ISSN : 2454-9150 Vol-06, Issue-07, OCT 2020

Design and Analysis of Honeycomb Structure Used in Different Automobile Applications

[1]V.LEELA SIVA SAI, [2]S.RAJESH, [3]P. RAMA MURTY RAJU

[1]Student, [2]Associate Professor, [3]Professor, Department of Mechanical Engineering,S.R.KR. Engineering College, China Amiram, Bhimavaram, A.P. India.

ABSTRACT:The wellbeing to driver and travellers is a significant worry to each vehicle maker. For achieving this, new norms are being set for the security of the tenant in various vehicle situations like frontal head crash. The car body is the primary burden transporter and energy retaining segment in all accident occasions. In the cutting edge world, fuel utilization additionally comprised as a major issue that must be thought of. Keeping all these obliges in thought, a light and stiffer material ought to be utilized in undercarriage. In current work, vital casing skeleton has been planned with honeycomb structure guard utilizing CATIA V5 programming and was broke down utilizing a limited component examination (FEA) program ANSYS. The flow research gives a standard limited component investigation system for planning rough terrain vehicle vital edge. A multi body dynamic accident investigation is an alternative to comprehend the specific conduct of the case for frontal impacts, to contemplate the impact of speed (120 km/hr.) of a vehicle, with various materials (body outline, body outline with Al7075 honeycomb structure, body outline with Al7075-TiB2 Composite honeycomb structure). This report incorporates the making of the sheltered plan and material mater for dynamic effect examination under frontal head crash condition. At long last, will close the reasonable plan and material dependent on results acquired by investigation.

Non-pneumatic tire is a compliant of cell adaptable talked segment which goes about as quality of a customary tire. In this undertaking we supplant customary amalgam wheel by adaptable talked structure. We researched various spokes structure for example Honeycomb spokes structure, Triangle spokes structure, Plate spokes structure and Diamond spokes structure for Non-pneumatic tire by applying uniaxial load and rotational speed. The spokes experience strain just as pressure while they are rolling. Non-pneumatic tires are planned in CATIA workbench and investigation is finished utilizing ANSYS workbench lastly completed the equal anxieties, strains, disfigurements, shear stresses. Model investigation is additionally done and afterward discovering the appropriate plan for Non - pneumatic tires.

Keywords: Car, Integral Chassis Frame, Honey Comb, Al7075, Titanium, Steel, Non-pneumatic, Crash Analysis, CATIAV5, ANSYS.

I. INTRODUCTION

1.1 ROLE OF CHASSIS IN AUTOMOTIVES:

Each vehicle body comprises of two sections; body and bodywork or superstructure. The undercarriage is the system of any vehicle. Its chief capacity is to securely convey the greatest burden for all planned working conditions. It should likewise retain motor and driveline force, suffer stun stacking and oblige turning on lopsided street surfaces. The case gets the response powers of the wheels during speeding up and slowing down and furthermore assimilates streamlined breeze powers and street stuns through the suspension. So the body ought to be designed and worked to expand payload capacity and to give flexibility, strength just as sufficient execution. To accomplish a good presentation, the development of a hefty vehicle suspension is the aftereffect of cautious plan and thorough testing.

It ought to be noticed that this 'stepping stool' sort of casing development is intended to offer great descending help for the body and payload and simultaneously give torsional adaptability, mostly in the district between the gearbox cross part and the cross part in front of the back suspension. This skeleton flexing is vital in light of the fact that an unbending edge is bound to fall flat than an adaptable one that can 'weave' when the vehicle is presented to burdensome conditions.

Figure.1 Crashing of Two Cars

 DOI : 10.35291/2454-9150.2020.0645

1.2 FRAME CONSTRUCTION:

The edge development normally comprises of channel-formed steel radiates welded and attached together. The casing (body) of vehicle will bolsters all the running apparatus mounted on it, it likewise including the motor, transmission, back pivot get together (if back wheel drive), and all the suspension parts. The kind of edge development that is alluded to as full casing, is finished to such an extent that most karts can generally be driven without the body. Terms and name of various sort of casing are as per the following stacking when the vehicle is on lopsided surfaces.

1.2.1 INTEGERAL FRAME:

In this kind of development, there is no different casing. It is additionally called unibody development. Which implies that all the get together units are connected to the body and all the elements of the casing are completed by the body itself. The body shell and under body are welded into a solitary unit. The under body is made of floor plates and box segments welded together. The first and greatest preferred position is weight reserve funds: Since all aspects of the vehicle is critical to basic respectability, there's no requirement for the additional mass of a devoted edge. Next, unibody plans make it a lot simpler to shield travellers by coordinating energy from an accident away from the lodge.

1.2.2 PERIMETER FRAME:

This kind of casing comprises of welded or bolted outline individuals around the whole edge of the body as appeared in Figure 2.2. The casing individuals will offer help underneath the sides just as for the suspension and suspension parts.

1.2.3 STUB-TYPE FRAME:

Stub-type outline appeared in is a halfway casing frequently utilized on unit-body vehicle, a sort of vehicle development, first utilized by the Budd Company of Troy, Michigan, that doesn't utilize a different casing. The body is constructed sufficiently able to help the motor and the force train, just as the suspension and controlling framework. The external body boards are essential for the structure to help the force train and suspension parts. It is additionally called support.

II. LITERATURE REVIEW

Thacker et.al [1] led crash-testing recreation investigation of a 1997 Honda Accord. Initially, a genuine vehicle was acquired and afterward the vehicle was stripped down to its essential parts, every segment was recognized, marked, and the material assessed. Information that could be productively extrapolated from existing sources were gathered.

Yucheng liu's [2] paper shows that the trial results and FEA results coordinates well overall and the legitimacy of the PC model is then checked.

Simonetta Boria's [3] study is the plan of an accident box for a Formula SAE vehicle and the examination, through a mathematical methodology, of its dynamic conduct in frontal effect conditions. The acquired outcomes show that the effect attenuator without anyone else can retain the all out active energy with dynamic clasping and plastic twisting of its structure with a normal deceleration restricted under a 20g worth.

Bižalana [4] et al., considered the mathematical reenactment of crash test utilizing Student Roadster (SR). The outcomes outline the significance of spaces in energy permeable pillars for plastic disfigurements shaped in those zones.

Un-koo Lee [5] et al., delineated a sub outline type fuel tank and assessed to build the vehicle security and the plan adaptability against back accident of car vehicles. The proposed plan of fuel tank gives the plan adaptability as well as satisfies the necessities of the updated Federal Motor Vehicle Safety Standards.

[6]Simulated crash-testing is as a rule progressively by different organizations to examine the result of a vehicular in different circumstances under various conditions. The upside of reenactment is that the FE models can be reused over and over and furthermore the client has the opportunity to change any of the boundaries of the test and furthermore the client can fluctuate the material properties just as the sort of material of the parts in the vehicle.

[7]The FE model was then used to mimic accident test. The FE programming utilized here to complete the recreation was LS-DYNA. One of the tests completed was the Frontal-balance crash at 40 mph. Before the reproduction could be completed, a few other preprocessing conditions must be indicated. The test outcomes were checked utilizing results from genuine accident test reports. Present runtimes on top of the line workstations for LS-DYNA vehicle models are as yet estimated in days, while multi-body run-times are normally under 1h, in any event, for the most intricate models.

[8]In the car business weight decrease is significant in light of the fact that fuel utilization is legitimately identified with vehicular weight. Composite materials are regularly used to diminish the heaviness of structures. Composite materials can offer noteworthy security benefits for vehicles contrasted and metals regarding high explicit energy ingestion (SEA) and quality contrasted with weight. Prior to beginning this task, a portion of the distributed written works and past investigates have been evaluated to develop a strong foundation in the region of vehicle reproduction and limited component examination

III. DESIGN CONSIDERATIONS AND PROCUDRE

3.1 MATERIAL PROPERTIES:

Body materials ought to likewise have adequate quality and controlled distortions under burden to retain crash energy, yet keep up adequate survivable space for satisfactory tenant insurance should an accident happen. Further, the structure ought to be lightweight to diminish fuel utilization. Most of mass-delivered vehicle bodies in the course of the most recent sixty years were made from stepped steel parts. Makers construct just a couple of restricted creation and strength vehicle bodies from composite materials or aluminum and for honeycomb structure.

 DOI : 10.35291/2454-9150.2020.0645

ISSN : 2454-9150 Vol-06, Issue-07, OCT 2020

3.2 SPECIFICATIONS OF EXISTING 2002 TATA INDICA VEHICLE:

The demonstrated vehicle outline which is produced in CATIA, where the vehicle was made as a day to day existence size model to precisely analyze the impacts of a fender bender. The vehicle model concentrated here is from Andrew Hickey &Shaoping Xiao International Journal of Modern Studies in Mechanical Engineering (IJMSME) Page | 2 2002 Tata Indica vehicle. The components of the vehicle were investigated online on the Tata site and converted into the plan in catia. The general elements of a 2002 indica are around 71"x190"x71" (W x L x H) portrays the model of the vehicle that was produced. As referenced previously, just the edge of the pioneer was produced so as to break down how the edge structure twists during the effect of an accident.

Figure 2 TATA INDICA MODEL

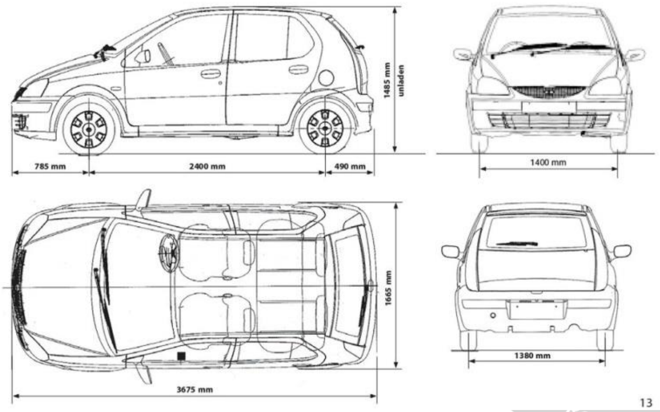


Figure 3 Dimensions of the vehicle

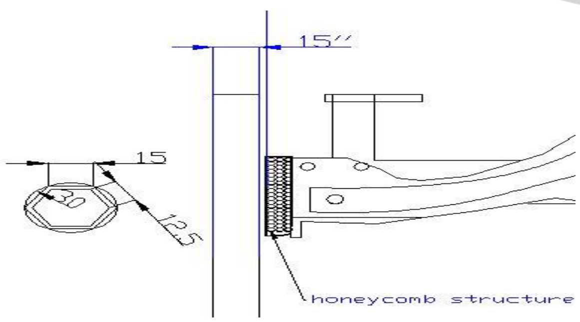


Figure 4 Honeycomb Structure Specifications

Case1

DESIGN PROCEDURE FOR CAR FRAME:

In CATIA V5, a 2D sketch (71"x190") of a vehicle outline grew at first. This 2D sketch is formed into a strong body by utilizing cushion (71") choice. A filet of range 200mm used to make the front bit and for the side piece of body filet of span 150mm utilized. Also, the shell choice is utilized for top and base side of the created vehicle body to eliminate superfluous material. A balance order is utilized to finish the vehicle body. By utilizing the manager expel alternative we are making a divider before vehicle body as appeared in figure. At long last, a strip comprises of honeycomb structure is connected to the front edge of the body

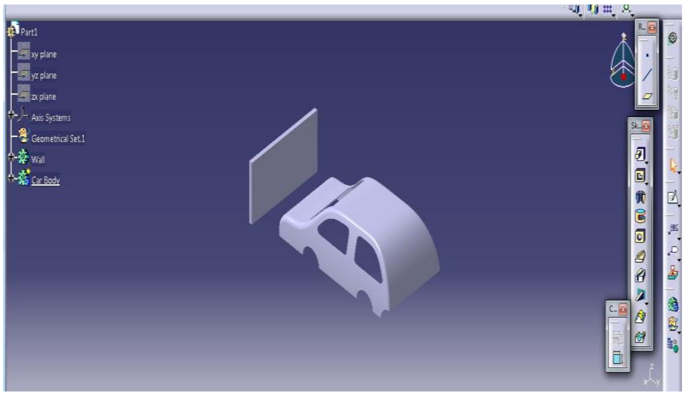


Figure 5a Car without honeycomb structure

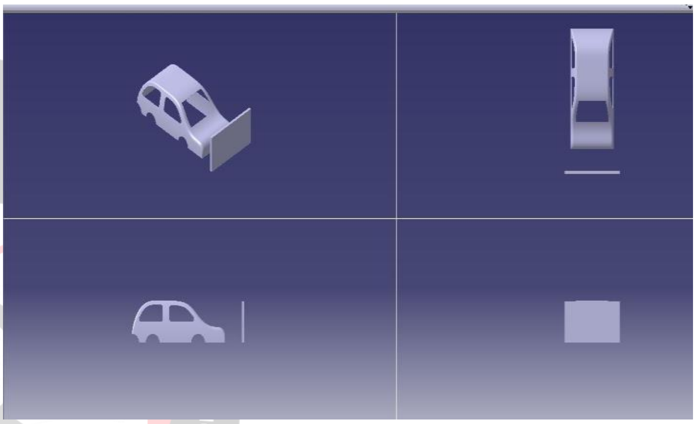


Figure 5b Car without honeycomb structure multi view

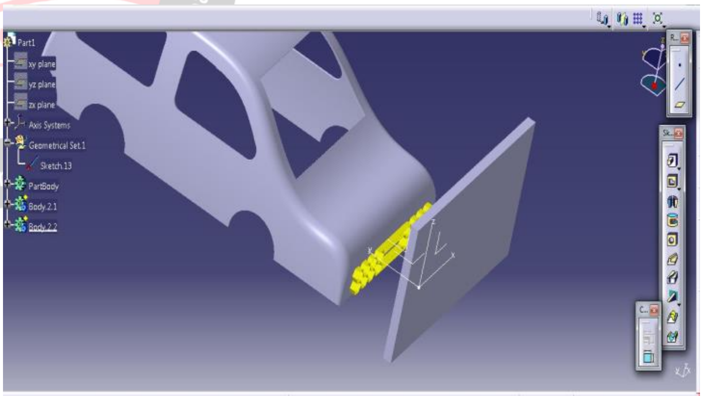


Figure 6a Car with honeycomb structure

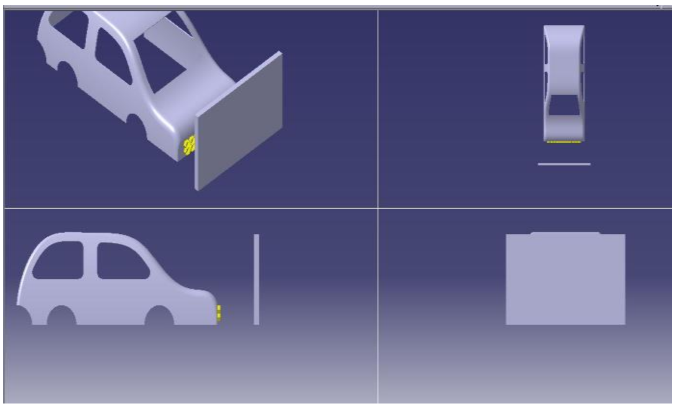


Figure 6b Car with honeycomb structure multi view

 DOI : 10.35291/2454-9150.2020.0645

ISSN : 2454-9150 Vol-06, Issue-07, OCT 2020

Case2

I.HONEYCOMB SPOKES STRUCTURE:

While planning the honeycomb structure, entire structure is separated in to cell. The single cell is made first and reflected to make whole structure. By considering the phone design measurements for example cell edge □, stature h, and length l that were referenced above in the mathematical measurements and mathematical viewpoints, the accompanying model of Honeycomb spokes structure tire is created which is demonstrated as follows

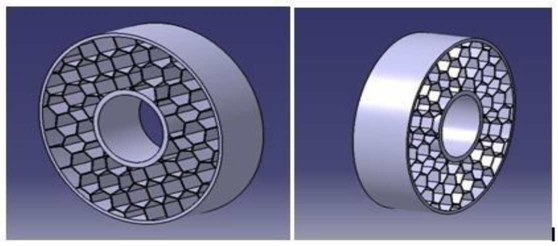


Figure7 Honeycomb spokes structure

2.PLATESPOKESSTRUCTUE:

While planning the plate spokes structure, the center point which conveys the whole structure is made first with the necessary measurements there after plate talked about referenced measurement is made on it and by utilizing turn order, giving the dividing required in this manner made a whole structure with the accompanying elements of the tire which is demonstrated as follows

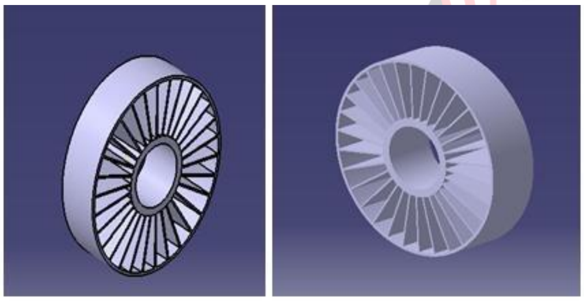


Figure8 Plate spokes structure

TRIANGLE SPOKESSTRUCTURE:

The plan technique is like the honeycomb spokes structure. While planning this structure, entire structure is partitioned in to cell. The single cell is made first and reflected to make whole structure. Furthermore, consequently following the mathematical perspectives and measurements, the accompanying model is created which is demonstrated as follows

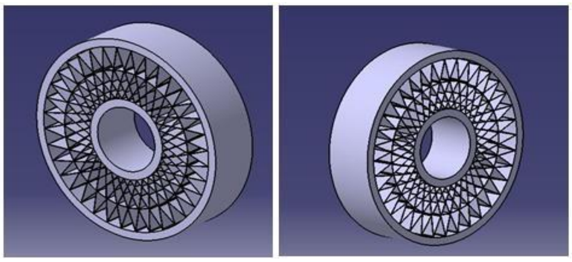


Figure9 Triangle spokes structure

DIAMOND SPOKESSTRUCTURE:

While planning the Diamond spokes structure, the center which conveys the whole structure is made first with the necessary measurements there after Diamond talked about referenced measurement is made on it and by utilizing pivot order, giving the dividing required along these lines made a whole structure with the accompanying components of the tire which is demonstrated as follow

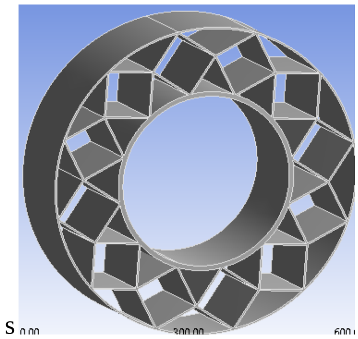


Figure10 Diamond spokes structure

IV. ANALYSIS

4.1 INTRODUCTION TO ANSYS:

ANSYS is a universally useful programming, used to recreate cooperations of all controls of material science, basic, vibration, liquid elements, heat move and electromagnetic for engineers. So ANSYS, which empowers to recreate tests or working conditions, empowers to test in virtual climate before assembling models of items. Moreover, deciding and improving powerless focuses, processing life and predicting plausible issues are conceivable by 3D reproductions in virtual climate. Additionally, it can work coordinated with other utilized designing programming on work area by including CAD and FEA association modules.

4.2 EXPLICT DYNAMICS ANALYSIS:

ANSYS 15.0 conveys imaginative, sensational reproduction innovation propels in each significant material science discipline, alongside upgrades in figuring rate and improvements to empowering advances, for example, math dealing with, lattice and post-handling. Here the accident investigation is done in the unequivocal powerful mode with the vehicle speed of 120 km/hr. The math was sent out as an IGS record from CATIA and afterward brought into ANSYS for work age and FEM investigation. The mass of a Tata Indica is 2458kg approx.., in view of the data in the Ford site. At the point when the CATIA model of a vehicle was moved into ANSYS, the mass was estimated to be 2327.84kg, which is precise to the genuine model. A tetrahedral work was created on the vehicle as appeared in Figure. At purposes of better detail, there are more hubs and components which are littler on the grounds that the calculation is more perplexing and along these lines better approximations must be made. The quantity of components and hubs in the FEM model of the vehicle are 88469 and 39045 separately.

4.4 BOUNDARY CONDITIONS:

Case1

Dynamic analysis

The Wall before the vehicle outline is fixed and zero

 DOI : 10.35291/2454-9150.2020.0645

ISSN : 2454-9150 Vol-06, Issue-07, OCT 2020

degrees of opportunity. The contact among divider and guard is eliminated by erasing contact requirement. At last, speed of the vehicle is provided in Z-Axis guidance just to crash with the divider.

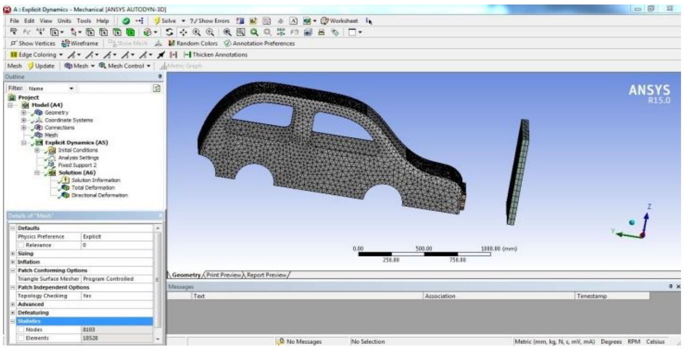


Figure 11 Vehicle Frame with Honeycomb Structure Bumper

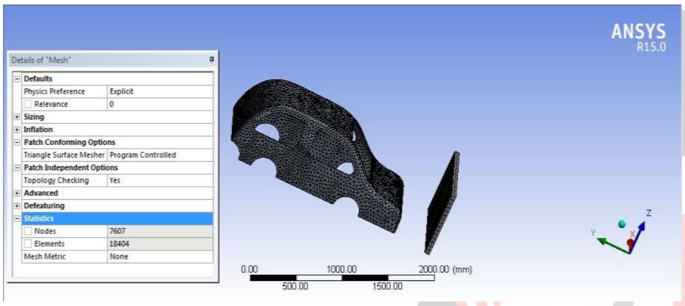


Figure 12 Vehicle Frame without Honey Comb Structure Bumper

V. RESULTS AND DISCUSSIONS

Dynamic Analysis

At first vehicle outline with typical guard having 120 km/hr speed is collided with the fixed and inflexible divider which is set ahead to the edge. That cycle is rehashed for the casing with Aluminum honeycomb structure guard and casing with Aluminum 7075TiB2 Composite honeycomb structure guard. Lastly, the consequences of the issue (Von-Mises Stress, Strain, Total Deformation, Shear Stress and Energy Absorption Summary) are outlined beneath.

5.1a Vehicle Frame without Honeycomb Structure Bumper:

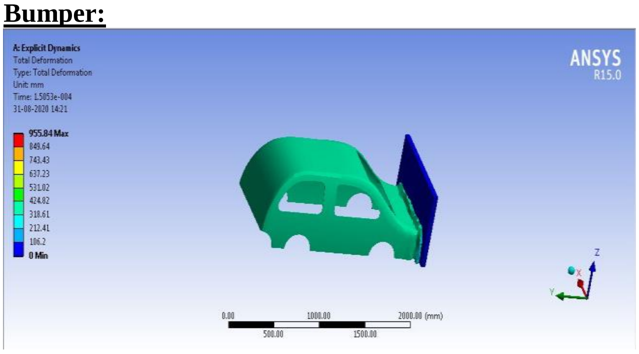


Figure 13 Von-Mises Stress of Vehicle Frame without Honeycomb

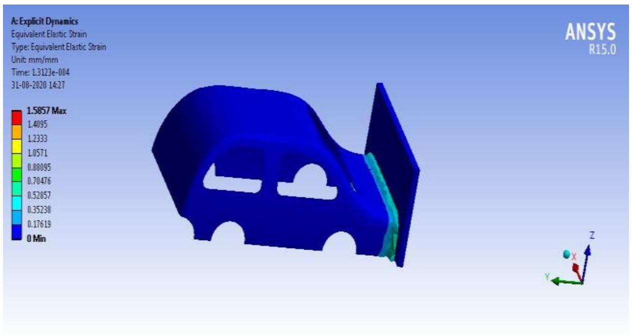


Figure 14 Total Deformation of Vehicle Frame

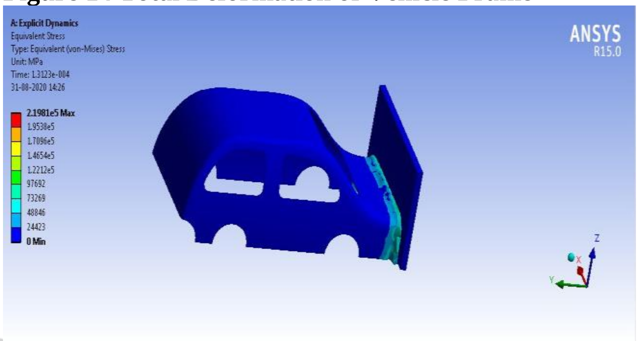


Figure 15 Strain of Vehicle Frame

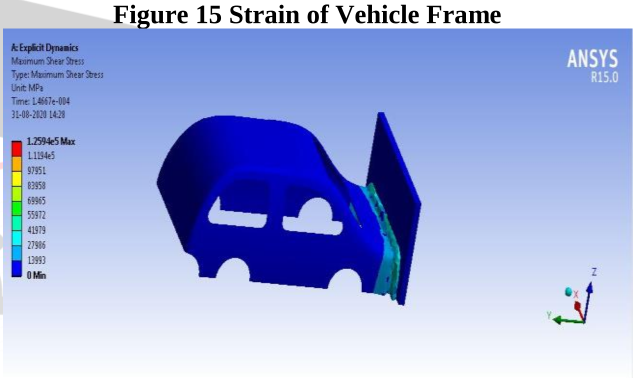


Figure 16 Shear Stress of Vehicle Frame

5.1b Vehicle Frame with Aluminum 7075 Honeycomb Structure Bumper:

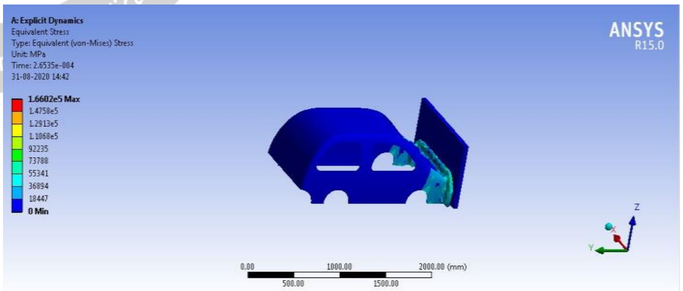


Figure 17 Von-Mises Stress of Vehicle Frame with Aluminum 7075 Honeycomb Structure Bumper

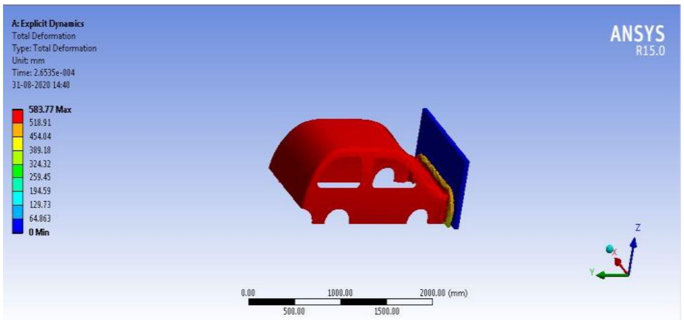


Figure 18 Total Deformation of Vehicle Frame with Aluminum 7075 Honeycomb Structure Bumper

 DOI : 10.35291/2454-9150.2020.0645

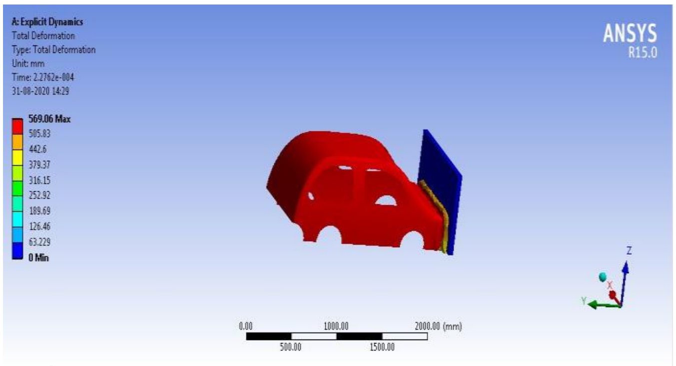


Figure 19 Shear Stress of Vehicle Frame with Aluminum 7075 Honeycomb Structure Bumper

5.1c Vehicle Frame with Aluminum 7075 –TiB2 Composite Honeycomb Structure Bumper:

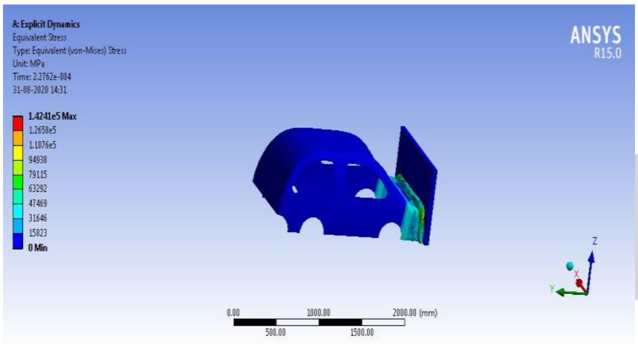


Figure 20 Von-Mises Stress of Vehicle Frame with Aluminum 7075 –TiB2 Composite Honeycomb Structure Bumper

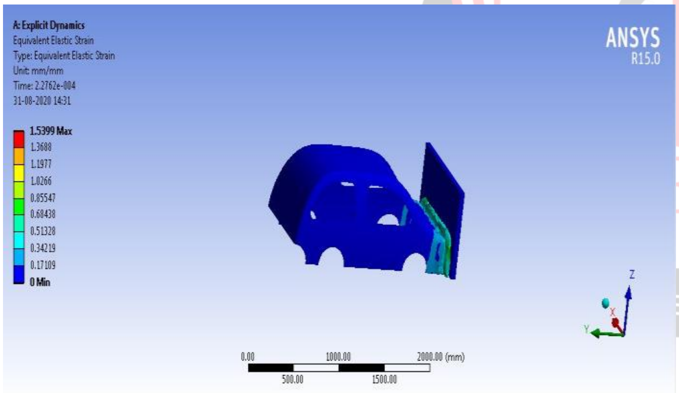


Figure 21 Strain of Vehicle Frame with Aluminum 7075 –TiB2 Composite Honeycomb Structure Bumper

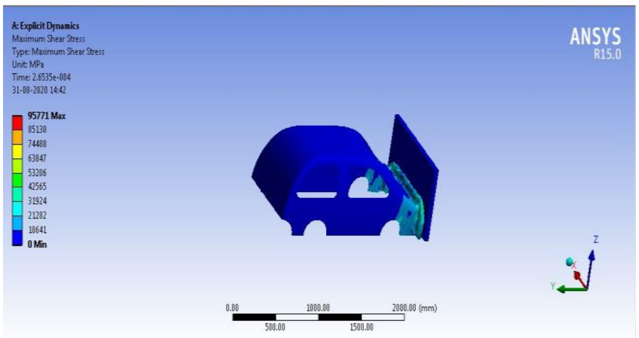


Figure 22 Total Deformation of Vehicle Frame with Aluminum 7075 –TiB2 Composite Honeycomb Structure Bumper

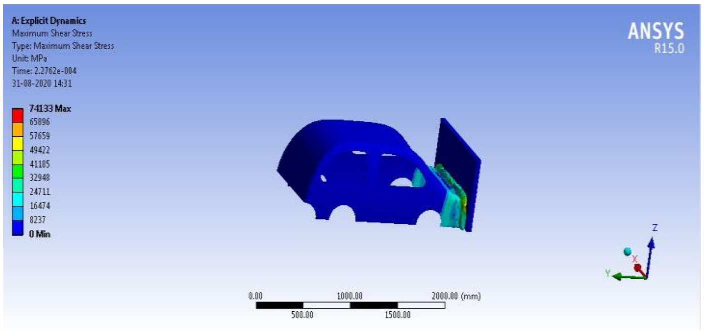


Figure 23 Shear Stress of Vehicle Frame with Aluminum 7075 –TiB2 Composite Honeycomb Structure Bumper

Case2

Regarding a moderately low worry in NPTs, just the dynamic conduct of NPTs planned with same reference load conveying limit. A rakish speed of 0.01 rad/ms (i.e.,3.32 m/s with a range of 332 mm) was applied at the center point community to mimic the dynamic conduct of NPTs.

5.2a Dynamic analysis result of Honey Comb structure

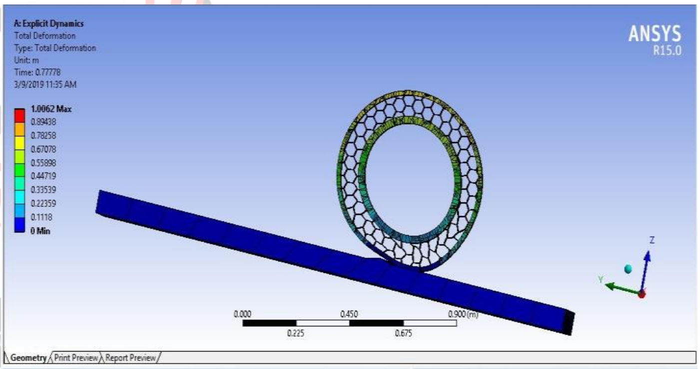


Figure24: Total deformation of honeycomb structure

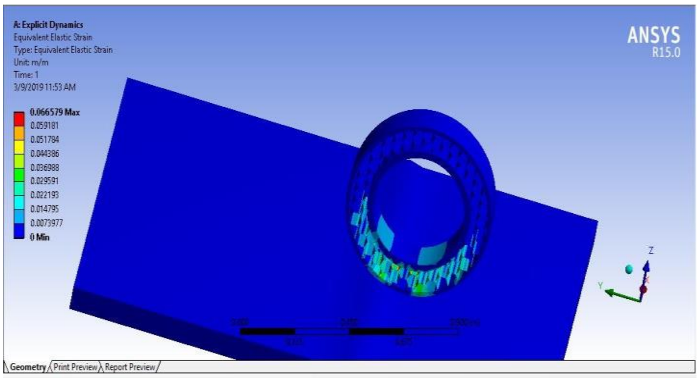


Figure 25Von-mises stress of Honeycomb spokes structure

 DOI : 10.35291/2454-9150.2020.0645

ISSN : 2454-9150 Vol-06, Issue-07, OCT 2020

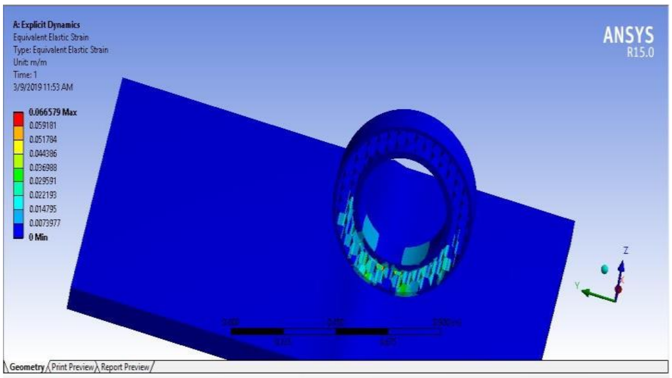


Figure 26 Equivalent strain of Honeycomb spokes structure

5.2b Dynamic analysis result of Spoke structure

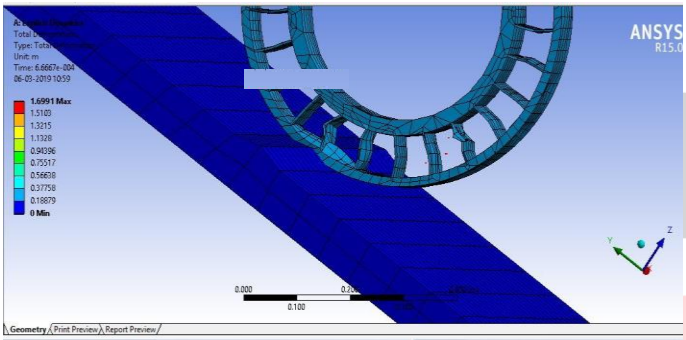


Figure27: Total deformation of plate spoke structure

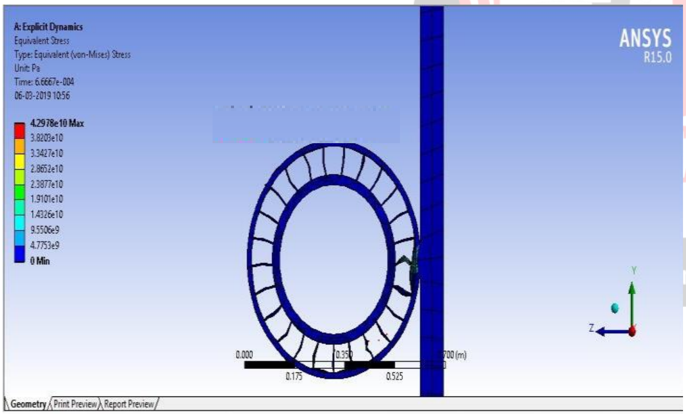


Figure28: Von-mises stress of plate spokes structure

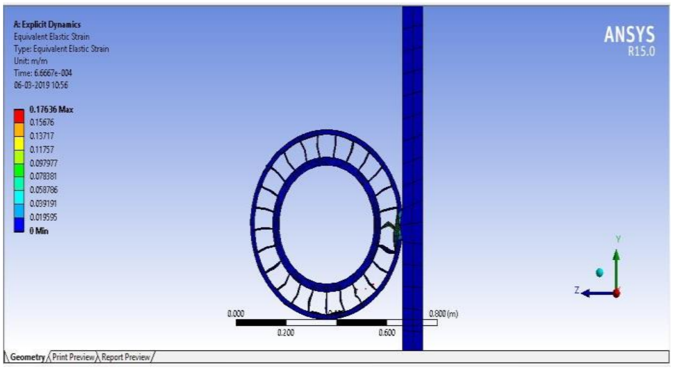


Figure29: Equivalent strain of plate spokes structure

5.2c Dynamic analysis result of Diamond structure

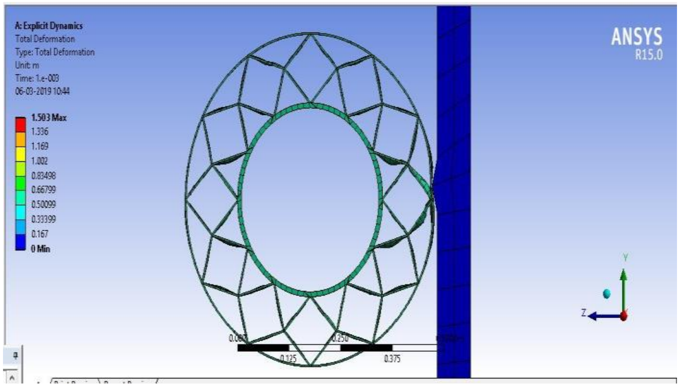


Figure 30 Total deformation of diamond structure

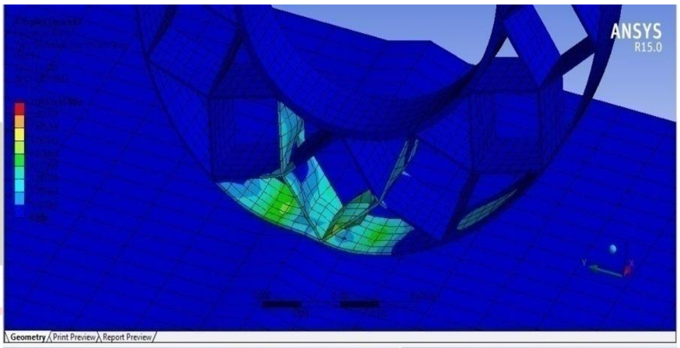


Figure31: Von-mises stress of diamond structure

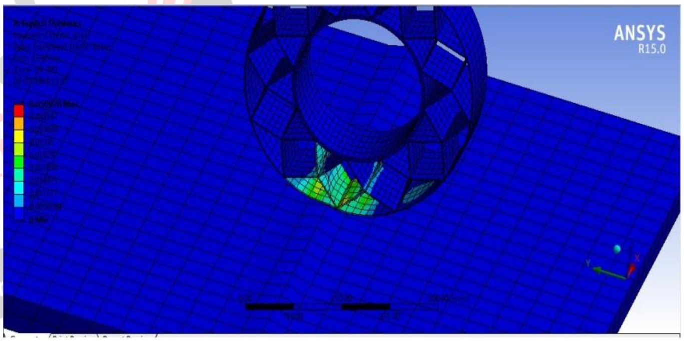


Figure 32 Equivalent strain of diamond structure

5.2d Dynamic analysis result of Triangle structure

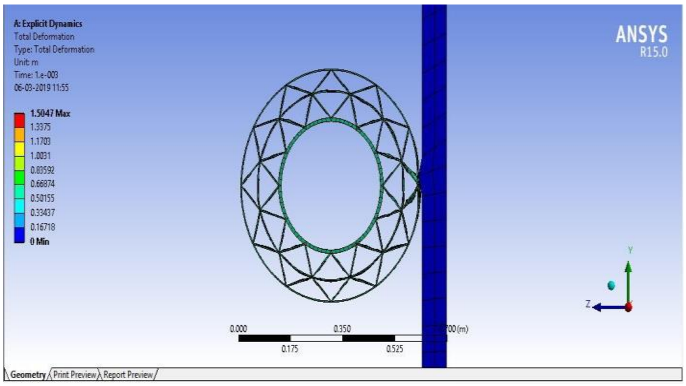


Figure33: Total deformation of Triangle structure

 DOI : 10.35291/2454-9150.2020.0645

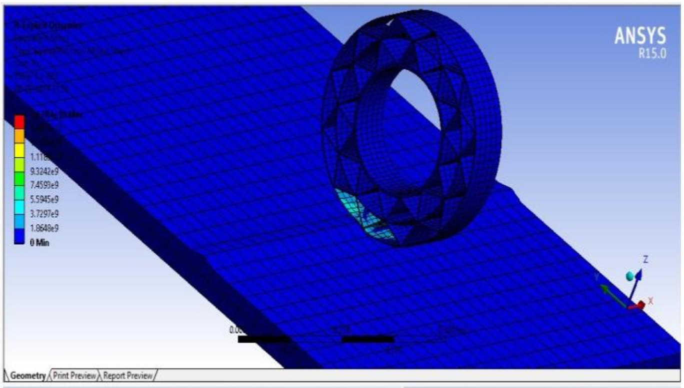


Figure34: Von-mises stress of Triangle structure

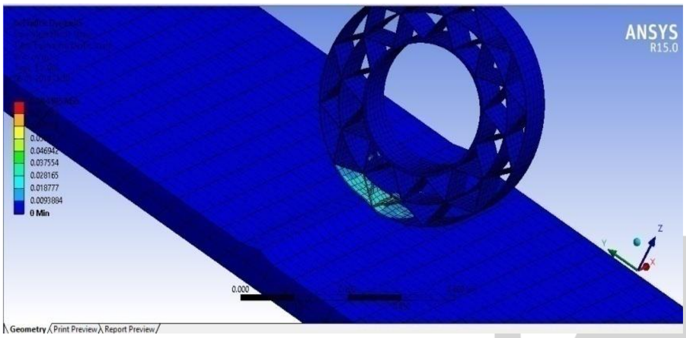


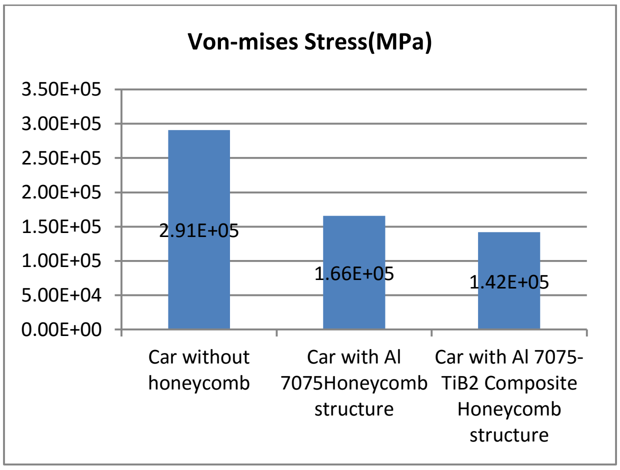
Figure35: Equivalent strain of Triangle structure

Case1

Dynamic Analysis

Von-Mises Stress:

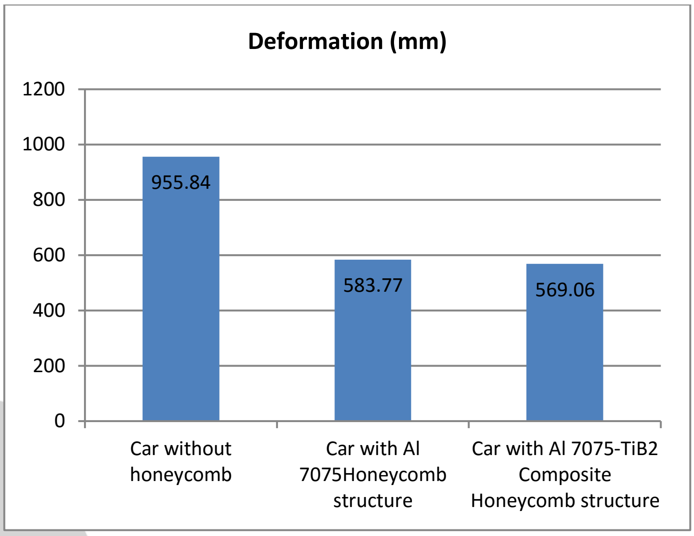
The variety of Total miss happenings among vehicle outline, outline with Al7075 honeycomb structure guard and edge with Al 7075-TiB2 honeycomb structure guard when they were affected to a fixed inflexible divider with 120km/hr. is delineated underneath. The padding property of honeycomb structure when it is affected prompts the low worries in outlines which have honeycomb structure guard than the ordinary casing without honeycomb structure.



Graph.1 Von-Mises Stress

Total Deformation Graph:

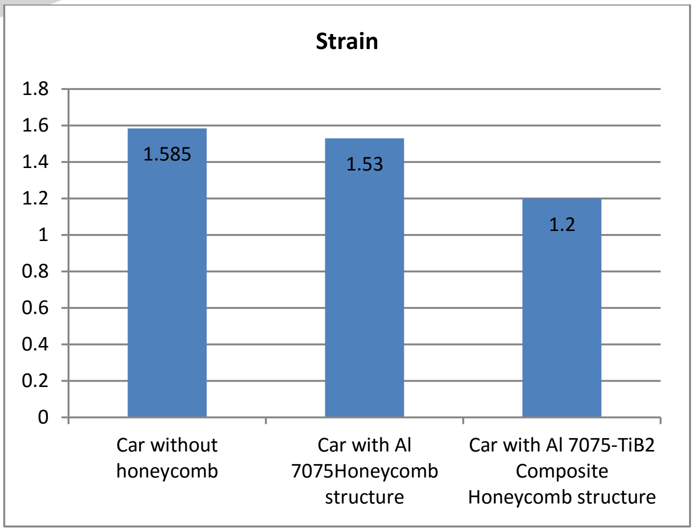
From the beneath graph it is plainly seen that the casings with honeycomb structure guard has less distortion than the ordinary casing without honeycomb structure guard. This is because of the shut cell structure of hexagon which assimilates the effect by padding impact.



Graph.2 Total Deformation

Strain Graph:

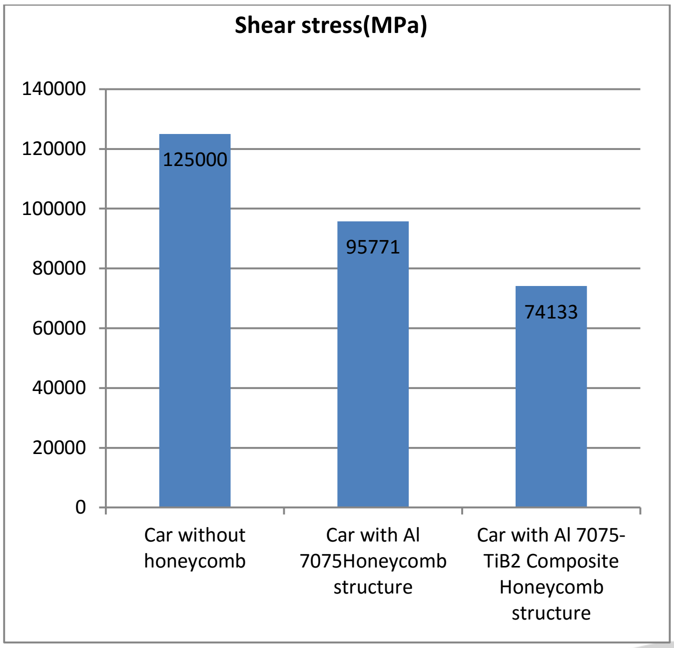
From the aftereffects of examination, it is discovered that the strain of casing which have honeycomb structure guard was less contrasted with ordinary Aluminum outline. The greatest strain was happened at honeycomb structure reason for its cell structure. Concerning the Aluminum outline with ordinary guard has bigger strains which lead to disappointment of the structure.



Graph .3 Strain Graph

 DOI : 10.35291/2454-9150.2020.0645

Shear Stress Graph:



Graph .4 Shear Stress

	Stress(Mpa)	Strain	Deformation(mm)	Shear Stress(Mpa)
Car without honeycomb	2.91 e 05	1.585	955.84	125000
Car with Al 7075Honeycomb structure	1.66 e 05	1.53	583.77	95771
Car with Al 7075-TiB2 Composite Honeycomb structure	1.42 e 05	1.20	569.06	74133

Table 1 Frame Structure Dynamic Results

STRUCTURE	STRESS (Mpa)	DEFORMATION (mm)	STRAIN
Honeycomb structure	9.51e09	1.0062	6.58e-03
Spokes structure	1.53e10	1.6991	4.38e-02
Diamond structure	1.02e10	1.503	7.42e-03
Triangular structure	1.67e10	1.5047	8.44e-03

Table:2 Dynamic results of tyres

VI. CONCLUSIONS

This Study was performed to decide the unwavering quality of honeycomb structure with reasonable material of vehicle body casing and guard when it was slammed. The Al 6061 edge with Spring Steel and Titanium Grade 3 honeycomb structure guards and the AL6061 outline without honeycomb structure guard were crash sway investigated at 120 km/hr speed of the vehicle.

Case1

The accompanying ends are drawn, in view of the outcomes got by investigation:

• The establishment of honeycomb structure to the vehicle outline shows better outcomes, reason for preferred effect ingestion over the typical edge without honeycomb structure.

• From Energy Summary Curve, the vehicle outline with Spring Steel honeycomb structure guard shows great energy retention than different edges yet it has higher pressure esteems when contrasted and Al 6061 edge with Titanium Grade 3 honeycomb structure guard.

• Based on Overall Explicit Dynamic Analysis, the examination of crashworthiness among Al 6061 vehicle outline, Al 6061 edge with Spring Steel honeycomb structure guard and Al 6061 casing with Titanium Grade 3 honeycomb structure guard shows Titanium Grade 3 honeycomb structure guard have great effect energy ingestion, less distortion and lesser anxieties prompted.

At last, it is reasoned that Al 6061 vehicle outline with Titanium Grade 3 honeycomb structure guard is suggested from this examination.

Case2

1.From the plan investigation, it was inferred that the Honeycomb spokes tire structure was discovered to be strong, and furthermore bears more burden relative to different structures.

2.Here honeycomb spokes configuration comprises low pressure esteems, strains and misshappenings than different plans in light of the fact that the honeycomb structure offers more space for a similar material and shut cell structural(hexagonal) which can continue more noteworthy measure of power in this way showing more compressive and shear quality.

3.Honeycomb spokes structure shows lower limited anxieties and distortion esteems which is useful for a weariness safe talked plan and along these lines the proposed work can tolerate a more prominent sum power and simultaneously shows a relatively little all out disfigurement.

4.The NPT dependent on hexagonal honeycomb spokes can be utilized to supplant an ordinary pneumatic tire since they give uniform footing and wear as that of regular tire and furthermore it offers great quality, exhaustion life (perseverance limit), dependability and lessens the general weight and cost than the customary pneumatic tyre.

Finally we concluded that the Honeycomb structure is applicable for different automobile applications

REFERENCES

[1]. Yuxuan Li, Zhongqin, Lin, Aiqin Jiang, Guanlong Chen (2003): Use of high strengthsteel sheet for lightweight

 DOI : 10.35291/2454-9150.2020.0645

and crashworthy vehicle body< Materials and Design>24, 177-182.

[2]. Chenga Z.Q, Thackera J.G, Pilkeya W.D, Hollowellb W.T, Reagana S.W, Sievekaa E.M (2001): Experiences in figuring out of a limited component car accident Model< Finite Elements in Analysis and Design> 37, 843–860.

[3]. J.G. Thacker, S.W. Reagan, J.A. Pellettiere, et.al, "Encounters during advancement of a powerful accident reaction vehicle model", Journal of Finite Element Analysis and Design 30 (1998) 279-295.

[4]. Z.Q. Chenga, J.G. Thackera, W.D. Pilkeya, W.T. Hollowellb, et.al, "Encounters in reverseengineering of a limited component car accident model", Journal of Finite Elements in Analysis and Design 37 (2001) 843–860.

[5]. Abdullatif K. Zaouk , Nabih E. Bedewi, Cing-Dao Kan, et.al, "Approval of a non-straight limited component vehicle model utilizing numerous effect information", The George Washington University FHWA/NHTSA National Crash Analysis Center.

[6]. T. Belytschko, W.K. Liu and B. Moran, Nonlinear Finite Elements for Continua and Structures, first ed. U.S.: Wiley, New York, 2001.

[7]. Lin C. S., Chou K. D. what's more, Yu C. C., Numerical reenactment of vehicle crashes, Appl. Mech. Tangle. 590, 135 (2014).

[8]. Kankariya N. what's more, Sayyad F. B., Numerical reenactment of guard sway examination and to improve plan for crash value, Int. J. Engrg. Sci. 4(5), 58 (2015).

[9]. Sun T., Liu T., Shen I F. furthermore, Ma Y. S., Numerical recreation of vehicle rash examination dependent on appropriated computational climate, Conference Proceeding, fifth Int. Meeting on Algorithms and Architectures for Parallel Processing, Pp 334-337, (2002).

[10]. Charles M. Rancher, Elisa R. Bolder and Eric L. Mitter, Two vehicle side effect crashes: The relationship of vehicle and crash attributes to injury seriousness, An and d. Butt-centric. andPrev, Vol. 29, No. 3, pp. 399-406, 1997

 DOI : 10.35291/2454-9150.2020.0645