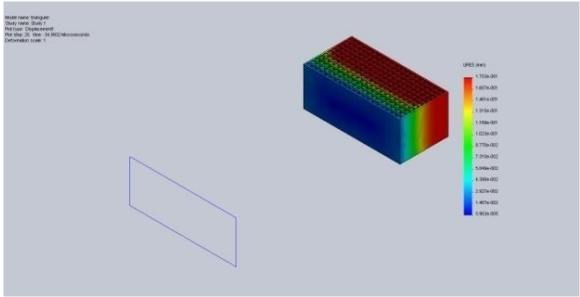


Fig.37 Displacement value, Min = 5.96288e-005 mm,Max = 0.175346 mm

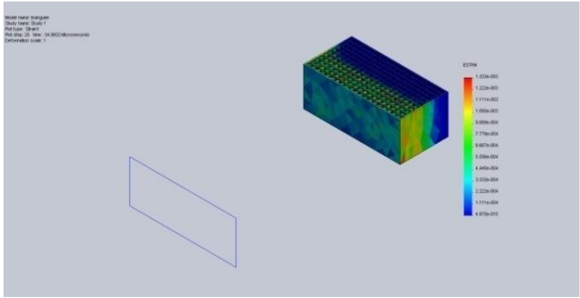


Fig.38 Strain value, Min = 4.9752e-010, Max = 0.00133339

Impact Analysis of TRIANGULER S2-Glass Structure

TRIANGULAR (s2-glass)

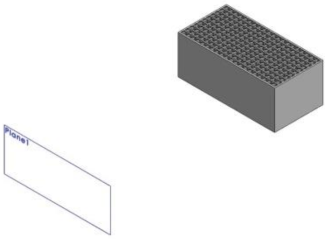


Fig.39 Solid model of TRIANGULAR (s2-glass)

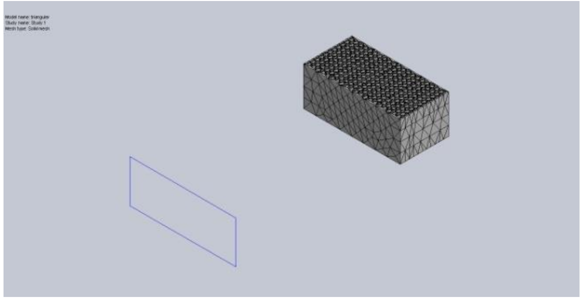


Fig.40 Meshed model of TRIANGULAR-S2-Glass

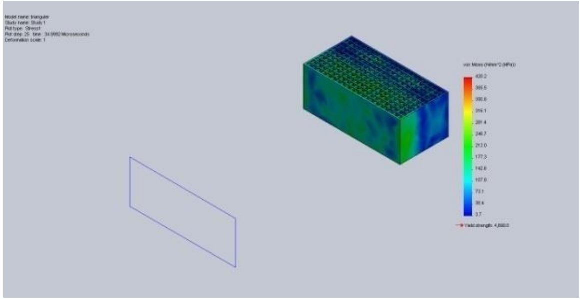


Fig.41 Von misses stress value, Min = 3.71096 N/mm^2 (MPa),Max = 420.233 N/mm^2(MPa)

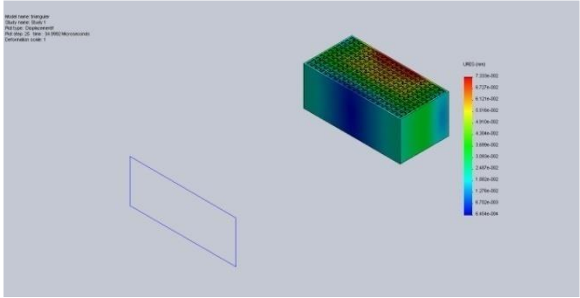


Fig.42 Displacement value, Min = 0.0006454 mm, Max = 0.0733271 mm

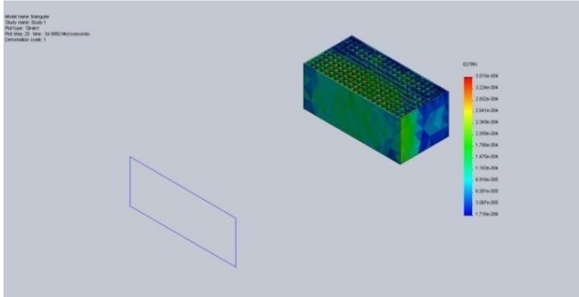


Fig.43 Strain value, Min = 1.71599e-006, Max = 0.000351508

Impact Analysis of TRIANGULER Aluminum Structure

TRIANGULAR (Aluminum)

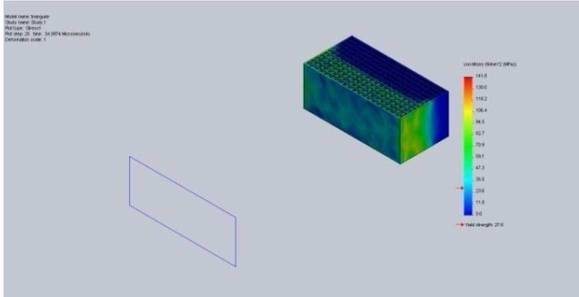


Fig.44 Von misses stress value, Min = 6.7617e-005 N/mm^2,Max = 141.817 N/mm^2

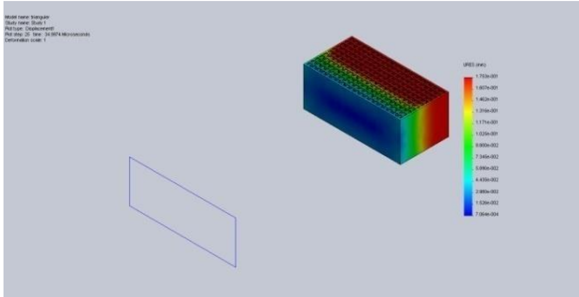


Fig.45 Displacement value, Min = 0.000706448 mm, Max = 0.175295 mm

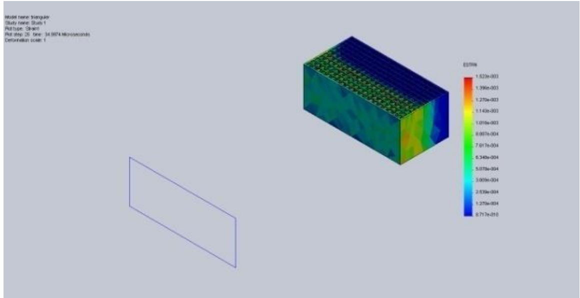


Fig.46 Strain value, Min = 8.71675e-010, Max = 0.00152341

7.RESULT

Name	Material	Von-misses stress In (N/mm^2)	Displacement in (mm)	Strain
Hexagonal	E-Glass	826.247	0.98144	0.0107664
	S_{2}- Glass	3561.1	0.544576	0.00331992
	Aluminum	842.841	0.981015	0.0121315
Square	E-Glass	141.632	0.200035	0.00130533
	S_{2}- Glass	281.863	0.0428777	0.000248751
	Aluminum	131.796	0.199973	0.0015333
Triangular	E-Glass	138.738	0.175346	0.00133339
	S_{2}- Glass	420.233	0.0733271	0.000351508
	Aluminum	141.817	0.175295	0.00152341

8. CONCLUSION

This project thesis gives brief explanation about impact barriers and composite textile technology.

As discussed earlier the honey comb textile impact barriers having delaminating problem .In these thesis different composite structures are validated to overcome the above said problem. Initially literature survey was done on impact barrier and textile structures, in the next step 3D models (honey comb, square, triangular) are Prepared to carry out the impact test. Impact test is conducted on honey comb structure to evaluate the results. And also impact test is conducted on new structures to validate the designs. Generally aluminum alloy is used to manufacture impact barrier and its core structure. This thesis also discusses about application FRP and CRF’s. (Epoxy’s). As per the analytical results obtained from impact analysis square type with s2-glass is the best replacement for honey comb textile technology.

9. REFERENCE

1. Investigation of different geometric structure parameter for honeycomb textile composites on their mechanical performance. A thesis submitted to the University of Manchester for the degree of Doctor of Philosophy In the Faculty of Engineering and Physical Sciences By Xiaozhou Gong
2. A New Method of Model Aluminum Honeycomb Based Crash barriers in Lateral and Front Load Cases By Thomas Jost, Thomas Heubrandtner, Charistian Ruff, Bernhard Fellner, Kompetenzzentrum-Das VirtuelleFahrzeugForschugsgesellschaftmb H,Graz,Austria.
3. Development of the Advanced Finite Element Model for ODB Impact Barrier MehrdadAsadi (m.asadi@cellbond.com) Cellbond Composites Ltd. (UK) Brian Walker ARUP (UK) Hassan Shirvani Anglia Ruskin University (UK)
4. Experiences in reverse-engineering of a "nite element automobile crash model Z.Q. Chenga, J.G. Thackera, W.D. Pilkeya , W.T. Hollowellb, S.W. Reagana, E.M. Sievekaa.
5. SIMULATION OF VEHICLE-PEDESTRIAN INTERACTION. A thesis submitted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy in Engineering in the University of Canterbury by T. J. Stevenson University of Canterbury 2006.
6. Defect Characterization of Composite Honeycomb planes by Non-Destructive Inspection Methods by A.B.doyum,M.Durer Department of Mechanical Engineering, Middle East Technical University, Ankara(TR).
7. Rapid Inspection of Composite Skin-honeycomb Core Structures with Ultrasonic Guide Waves by Thomas R. hay, Lou Wei and Joseph L. Rose, Engineering Science and Mechanical Department, The Pennsylvania State University.