International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com

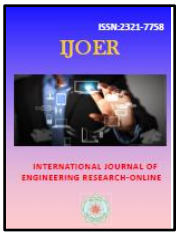
Vol.6., Issue.4, 2018
July-Aug.

RESEARCH ARTICLE

ISSN: 2321-7758

CRASH ANALYSIS ON FASCIA USING LS-DYNA

G.HARSHIYA BEGUM[1], A.V.HARIBABU[2]
[1,2]Mechanical Engineering, SVR Engineering College,
Nandayal, Andhra Pradesh



ABSTRACT

Car guard shaft get together assumes vital part in engrossing effect vitality and shields travellers from front and back crashes. A crash-test is a type of dangerous testing for the most part performed keeping in mind the end goal to guarantee safe outline measures in crashworthiness and crash similarity for cars or related segments.

The re-enactments of vehicle crashes by utilizing PC programming's has turned into a crucial apparatus for shortening car advancement time and bringing down expenses. This undertaking provides details regarding the reproduced crash trial of auto frontal sash. The model utilized here was that of a Toyota Camry 2012 travellers auto. The auto belt is planned with thickness of 2.15 mm.

The composed auto belt was fit in HYPERMESH-12 with blended components of size 4 mm for showing signs of improvement exactness and mimicked in LS-DYNA. The outcomes are deciphered by utilizing LS-PREPOST to investigate the vitality retention attributes amid crash for various materials at a speed of 30mm/ms which is around 108 km/hr for the length of 15 ms.

The undertaking is completed for three cases and they are diverse material models, steady speed for specific chose material model and utilizing same thickness for specific material model. With the assistance of LS-DYNA codes nonlinear powerful contact investigation by utilizing diverse materials should be possible adequately and precisely. The outcomes are discovered that steel material assimilates greatest inner vitality of 88.25% took after by aluminum and plastic materials with 82.28 and 72.23% individually.

This is on the grounds that steel has high Youthful's Modulus when contrasted with aluminum and plastic material and furthermore affect compel conveyance is uniform in steel material.

Introduction

Auto crashes are going on consistently. Most drivers are persuaded that they can stay away from such troublesome circumstances. By the by, we should consider the measurements ten thousand dead and several thousands to million injured every year [Hosseinzadeh et al. (2005)]. These numbers require the need to enhance the security of vehicles amid mischance. An auto guard is a front piece of the auto that covers the auto's undercarriage.

At the point when the guard is affected by a firm protest, such kind may occur in a stopping mishap or in the authoritative low speed affect pendulum test, at that point the guard belt alone may not be there to withstand the effect without considering the powers following up on it. Along

these lines, there were four principle key parameters being considered amid the test.

There are a few factors that an architect must consider while choosing a guard framework. The most critical factor is the capacity of the guard framework to retain enough vitality to meet the OEMs interior guard standard. Weight, manufacturability and cost are additionally imperative factors that specialists consider amid the plan stage. The formability of materials is essential for high-clear guard frameworks. Another factor considered is recyclability of materials, which is an unmistakable favorable position for steel. As appeared in Figure 1.1, there are five guard frameworks in like manner utilize today: Car guard framework assumes a vital part in retaining sway vitality as well as in a styling stance. A lot of consideration with in the car business has been engaged upon light weight and adequate wellbeing lately. Consequently, the guard framework outfitted with thermoplastic and vitality retaining component is another world pattern in the market. The real point for the outline of guard framework is abridged as a level of retention of effect vitality in a constrained freedom between back face of guard and body parts of the vehicle. While exploratory test is fairly exorbitant and tedious, limited component examination causes architects to contemplate outline idea at an early plan arrange when models are not accessible.

A. Metal face bar
B. Plastic sash and fortifying pillar
C. Plastic sash, fortifying pillar and mechanical vitality safeguards
D. Plastic sash, fortifying pillar and froth or honeycomb vitality safeguard
E. Plastic sash, fortifying pillar, froth, and mechanical vitality safeguards.

Fig.1. Euro-NCAP Frontal Impact Test setup.

Problem Statement-Need for Simulation

For straightforward geometries, for example, just upheld shafts or cantilever bars it is anything but difficult to envision purpose of most extreme pressure and dislodging. Be that as it may, all things considered, for parts or gatherings with complex geometrical shapes, made of various materials with numerous discontinuities subjected to adaptable limitation, complex stacking fluctuating with deference time and purpose of utilization, additionally confounded by remaining burdens and joints like spot and curve welds and so on., it is difficult to anticipate disappointment area. Envision somebody shoes you a convoluted motor square except if and until the point that you have long periods of involvement in the comparable field. Be that as it may, with apparatuses like computer aided design and CAE, if displayed in proper form, one can without much of a stretch get pressure shape plots plainly showing areas of high pressure or relocation.

Literature Review

Hosseinzadeh et al. (2005)[1] in their paper says that guard pillars are one of the principle structures of traveler autos that shield them from front and back crashes. In their paper, a business front guard shaft made of Glass Tangle Thermoplastic (GMT) is examined and described by affect displaying utilizing LS-DYNA ANSYS 5.7 as indicated by the E.C.E. Joined Countries Assertion, Uniform Arrangements concerning the Endorsement of Vehicles with respect to their Front and Back Defensive Gadgets (Guards, and so on.), E.C.E., 1994].

Evans and Morgan (1999)[2] have examined that as vehicle producers keep on becoming more forceful with the styling of new vehicles, guard framework advancements will be required to discover new arrangements that fit into the diminished bundle spaces while proceeding to meet the vehicle execution and cost necessities. It was proposed to present new and inventive Extended Polypropylene (EPP) froth advances and strategies.

Bautista et al. (2009) [3] considered the distinctive effect gauges and for the particular material they enhanced the state of guard bar by playing out the product reproduction. They likewise

examined the impact of metallic vitality safeguard in guard framework. Most extreme pressure and distortion were utilized as plan criteria. They have agreed numerous global guidelines for guard pillar plan.

Marzban0rad et al. (2009) [4] examined the most essential parameters including material, thickness, shape and effect condition are considered for plan and examination of a car front guard shaft to enhance the crashworthiness configuration in low-speed affect. The reenactment of unique guard under condition affect is as per the low-speed standard of automotives expressed in E.C.E. Joined Nations Agreement Regulationno.42, 1994.

Blocks Physical crash-tests are valuable as they are better prepared to give more handy data to cruiser crashes. Of course, the two key damages of physical cruiser crash-testing consolidate the inconvenience of reproducibility of tests and furthermore their by and large extreme and dreary nature. An elective methodology, PC helped diversion of crash-testing, makes it possible to coordinate endless at a by and large insignificant exertion, repeatability and their capacity to distinguish the remarkable parts of wounds and damage components in crash-test circumstances, they are constrained in different ways, including the way that the improvement required in these models avoids an exhaustive investigation of the intricacy of the circumstance. Part testing or sub-framework testing gives yet another option or supplementary way to deal with physical crash-testing or potentially crash reenactment.

There have been a few distinct methodologies taken by analysts in the past for the motivations behind physical crash-testing. Varieties between tests incorporate the effect speed, affect point, regardless of whether the effect happens with the rider still on the cruiser or with the rider having effectively isolated from the bike, and provided that this is true, with the rider head or feet first. The genuine crash arrangement received will rely upon whether to explore regular crash-test situations and additionally most noticeably bad/outrageous case situations.

METHODOLOGY

Crash reenactment is non direct express in nature. As it were, it is time subordinate. The misshapenness can be figured at any moment of time. The accompanying well ordered technique is to be taken after to achieve crash examination with better outcomes. Research Methodology:

A. *Applying of Boundary conditions:* On the off chance that the FE examination is being done for all intents and purposes approve any test done at lab, at that point it is a decent practice to visit the testing office and step through essential estimations on exam apparatuses and stacking gadgets. These estimations will help apply burdens and limit conditions in Fe demonstrate doing likewise route as the part or test example is subjected to at the season of testing. For instance, estimations of stacking gadget would help putting in the heaps on specific hubs or components. Additionally, the installations measurements would direct imperatives areas (hubs) and its degrees of opportunity.

B. *Assign Matrial Proprties:* Material non-linearity is characterized in the FE display by means of this vital advance. The reaction of the structure relies upon the properties provided to the FE demonstrate. The product manual ought to be alluded to comprehend the information configuration of the material information card, as various codes may have diverse organization. On the off chance that the product expects the genuine pressure strain information then the test pressure strain ought to be changed over into genuine information before nourishing them to the FE display.

C. *Assign Material Properties:*Material non-linearity is characterized in the FE display by means of this vital advance. The reaction of the structure relies upon the properties provided to the FE demonstrate. The product manual ought to be alluded to comprehend the information configuration of the material information card, as various codes may have diverse organization. On the off chance that the product expects the genuine pressure strain information then the test pressure strain ought to be changed over into genuine information before nourishing them

to the FE display. Adequate pressure strain information point ought to be incorporated to catch the non-linearity of the material.

D. *Control Parameters:* The fundamental controlling parameters for the examination are introductory addition, least and most extreme augmentation, greatest number of cycles, the interim at which comes about document are to be yield and joining criteria for emphases (adequate leftover load).

E. *Run the Analysis:* The FE model is now ready to be run. The analysis run command may have options to specify solver version, memory size, and number of CPU's to better control execution.

F. *Interpret the results:*It is highly recommended that the analysis results should be carefully reviewed and checked for accuracy before making any conclusion based on simulation. There are many ways the FEA results can be checked. Some of them are

Observe for unexpected movements in the animation

Compare the reaction forces against applied forces.

Check if the stress and strains are as per material properties supplied to the FE model.

Check interacting surfaces in the contact set for any malfunction.

Make quick hand calculations by simplifying the problem and compare it to with FEA results.

G. *Hyper Mesh:* Hyper Mesh is product of design and development of Altair Engineering. It is a software which is based on CAE models as these CAD models were imported through this software and further the Meshing process occurs. The meshing of a model plays a very important role in analysis of an object. Through this analysis various amount of forces, stresses and displacement can be calculated. As there are numerous of software which provides quite appreciable analysis of these objects. But the basic purpose to choose this software for analyzing is that it gives quite understandable results as well as it is famous for crash analysis. In today's world crash analysis is now getting very much importance for safety and security of the passengers as well as for the vehicles.

H. *LS DYNA:* LS-DYNA is a highly advanced general purpose nonlinear finite element program that is capable of simulating complex real world problems. The distributed and shared memory solver provides very short turnaround times on desktop computers and clusters operated using Linux, Windows, and UNIX. With LS-DYNA, Livermore Software Technology Corporation (LSTC) aims to provide methods to seamlessly solve problems requiring

LS-DYNA is a universally useful limited component code for dissecting the huge misshapening static and dynamic reaction of structures including structures coupled to liquids.

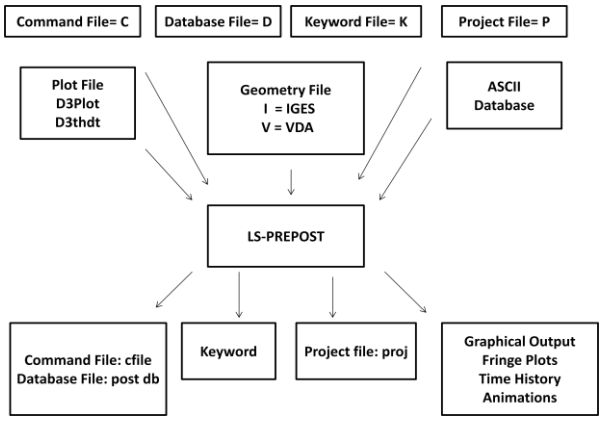


Fig.2. Final Organization in Ls-Prepost.

I. *MESH QUALITY:* Component quality is a subject frequently discussed and never completely comprehended. The purpose behind this is perplexing yet is identified with the way that quality is relative and the arrangement, by definition, is surmised. In the plan of limited components a neighbourhood parametric arrange framework is expected for every component write and how well the physical organize frameworks, both component and worldwide, coordinate the parametric manages component quality. Underneath you see a few designs speaking to component quality and you should endeavour to tail them, be that as it may, there will be a state of decreasing return on the off chance that you make a decent attempt to get each component inside the acknowledgment criteria.

International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com
Vol.6., Issue.4, 2018
July-Aug.

Skew

Skew for quadrilateral component = 900 short the base point between the two lines joining the inverse mid-sides of the component (α). Skew for triangular component = 900 short the base edge between the lines from every hub to the restricting mid-side and between the two contiguous mid-sides at every hub of the component as appeared in the Figure 3.

Perfect esteem = 0 (Acceptable < 450)

Fig.3. Skew in Mesh quality.

Jacobian

In simple terms, the Jacobian is a scale factor arising because of the transformation of the coordinate system. Elements are transformed from the global coordinates to local coordinates (defined at the centroid of every element), for faster analysis times.

Ideal value = 1.0 (Acceptable >0.6)

Distortion

Distortion is defined as - | Jacobian | * $Area_{LCS}$ / $Area_{GCS}$

Ideal value = 1.0 (Acceptable > 0.6)

LCS – Local Coordinate system, GCS – Global Coordinate system

Stretch

For quadrilateral elements stretch = L_{min}* √ 2 / d_{max}

Stretch for triangular element = R * √ 12 / L_{max}

Ideal value: 1.0 (Acceptable > 0.2). It is shown in the Figure 4.

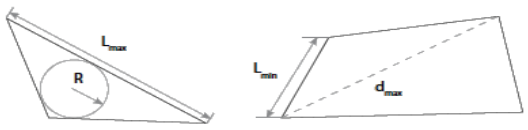


Fig.4. Stretch in Mesh quality.

Control Cards

The known favorable position with understood reproductions is that the arrangement is unequivocally steady permitting bigger estimations of time step. In understood static recreations (IMASS=0 in *CONTROL_IMPLICIT_DYNAMICS), the reenactment time has no genuine noteworthiness yet is somewhat a sign of the connected load greatness. For instance on the off chance that we have a reenactment where a heap is connected directly with the end goal that it achieves 100% of its extent at the end time of 100seconds and the present recreation time is 20seconds utilizing a subjective time advance of 1second, at that point we can decipher that our heap (accepting straight scale) is 20% of its most extreme load. On account of understood powerful recreations (IMASS=1) time takes genuine significance and not at all like unequivocal arrangement, the time step is unequivocally steady and along these lines enables us to pick an expansive time step.

Naturally, LS-DYNA utilizes a steady understood time step, indicated utilizing DT0 in *CONTROL_IMPLICIT_GENERAL, for the whole span of the reproduction time. The size of DT0 is normally pick as a small amount of the aggregate reenactment time and is altogether subject to the nonlinearity of the issue. Utilizing a consistent time step is exceptionally traditionalist in nature since regardless of the quantity of emphasess each time step was required to focalize, the time step is unaltered and this may bring about vast number of costly cycles. For an issue whose non-linearity is obscure, this is really not a terrible thing since littler time steps posture lesser nonlinearity issues and might be simpler to focalize. Notwithstanding, once the client gets comfortable with an issue, cautious use of programmed understood time step control in LS-DYNA is a decent other option to diminish the quantity of cycles in this way lessening the reenactment time.

The reason for the control cards is,

1. Activate arrangement choices; understood arrangement, versatile re coinciding, mass scaling
2. Change default esteems on choices and parameters
3. Ordering amongst them and position are self-assertive Good practice is to put them first in your info record
4. Do not utilize all the more then one control card of each sort

5. All control cards are discretionary aside from *CONTROL_TERMINATION. Continuously consider the accompanying control cards since they can unequivocally influence your outcomes or yield

i. *CONTROL_ACCURACY
ii. *CONTROL_CONTACT
iii. *CONTROL_ENERGY
iv. *CONTROL_HOURGLASS
v. *CONTROL_SHELL
vi. *CONTROL_SOLID
vii. *CONTROL_TERMINATION
viii. *CONTROL_TIMESTEP

TIME STEP

Automatic time step control is activated using *CONTROL_IMPLICIT_AUTO by setting AUTO = 1 the time step and the logic is purely based on the number of iterations that was taken at the current time step. If the number of iterations to converge at the current time step is greater than ITEOPT, LS-DYNA then reduces the current time step (using a built in scale-factor) in an attempt to reduce the non-linearity of the problem. However, if the number of iterations at the current time step is less than ITEOPT, LS-DYNA then increases the current time step (using a built-in scale-factor) assuming the problem is getting in easier to solve. To allow some tolerance to the value of ITEOPT, the parameter ITEWIN is a very useful feature which prevents LS-DYNA to hastily auto-adjust the time step. When ITEWIN is defined (default is 15) and the number of iterations at the current time step falls in the rage of ITEOPT +/- ITEWIN, then LS-DYNA bypasses the auto-adjust of the time step.

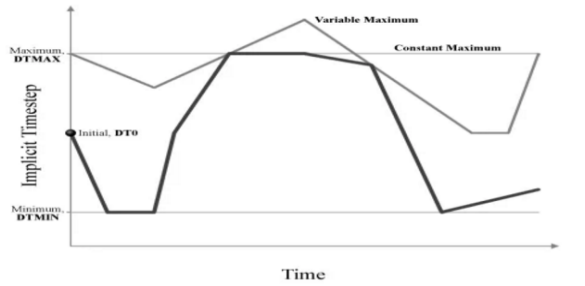


Fig.5. Time step.

OUTPUT FILES

The yield records are utilized to create the outcomes. The accompanying are the yield records found in Ls-Dyna to produce yield.

1. D3PLOT (database for finish yield states)
2. D3DUMP (finish database for restart)
3. RUNRSF (running restart document, overwritten)
4. INTFOR (database for yield of contact interface information)
5. XTFILE (additional time history information)
6. D3EIGV (modular information from Eigen esteem examination)
7. D3CRCK (break information from Winfrith solid model)

Simulation steps

1) *Applying of Boundary conditions:* The Toyota Camry 2012 model auto sash is planned by utilizing Auto CAD programming according to the measurements. The openings are joined in outlining the belt to withstand the drag powers when the vehicle is in movement. The accompanying figure demonstrates the CAD model of sash as appeared in Figure

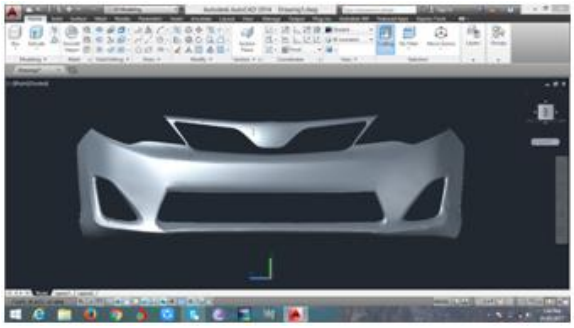


Fig.6. Front view of signed in Fascia AutoCAD

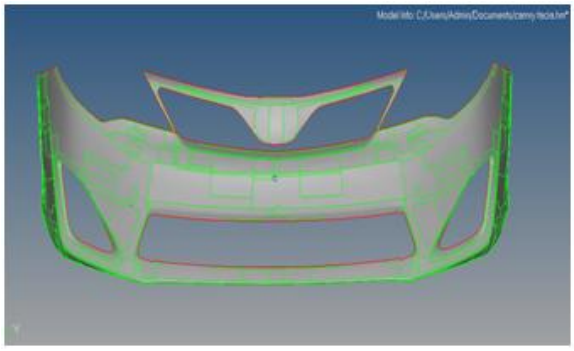


Fig.7. Design model of Toyota Camry Fascia

International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com
Vol.6., Issue.4, 2018
July-Aug.

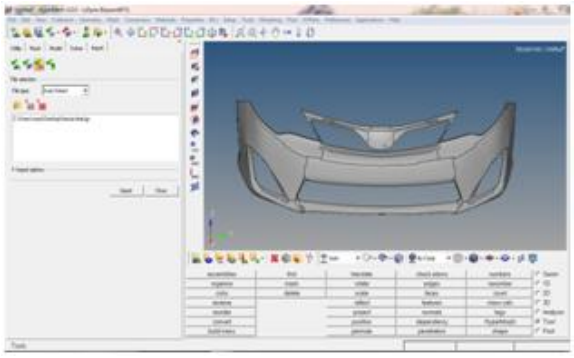


Fig.8. Toyota Camry Fascia imported in to hyper mesh

Fundamental topic of FEA is to make counts at just predetermined number of focuses and afterward introduce the outcomes for whole domain(Surface or volume). Any consistent protest has unending degrees of opportunity and its fair impractical to take care of the issue in this configuration. Limited Element Method lessens degrees of opportunity from unbounded to limited with the assistance of discretization i.e. fitting (hubs and components).

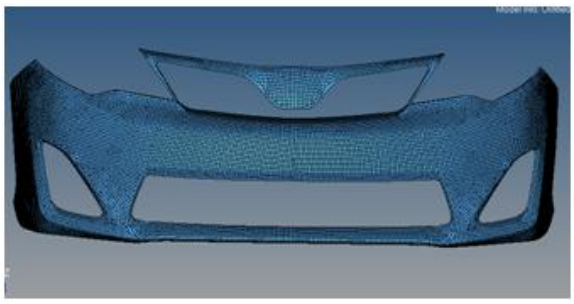


Fig.9. Toyota Camry Fascia method *in hyper mesh.*

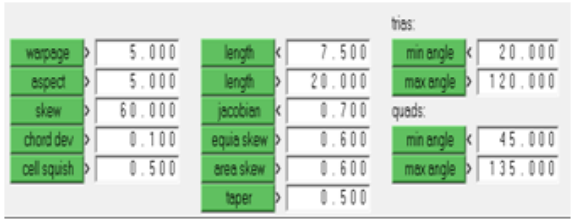


Fig.10. Table shown in hyper mesh.

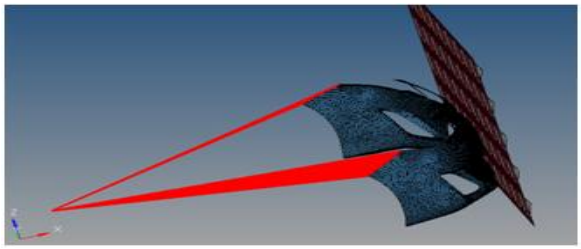


Fig.11. Before contact is applied between Fascia and Rigid wall.

Fig.12. After contact is applied between Fascia and Rigid wall.

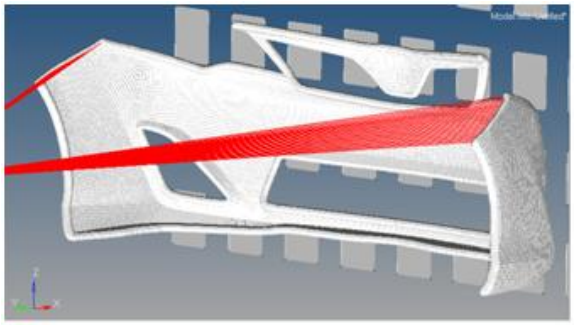


Fig.13. Node set for assigning velocity.

RESULT & DISCUSSIONS

The Toyota Camry display 2012 is considered for examining the vitality assimilation attributes. Three unique materials, for example, Steel, Aluminum and Plastic are considered. A speed of 30 mm/ms i.e. 108 km/hr is alloted and a run time of 15 ms is given and the outcomes are deciphered as takes after.

1) Energy Balance Curves: According to Law of Conservation of vitality, Energy can nor be made nor be obliterated, yet it can be changed over from one type of vitality to other frame. Applying a similar guideline to crash investigation, the measure of dynamic vitality lost amid affect must be changed over to different types of vitality, for example, inward vitality, sliding vitality and hour glass vitality. It is additionally noticed that, there might be unimportant mistakes in ascertaining vitality proportion since every one of the procedures in this universe are irreversible and a few misfortunes are constantly included which goes amiss vitality proportion somewhat from one.

From the Fig. 4.1 plainly the retention of Internal Energy (IE), Sliding Energy (SE) and Hour glass Energy (HE) for steel is 88.25, 7.05, 4.55% separately. The summation of the considerable number of energies prompts 99.85% which

demonstrates the vitality proportion is around one with a mistake of 0.15%. At 0 ms, the level of interior vitality. It demonstrate that the motor vitality lost amid affect is showed up as IE, SE and HE.

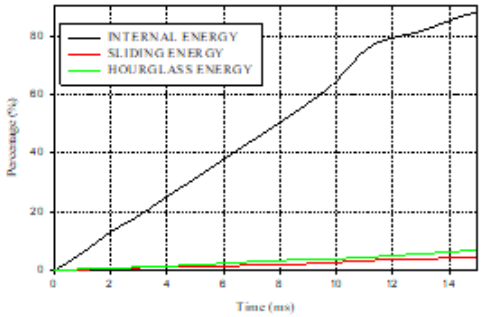


Fig.13. Energy balance curve for steel material

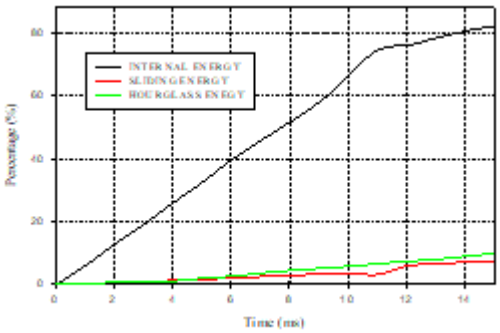


Fig.14. Energy balance curve for Aluminium material

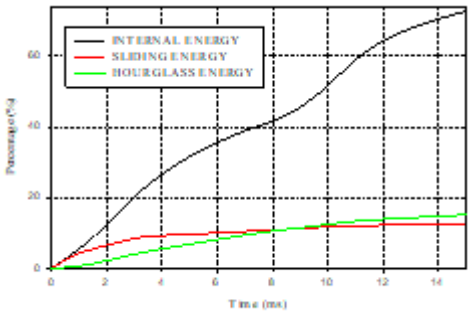


Fig.15. Energy balance curve for Plastic material

Variation of Kinetic Energy

Kinetic Energy regard to Time, plainly dynamic vitality lost amid affect by steel, aluminum and plastic is 22430, 7920 and 2240 J separately. Regarding rates, the active vitality lost from the aggregate vitality for steel, aluminum and plastic is 3.04, 1.09 and 0.31% individually. It is noticed that, the underlying dynamic vitality for these materials is distinctive because of various masses. The motor vitality for steel falls radically around 3.04% from the aggregate vitality in light of the fact that the effect drive following up on the belt made of steel is consistently disseminated over the surface with the end goal that it retains extensive measure of vitality [Pecht (2005)].

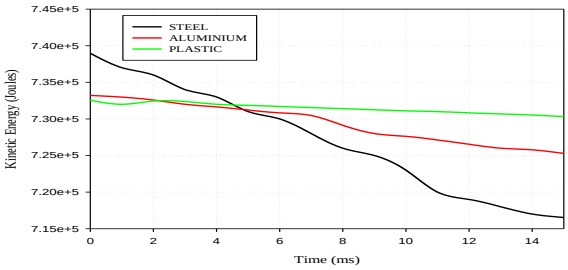


Fig.16. Kinetic Energy with respect to Time

Variation of Internal Energy

Internal Energy with respect to Time, it is clear that, the percentage of internal energy absorbed by steel, aluminium and plastic is 88.25, 82.25 and 72.74% respectively. It is because steel is much stiffer than aluminium and plastic. Also, the young's modulus value of steel is higher than aluminium and plastic which enables it to absorb more energy [David (2013)]. It means for the same strain value the stresses induced in steel are much higher than aluminium and plastic indicating steel has more energy absorption capacity comparatively.

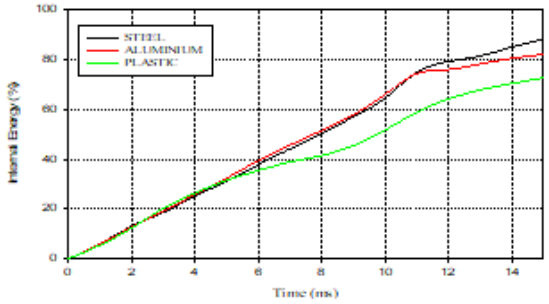


Fig.17. Internal Energy with respect to Time

H. Variation of Hour Glass Energy: Hourglass Energy as for Time, obviously hourglass vitality esteems for steel, aluminum and plastic is 7.05, 9.88 and 15.08% separately. Hourglass vitality is additionally called Zero Energy Mode which is only misshapening of components without earlier vitality ingestion. Thinking about the above qualities, plastic has higher incentive than steel and aluminum [Chandan (2013)]. It implies the components in plastic twists more without engrossing vitality. That is the reason, the plastic distorts increasingly and

ingests less vitality when contrasted with steel and aluminum.

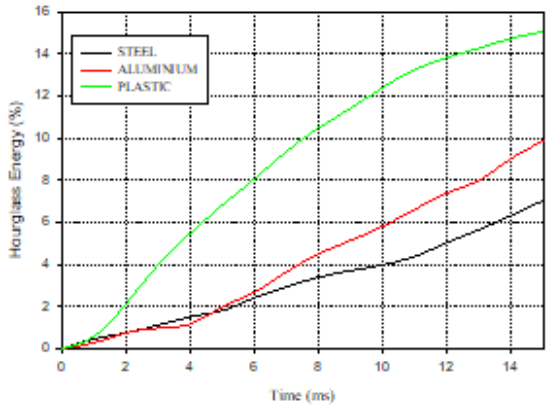


Fig.18. Hourglass Energy with respect to Time

CONCLUSIONS

Auto belt is the as a matter of first importance part that gets harmed and assimilates vitality amid a crash. In the event that sash is made of appropriate materials, at that point it retains significant piece of vitality amid crash and ensures the inhabitants. In our work, Steel, Aluminum and Plastic utilized as materials for sash and crash recreation is completed at 30 mm/ms i.e. 108 km/hr for 15 ms. From the outcomes, the accompanying conclusions can be drawn.

1. Among the three materials, steel material assimilates greatest interior vitality of 88.25% took after by aluminium and plastic materials with 82.28 and 72.73% separately. This is on account of, steel material has high Young's Modulus when contrasted with Aluminum and plastic material and furthermore affect compel circulation is uniform in steel material.
2. The change of sliding vitality from the accessible active vitality is more in plastic material took after by aluminium and steel materials. It demonstrates the shakiness of plastic on account of most reduced youthful's modulus.
3. The transformation of hourglass vitality from the accessible dynamic vitality is more in plastic material took after by aluminum and steel materials. This is on the grounds that components in plastic material disfigures more without engrossing vitality because of less component solidness when contrasted with aluminum and steel materials.
4. The lessening in motor vitality amid affect is more in steel material with 3% took after by aluminum and plastic materials with 1 and 0.3% individually.

References

1. Hosseinzadeh R. M., M. Shokrieh and L. B. Lessard (2005) Parametric study of automotive composite bumper beams subjected to low-velocity impacts, Journal of Composite Struct, 68, 419 - 427.
2. Suddin M, A. Din, M. F Abdullah and S. A Shamsudin (2007) Conceptual design of automotive bumper beam, Proceedings of the Conference on design, simulation, product development and optimization, Penang, Malaysia, 10-11.
3. Nitesh Joshi, RupeshTiwari and G. V. R. SeshagiriRao (2016) Design and analysis of Front Bumper for Light Passenger Vehicles, International Journal for Rapid Research in Engineering Technology & Applied Science, 2(4), 452-459.
4. TejasagarAmbati, K. V. N. S. Srikanth and P. Veeraraju (2012) Simulation of Vehicular Frontal Crash-Test, International Journal for Innovative Research in Science & Technology, 2(1), 251-257.
5. Chandan D., P. Anand Joshi and A. Sainath (2013) Crash test for 40% offset frontal bumper car analysis using CAE,Journal of Engineering Research and Studies, 4(4), 21-23.
6. Toccalino E. (2003) Passenger vehicle safety rating (EURO, US-NCAP AND IIHS): Performance overview and energy management solutions. SAE Technical Paper 2003-01-0230,.doi: 10.4271/2003-01-0230
7. Snider H. P. (1964) Vehicle instrumentation for crash testing. Industrial Electronics and Control Instrumentation, IEEE Transactions on, IECI-11(1):44
8. Karim Nice and G.W. Miyasaki (1987) Automobile Crash Test Facility and Preliminary Analysis of Low Speed Crush Characteristics. Thesis: M. A. Sc. University of British Columbia,
9. Robert (2004) Crash analysis: an investigation of current speed estimation techniques. Master's thesis, Dublin Institute of Technology, Ireland.