DESIGN AND CRASH ANALYSIS OF SCOOTER FRONT GUARD

[1*]R.Balamurugan, [2]S.Mohamed Abdul Sukkoor, [3]S.Madhankumar, [4]A.Tamilselvan

[1]Assistant Professor, [2]PG Scholar, [3]Assistant Professor, [4]Assistant professor
[1]Automobile Engineering, [2]Engineering Design, [3]Mechotronics Engineering, [4]Automobile Engineering
[1]Bannariamman Institute of Technology, Erode, India.[2]Government College of Technology, Coimbatore, India.[3]Sri Krishna College of Engineering and Technology, Coimbatore, India.

***Abstract**:* **Bike accidents are happening every day. Most drivers were convinced that they can avoid such troublesome situations. The development of Automobile Technology, more and more lightweight materials are applied to automobile body for the purpose of light weighting and environment protection. This research work describes the Design and crash Analysis of Scooter Front safety Guard. The front guard is a protection device in front of the Scooter bike. This project was designed a safety guard S- Shaped longitudinal member. These S- shaped longitudinal members are good crash behavior and energy absorption characteristics compared existing guard. This Project model built using the Creo 2.0 Software and while the simulation of crash done in Numerical study carried by simulation via the Explicit Dynamics in ANSYS 16.0. To determine the impact energy absorbing member and also investigate to determine the stiffness on the crash behavior.**

Keywords: Crashworthiness, Front Guard, Frontal crash, Safety.

I. INTRODUCTION

However the statistics show that ten thousand dead and hundreds of thousands to million wounded each year. Hence, improvement in the safety of automobiles is prerequisite to decrease the numbers of accidents. Automotive safety guard system is one of the key systems in scooter bike. The scooter safety guard is a structural component of an automotive vehicle which contributes to vehicle crashworthiness or occupant protection during front or rear collisions. Crashworthiness requirement of the front guard is to absorb the impact energy, but at the same time, it should be stiff enough to sustain the impact load without any failure from the mountings. The excessive displacement is not intended since it can damage the rider's knee and tibia after the impact. Hence, optimum design of front safety guard shall be made to meet the impact and strength requirement. When it is installed in a structure to be protected from shock, but its volume may be. Front guard beams are usually made of steel, aluminum, or composite materials also the backbone of the energy absorbing systems located at the front of the scooter bike. Safety guard which looks like a connecting between a front of the part, This member for the purpose of damping the shock loading during a low speed collision between the motor vehicle and an obstacle. Crashworthiness requirement of the front scooter guard is to absorb the impact energy, but at the same time, it should be stiff enough to sustain the impact load without any failure from the mountings. The excessive displacement is not intended since it can damage the rider's knee and tibia after the impact. Hence, optimum design of front guard shall be made to meet the impact and strength requirement. These paper FEM techniques used to demonstrate the design of scooter front guard for considering strength and impact load.

1.1 CRASH REPORT

Occupants of motor vehicles are injured or killed in different types of crash events such as the front side, rear side, rollovers, and others. With each type of crashes there are different crash severities, causes, and risk of injuries to the occupant for a given type of vehicle. The most severe accident situations are frontal impact crashes. After frontal impact crashes, the second most serve type of automobile impacts in the united states are side impact which results in series head and pelvic injuries of the occupant. Over the years, researchers have carried out a wide range of studies and analysis on front impact crashes. They have largely been successful in reducing the injuries parameters sustained by the vehicle occupant shows vehicle crashes by various crash type and provide a comparison of the injuries involved in frontal and side impact scenarios. This clearly indicates that researchers have been successfully in the reduction of injury level in frontal impact. However the injuries involved in side impact crashes have increased. Many design and material changes have been made in an effort to reduce injury severity, mainly by improving frontal impact protection techniques. Nearly 1 lakh vehicle occupants die every year in frontal impact crashes, of which more than 50% of deaths are due to head injuries. Impacts with poles represent a significant portion of the vehicular collision. Fixed object collisions account for less than 8% of all crashes in India, but they represent nearly.

1.2. CRASH MANAGEMENT SYSTEMS

Automotive safety can be improved by "active" as well as "passive" measures. Active safety refers to technology which assists in the prevention of a crash. Passive safety includes all components of the vehicle that help to reduce the aggressiveness of the crash event. Crash protection priorities vary with the speed of the car when crash occurs:

- At speeds up to 15 km/h, the main goal is to minimize repair costs.
- At speeds between 15 and 40 km/h, the first aim is to protect pedestrians.
- At speeds over 40 km/h, the most important concern is to guarantee occupant protection.

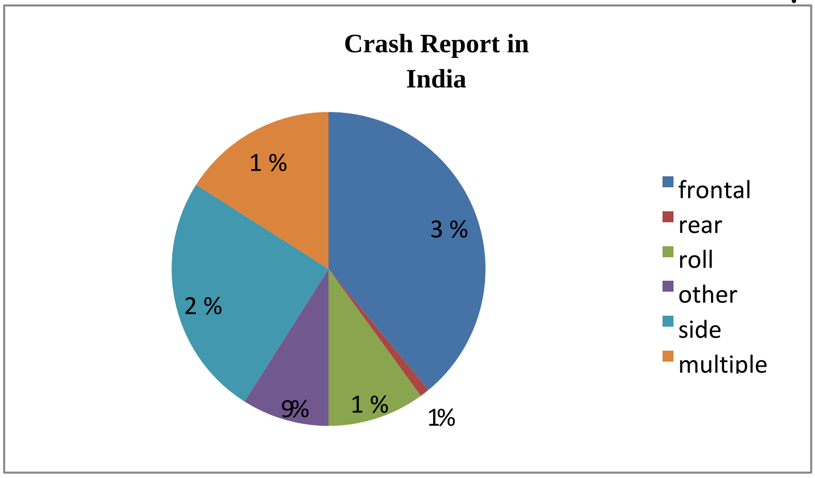


Fig.1 Crash Report in India

1.3 FRONT GUARD

A Front guard is a mechanical device designed to absorb and damp shock impulses. It does this by converting the kinetic energy of the shock into another form of energy which is then dissipated. An automobile safety guard is a device installed on the front of a vehicle. It protect its front from collisions, whether an accidental collision with a large animal in rural roads, or an intentional collision with another vehicle. They range considerably in size and form, and are normally composed of welded steel tubing, or more recentlymoulded polycarbonate and polyethylene materials.

Fig.2 Scooter Front Guard

Fig.3 Scooter Bike

1.4 OBJECTIVES OF THE WORK

The aim of this work is to study the front Guard one of the existing Scooter in Indian market, and suggest Redesign Improvement in front guard in terms of material selection using Impact Analysis.

1. To analyze the mechanical properties on front part (fascia) of bike bumper by comparative speed impact analysis.
2. To analyze on mechanical properties focus on stress analysis
3. To modeling the actual dimension of the bike bumper into the Creo 2.0 software and analyze by using impact loading.
4. To Analyze and compared the safety guard by used ANSYS Explicit solver.

1.5 MATERIALS

Design Improvement in Scooter Front Body materials for using Impact Analysis for two types of material defines the statement of the problem. Scooter safety guard made in steel material and scooter body material assuming ABS (Acrylonitrile - Butadiene – Styrene) Plastic material and PEI material.

Table 4.1: Mechanical properties

S.no	Material	Density (Kg/m^3)	Modulus of Elasticity (N/mm^2)	Modulus of Rigidity (N/mm^2)	Poisson's ratio
1	ABS Plastic	1020	33.8	$3.189*10^2$	0.394
2	PEI	1480	$3.38*10^4$	$3.189*10^2$	0.4
3	steel	7850	$2*10^5$	$0.79*10^5$-$0.89*10^5$	0.33

II. METHODOLOGY

Model and FEM approaches have been used to evaluate the strength under impact loading. For the model created by used for Creo 2.0 software, For FEM approach, ANSYS 16.0 is used as a pre-processor, Explicit dynamics Structural solver is used as a solver Post processing is carried out respectively.

Explicit Dynamic Analysis ⇨ Literature Review ⇨ Theoretical Study ⇨ Model ⇨ Analysis Solver ⇨ Result

III. DYNAMIC FORCE CALCULATION

Mass of the bike (Access) = 102 kg
Mass of one person = 68 kg
Total mass =102+68 = 170 kg
Speed of the bike = 36 km/hour = 10 m/s.
Assume this bike is hitting at another identical one and it will stop in 0.1 seconds.

- Deceleration of the bike = (v-u)/t =(10-0)/0.1 = 100 m/s^2
  v = final velocity of bike in m/s, u = Initial velocity of bike in m/s,
  t = time after which vehicle stopped in seconds.
- Force acted during collision =m*a =170*100 = **17.0 KN**
  m= mass of bike in kg, a = acceleration of bike in m/s^2
- Final momentum = mass*velocity= 170*10= 1700 kg.m/s.
- Loss of kinetic energy = Initial K.E – Final K.E
  $=W/2g*u^2- W/2g*v^2 = 0- 170/2*(10^2)$
  Loss of K.E = **8500 J**

Finally we are compared the solid modeling of Safety Guard, which is resist the more impact energy. The solid model created by using Creo 2.0 software. The Creo model obtained is imported into ANSYS for Explicit impact solver. After this, the new model is imported into ANSYS Workbench for analyzing the dynamic stability with modal analysis.

3.1 EXISTING DESIGNMODEL

This Existing model built using the Creo 2.0 Software and while the simulation of crash done in Numerical study carried by simulation via the Explicit Dynamics in ANSYS 16.0.To determine the impact energy absorbing member and also investigate to determine the stiffness on the crash behavior. The Existing design model was tested under frontal collision conditions and the resultant deformation and stress, strain are determined and compared using ANSYS software.

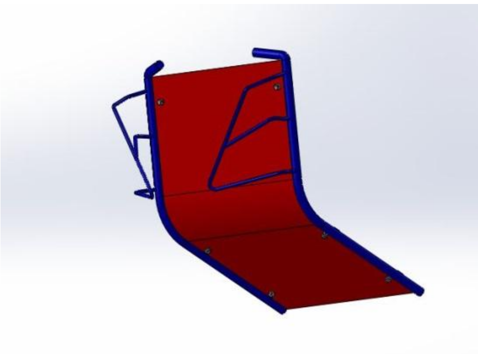


Fig.4 Existing Guard

3.2 NEW DESIGNMODEL

Vehicle manufacturers are go to through a rigorous process of design, experimentation and validation based on best of strength requirement, weight reduction, improved fuel efficiency etc. The objective of this work is human safety and vehicle safety. This new design was designed a safety guard S- Shaped longitudinal member. These S- shaped longitudinal members are good crash behavior and energy absorption characteristics compared existing guard. Finally we are compare the Existing design model and new design is tested under frontal collision conditions and the resultant deformation and stress, strain are determined and compared using ANSYS software.

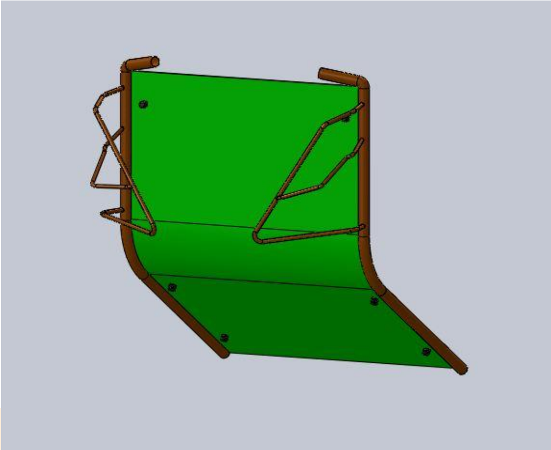


Fig.5 New Guard

3.3 TEST PROCEDURE

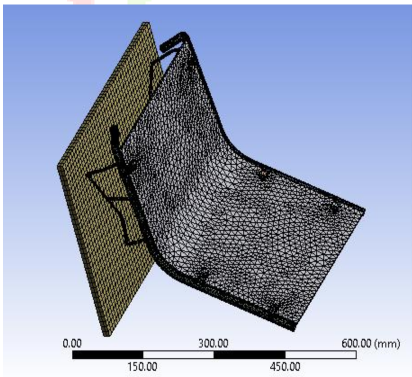
(i) Evaluation of existing design was straight beam are used. It was attached directly to the body cross member section by means of bolted appearing vertically suspended. By application of load of 17kn, and velocity is 36Km/hr it seemed to satisfy the I.S. standard. But when we tested for impact loading condition like direct perpendicular impact and oblique impact, it is observed that was failed to withstand the impact forces

(ii) Evaluation of New design the existing design was S-shaped longitudinal beam are used. It was attached directly to the body cross member section by means of bolted appearing vertically suspended. It seemed to satisfy the I.S. standard. But when we tested for impact loading condition like direct perpendicular impact and oblique impact, it is observed withstand the impact forces compare than Existing guard.

(iii) Basic aim for modification was to move impact / Dynamic loads or dissipative force to more rigid structure on to chassis section. To check its performance in case of impact loading, two bike models with 102kg and 110kg masses were used for study purpose. Finally we are comparing the Existing and New model Scooter front guard.

IV. ANSYS EXPLICIT DYNAMICS

ANSYS EXPLICIT DYNAMICS is a general purpose of software suite that combines an advanced solver with powerful pre- and post-processing capabilities. It includes the following features: The ANSYS Workbench acts as a single window through which different modules such as design modeler; Ex-Dynamics system in ANSYS Workbench incorporates the following components.



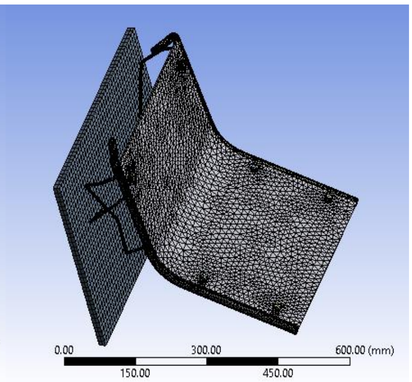
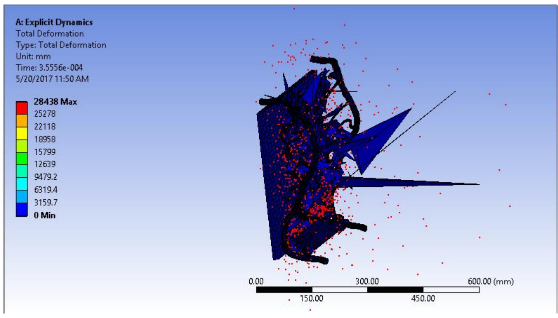


Fig.6 Existing Mesh Assembly

Fig.7 New Mesh Assembly



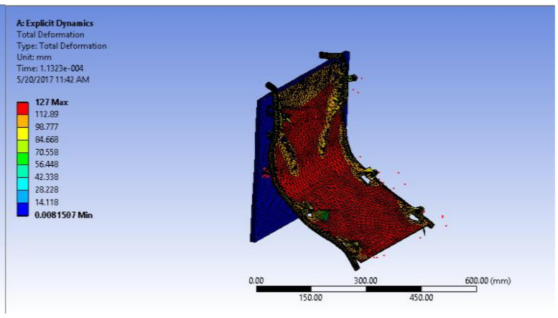
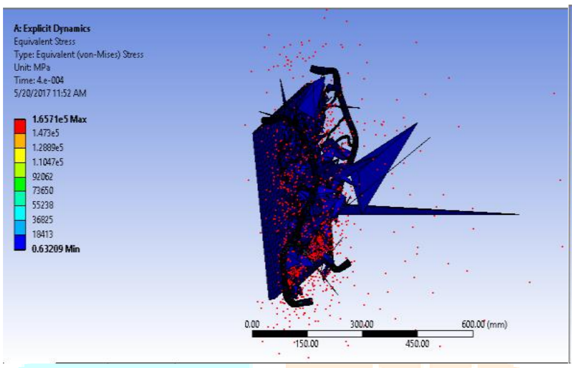


Fig.8Total Deformation of Existing Guard Fig.9 Total Deformation of New Guard



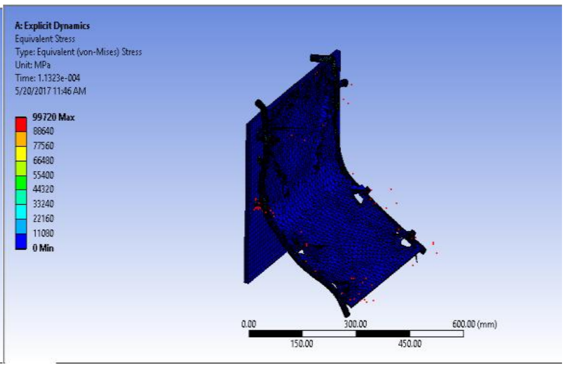
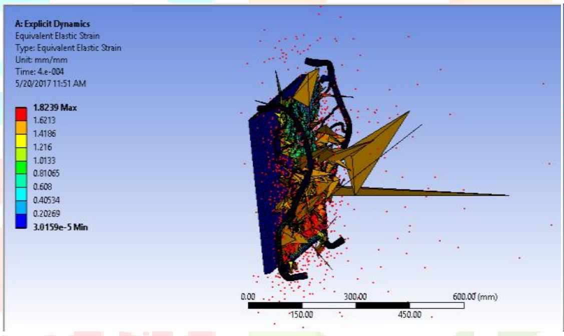


Fig.10 Stress distribution of Existing Guard Fig.11 Stress distribution of New Guard



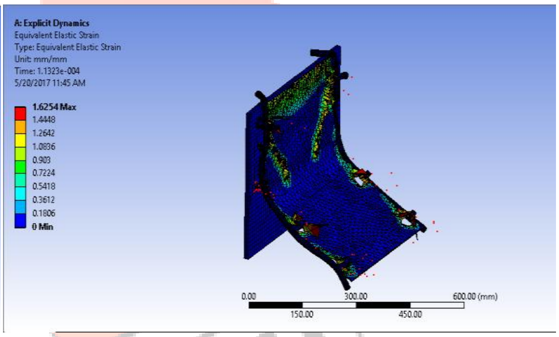
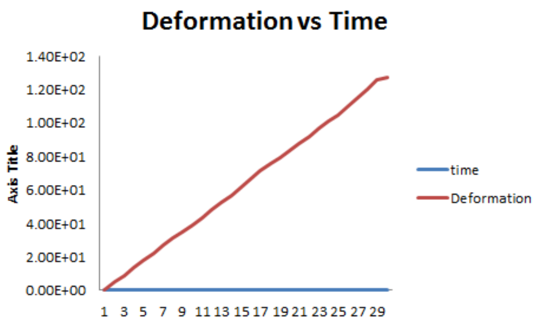


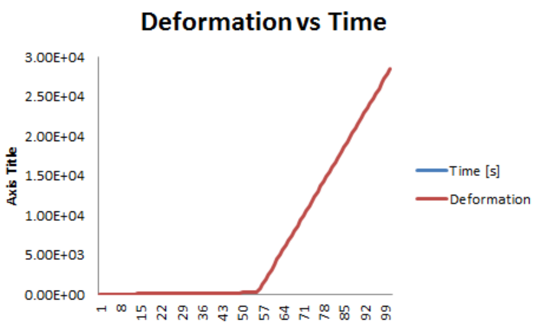
Fig.12 Strain distribution of Existing Guard Fig.13 Strain distribution of New Guard

Evaluation of Scooter Front Guard Design, It was attached directly to the body cross member section by means of bolted appearing vertically suspended. By Appling the Boundary conditions of Fixed Support and velocity is 36Km/hr it seemed to satisfy the I.S. standard. But when we tested for impact loading condition like direct perpendicular impact and oblique impact, it is observed that was failed to withstand the impact forces.

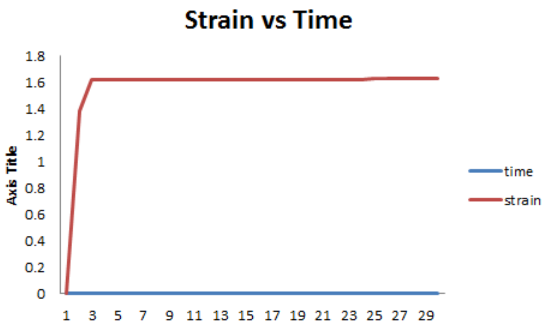
V. RESULTS AND DISCUSSIONS

The characteristics of the Front Guard with velocity 36 Km/hr applied, The results obtained from ANSYS Explicit Dynamics solver. The results are comparing the Existing vs New Design.

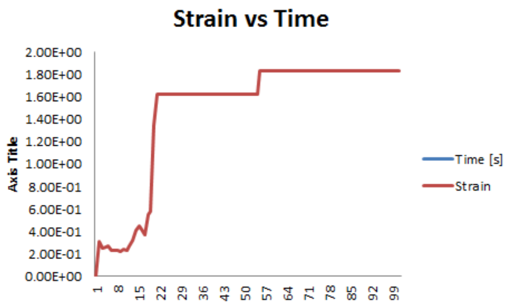




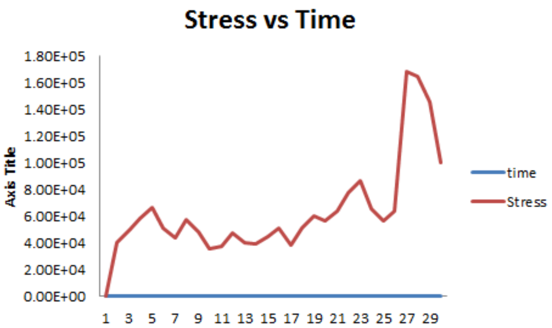
Graph1. Existing model (Deformation vs time) Graph2. New model (Deformation vs time)



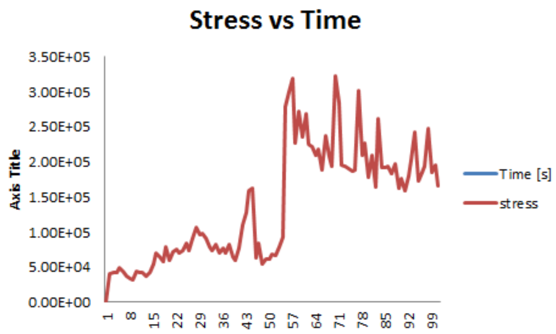
Graph3. Existing model (Strain vs time)



Graph4.New model (Strain vs time)



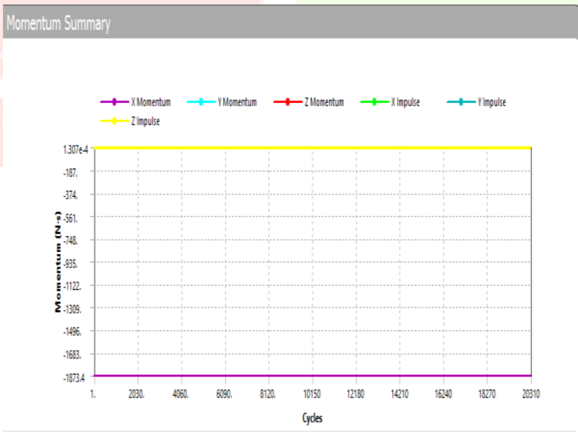
Graph5.Existing model (Stress vs time)

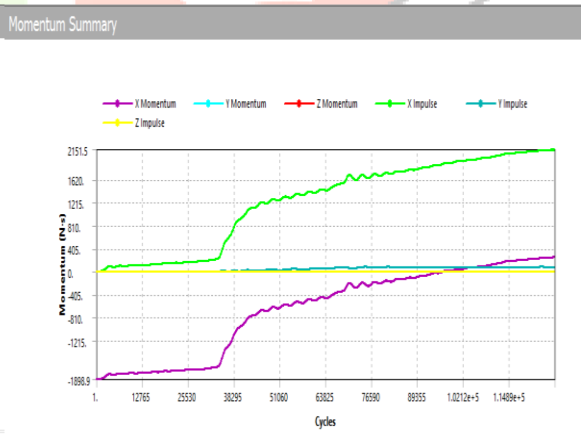


Graph6. New model (Stress vs time)

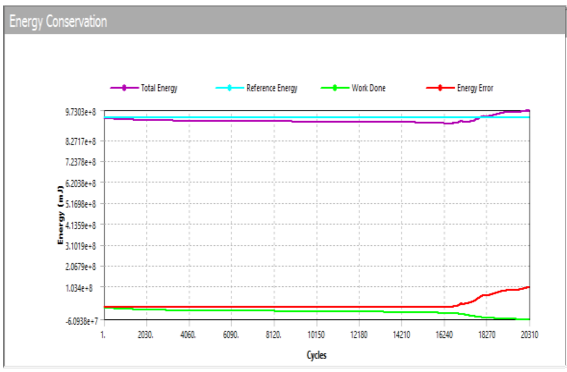
To check its performance in case of impact loading, two Guards models with same Forces were used for study purpose. Existing compare than new model absorbing more impact energy. To validate the model, Existing responses of the model were compared with new guard test data at specified locations. Experience showed that different methods of calculation resulted in significant variations of energy responses.

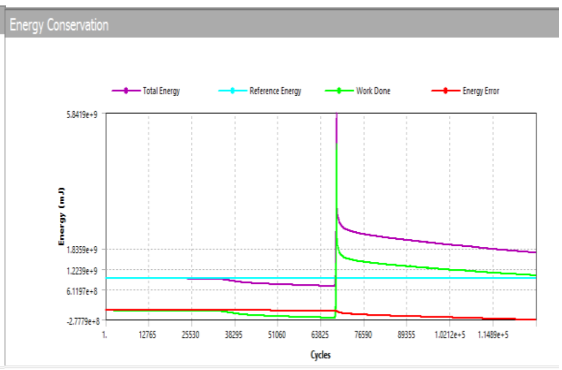
5.1 Momentum Summary (Existing vs New Guard)



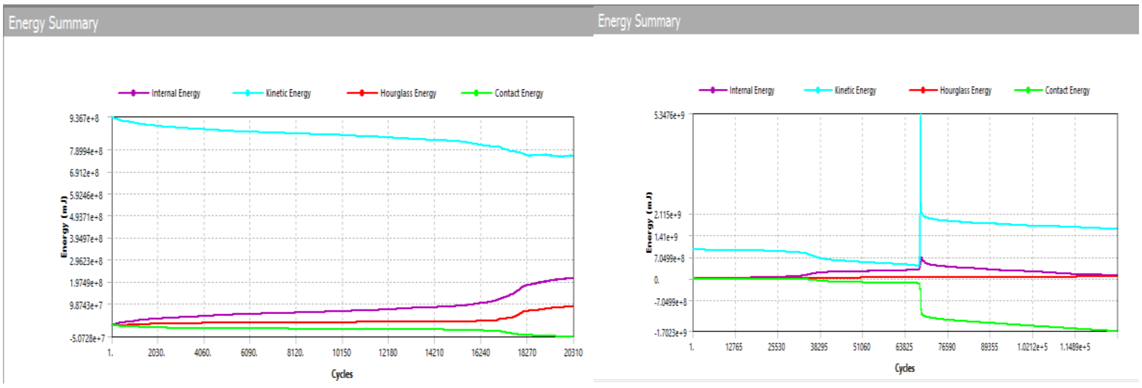


5.2 Energy conservation (Existing vs New Guard)

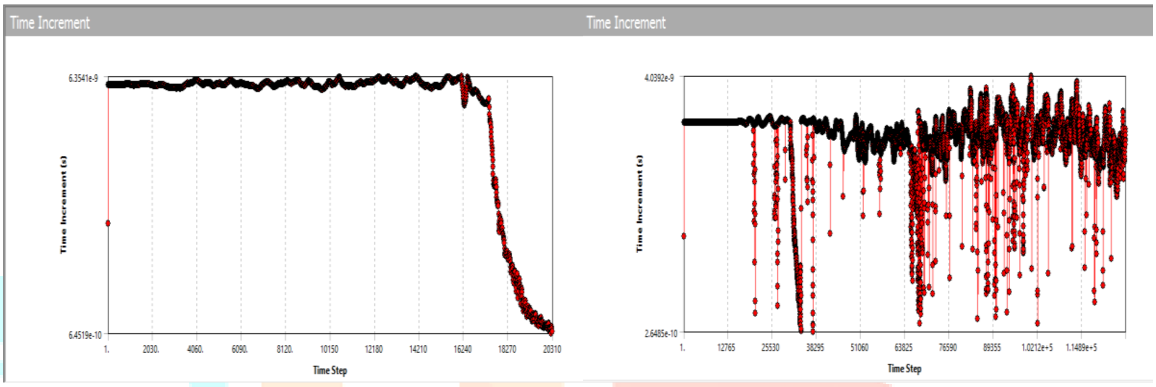




5.3 Energy Summary (Existing vs New Guard)



5.4 Time Increment (Existing vs New Guard)



Originally, the calculation of energy conservation of the model was accomplished by averaging the accelerations of a group of nodes from the region of a part where an accelerometer was placed in the physical test. The above graph indicates in Energy, Momentum with respect to time. From the above tables shows that the changing of front guard would leads to increase the impact load.

VI. CONCLUSION

In this work, ANSYS 16.0 Linear Explicit solver has been used to simulate the impact analysis, crashworthiness for Scooter front guard. The results are improved with the existing guard, and required design modifications have been done from further analysis and iterations. The work presented in this paper is in the early phases of ongoing work and it is important to note these promising results will strongly demand more detailed analysis as mentioned in further scope for study. Results can be obtained by observing the graphs of Momentum summary, Energy conservation and Energy loss to decide an absorbing more impact energy. To compare the existing Impact Analysis results like Stress, Strain, and Displacement for Same speed improved the new design.

VII. SCOPE OF FUTURE STUDY

The future development will be aim to achieve the following objectives,

- Material selection for Automobile Bodies.
- To Analyze the Human safety and vehicle safety in Automobile vehicles.

VIII. REFERENCES

[1] I.S., FMVSS, NHTSA, CANADIAN standards and norms.
[2] Matthew L. Brum below, “Crash Test Performance of Large Truck Rear Underride Guards” Insurance Institute for Highway Safety United States Paper No. 11-0074.
[3] José Ricardo, LenziMariolani Antonio Celso Fonseca de ArrudaLuís Otto Faber, “Development of New Underride Guards for Enhancement of Compatibility between Trucks and Cars” Schmutzler State University of Campinas Brazil Paper Number 425.
[4] Byron Bloch, “Improved Crashworthy Designs for Truck Underride Guards”, Auto Safety Design Potomac, Maryland USA Louis Otto Faber Schmutzler Biomechanics Engineering Lab. Unicamp State University
[5] Hosseinzadeh RM, Shokrieh M, and Lessard LB, “Parametric study of automotive composite bumper beams subjected to low-velocity impacts”, J. CompositeStuct., 68 (2005):419-427.
[6] Marzbanrad JM, Alijanpour M, and Kiasat MS, “Design and analysis of automotive bumper beam in low speed frontal crashes”, Thin Walled Strut., 47 (2009): 902- 911.
[7] http://www.nhtsa.dot.gov/cars/testing/procedures/TP- 581-01.pdf.

[8] Andersson R, Schedin E, Magnusson C,Ocklund J, "The Applicability of Stainless Steel for Crash Absorbing Components", SAE Technical Paper, 2002.
[9] Butler M, Wycech J, Parfitt J, and Tan E, "Using Terocore Brand Structural Foam to Improve Bumper Beam Design", SAE Technical Paper, 2002,
[10] Carley ME, Sharma AK, Mallela V, "Advancements in expanded polypropylene foam energy management for bumper systems", SAE Technical Paper, 2004.
[11] Evans D and Morgan T, "Engineering Thermoplastic Energy for Bumpers", SAE Paper, 1999.
[12] Witteman WJ, "Improved Vehicle Crashworthiness Design by Control of the Energy Absorption for Different Collision Situations", Doctoral dissertation, Eindhoven University of Technology, 2000.