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Virtual Crash Test Analysis of Modern Car through ANSYS Software

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ABSTRACT

Today's world is more curious about the automobile safety performance. Everyone, who wishes to purchase their own vehicle, is concentrating on the safety features of the vehicle so that his journey must be safe. Most of the automobile companies in India now a day are focusing on the strength improvement of vehicle. In order to achieve the maximum safety the vehicle must undergoes the different types of test, which is to be performed during the design and development phase. Individual companies follow their own testing methods, but out of them some tests are common and must be taken before launching the vehicle in the market.

Crash Test is the one of the important test which is to be conducted during the development of car. It is the method of hitting the car on an obstacle with a particular speed in order to observe and record the damage on vehicle, passenger and percentage of failure of component. This test is to be carried out with strong observations and standard speed. There are two methods of conducting crash test. One is physical crash test and other is virtual crash test. Physical crash test is time consuming, having wastage of money, material and efforts. But the plus point is it has accurate results. While virtual crash test eliminates all the above lacunas of physical crash test but the results are approximate. In this paper the modern vehicle like car crash test is to perform by using Virtual CAD Model and CAE tool like ANSYS 2020 R1 workbench. The vehicle is to be allowed to hit an obstacle with a particular speed and percentage of damage along with maximum deformation and stress concentrations is to be studied well. Three different materials are to be tested in order to achieve the better results. Based on obtained results, results are drawn.

Keywords: CAD, CAE Tool, Crash Test, Virtual CAD Model

I. INTRODUCTION

Virtual testing for vehicles uses software and mathematical models to replicate thousands of different scenarios to ensure that new vehicles comply with global safety regulations. Virtual testing therefore does not only include traditional crash simulation, but NVH, durability, strength, stiffness testing and much more. Virtual testing is often correlated with physical testing results to ensure accuracy and reliability.

Crash test dummies have been the subject of public service announcements, cartoons, parodies, even the name of a band. Real crash test dummies, however, are true life-savers as an integral part of automotive crash tests. Even though cars get a little safer each year, and fatality rates are declining, car crashes are still one of the leading causes of death and injury in the United States.

One of the reasons cars have been getting safer is because of a well-established testing program. In this chapter, we'll learn all about automotive crash testing, including crash test programs, ratings, dummies and future improvements. We'll be amazed at how much thought and preparation goes into making sure that safe cars are on the roads!

A. Aims of Paper

1) Study of Virtual and Physical Crash Test.
2) Study of Virtual CAD model of Modern Car Body with the help of CAD Tool like Solidworks.
3) Study of Literature available on crash test.
4) Study of FEM Process.
5) Study of performance of virtual crash test.

B. Objectives of Paper

1) Performance of Finite Element Analysis of Modern Car Body.
2) Performance of Virtual Crash test with different body materials.
3) Observation of impact regions and study of deformation and stress development.
4) Generation of suitable conclusion based on the the results obtained with the help of virtual crash test analysis.

II. LITERATURE REVIEW

Andrew Hickey, Shaoping Xiao, Finite Element Modeling and Simulation of Car Crash. In this paper, quasi-static simulations were conducted to simulate car crash via finite element method. [1] Michael S. Varat, Stein E. Husher, Crash PulseModeling for Vehicle Safety Research. Computer simulation, component testing, and sledtests often require the generation of suitable, derivedacceleration time histories to define a collision event. [2] Tomiji Sugimoto, YoshijiKadotani, Shigeru Ohmura, The Offset Crash Test -A Comparative Analysis Of Test Methods. This research will discuss the issue of how the currentlyused frontal crash tests correlate to actual accidents. [3]

T. J. Hirsch, Vehicle Crash Test And Evaluation Of Median Barriers For Texas Highways. This study adds support to the vast knowledge obtained from previoustesting programs and field experience in demonstrating that maintenancerepair increases as barrier flexibility increases. [4]

Witold Pawlus& Hamid Reza Karimi &Kjell G. Robbersmyr, Investigation of vehicle crash modeling techniques:theory and application. Creating a mathematical model of a vehicle crash isa task which involves considerations and analysis of differentareas which need to be addressed because of the mathematicalcomplexity of a crash event representation. [5] Tso-Liang Teng1, Peng-Hsiang

Chang2, Cho-Chung Liang3 and Da-AnFung3, Application of crash pulse on the carcrashworthiness design. Crash pulse is an acceleration curve measured in the car during a crash test. [6]

T. Ananda Babu 1 D. Vijay Praveen 2 Dr.M.Venkateswarao 3, Crash Analysis Of Car Chassis Frame Using Finite ElementMethod. In this project impacts and collisionsinvolving a car frame model are simulated andanalyzed using ANSYS software. [7] Raj Kumar G, Balasubramaniyam S, Senthil Kumar M, Vijayanandh R, Raj Kumar R, Varun S, Crash Analysis on the Automotive Vehicle Bumper. In this chapter deals the crash investigation of Bumper for different materials using ANSYS Workbench. Bumper is a vital parameter which is used as safety protection for passengers from accidents by means of impact energy absorption from collision environment. [8]

Woon Kim,Raul Arbelaez,Jack Jensen, Impact of Speeds on Drivers and Vehicles Results from Crash Tests. Aseries of crash tests requires an appropriate facility and specialized equipment, along with detailed preparation work for setup and execution. [9]

III. CAD MODELLING OF CRASH TEST SETUP

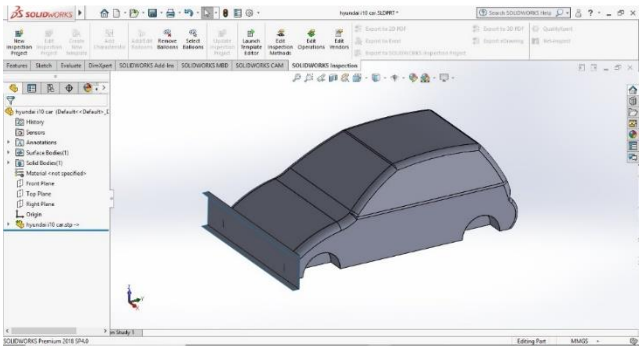

Figure 1: Crash Test Developed in SolidWorks Software

Figure 1 shows the car body and abstacle modeled in Solidworks software. It is developed in part module with various commands are utilized like extruded boss, Extruted Cut, Revolved Boss, Sweep etc are used. Line, arc, trim, mirror, diamention etc commands from sketcher module is used to develop base model.

IV. FEA ANALYSIS

A. Meshing

A mesh is a network of line elements and interconnecting nodes used to model a structural system and numerically solve for its simulated behavior under applied loading. First, computational techniques create an analytical model by populating the material domain with a finite-element mesh in which each line element is assigned mathematical attributes (axial, bending, shear, and torsional stiffness, etc.) which simulate the material and geometric properties of the structural system. The system is then restrained within boundary conditions and subjected to mechanical or thermal loading. Numerical solution may then resolve structural stresses, strains, and displacements.

Table 1: Nodes and Elements

Type of Element	3D Tetragonal
No. of Elements	51768
No. of Nodes	17854
Type of Elements	Square and 3D Tetragonal

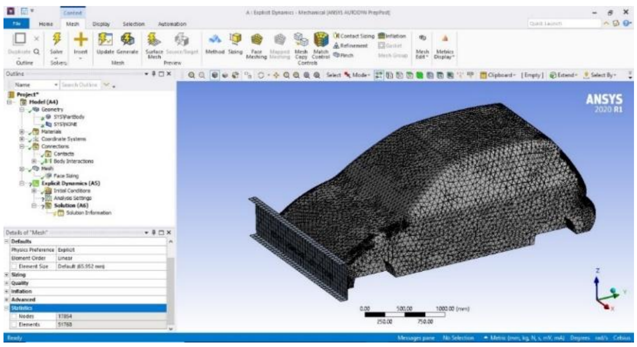

Figure 2: Meshed view of Crash Test Set-up

B. Material Properties Required

Table 2: Properties of Structural Steel for Crash Test Analysis.

Property	Value
Young's Modulus (E)	2e5 MPA
Poisson' s Ratio (μ)	0.3
Density (ρ)	7850 kg/m³

Table 3: Properties of Stainless Steel for Crash Test Analysis.

Property	Value
Young's Modulus (E)	2.1e5 MPA
Poisson's Ratio (μ)	0.285
Density (ρ)	7865 kg/m3

C. Boundary Conditions

To simulate the proper physical condition, velocity and abstacle fixing are to be attached properly. In case of Crash Test Set-up, it is fixed at the end of the abstacle where it actually comes in contact with car body. A car with 65 km/Hr, 75 km/hr and 85 km/hr velocities are in the considoration. Hence the velocity which is to be applied on Crash Test Set-up is considered including thrust and torque. Hence the Actual Boundary Conditions are as follows.

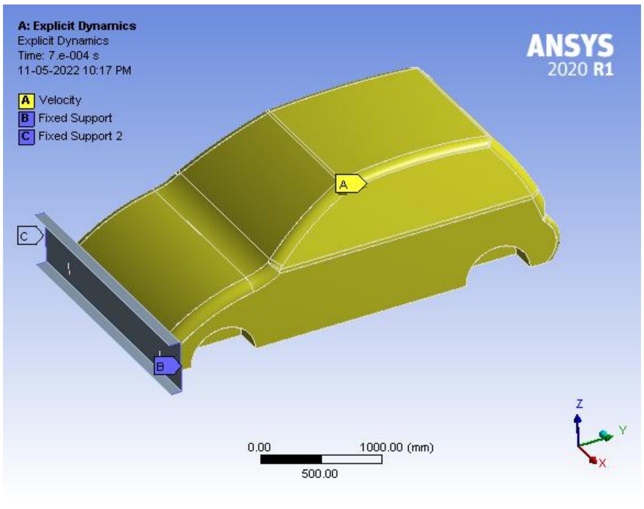

Figure 3: Boundary Conditions applied on Crash Test Set-up for analysis.

D. Crash Test Results for 65 km/hr Car Velocity

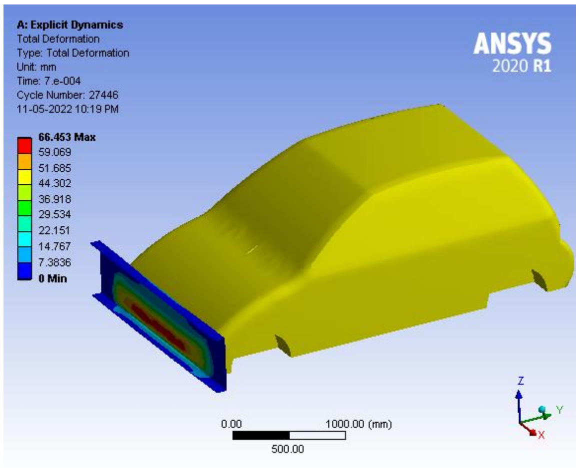

Figure 4: Total Deformation Due to 65 km/hr speed velocity during Crash

Figure 4 shows the total deformation due to hitting an abstacle with a speed of 65 km/hr. It is found that deformation is 66.43 mm which is too large and it will damage abstacle as well as car front surface as shown in figure. The maximum deformation is observed at the abstacle surface. But also same deformation is observed on fev spots of car body.

Figure 5 shows the equivalent stresses due to crash. These stresses are to high and obstacle as well as car body is not able to withstand on such high stresses. Hence the failure of bodies are conferm with maximum possible damage.

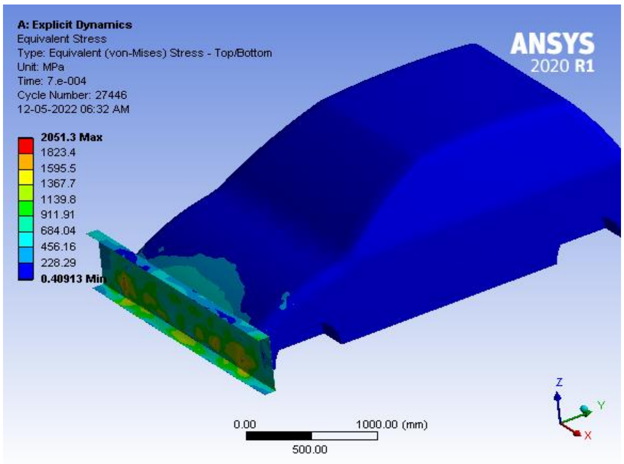

Figure 5: Equivalent stresses developed due to crash

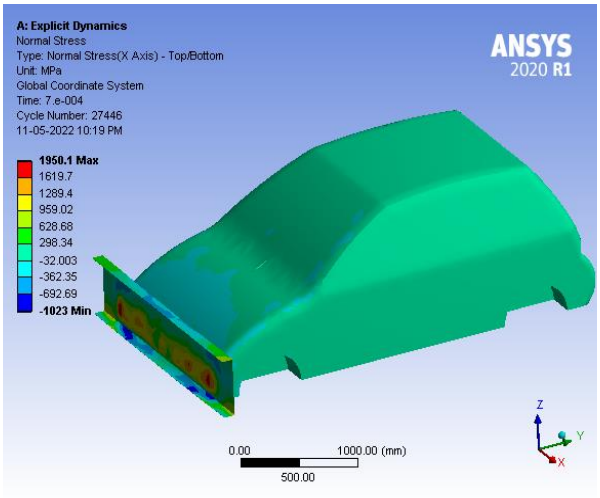

Figure 6: Normal Stresses observed at 65 km/hr speed

Figure 6 shows the normal stresses which are 1950 MPa. These stresses are also at higher value. Both object can fail or damage on this stress value. Obstacle is going to damage with maximum intensity, whereas the car body observe the few spots of stress concentration.

Figure 7 shows the shear stress value at 65 km/hr speed. As compaire with other stresses induced in both bodies it is found less (788 MPa) but beyond acceptable range. Hence these stresses also cause the failure of both object with maximum impact of failure.

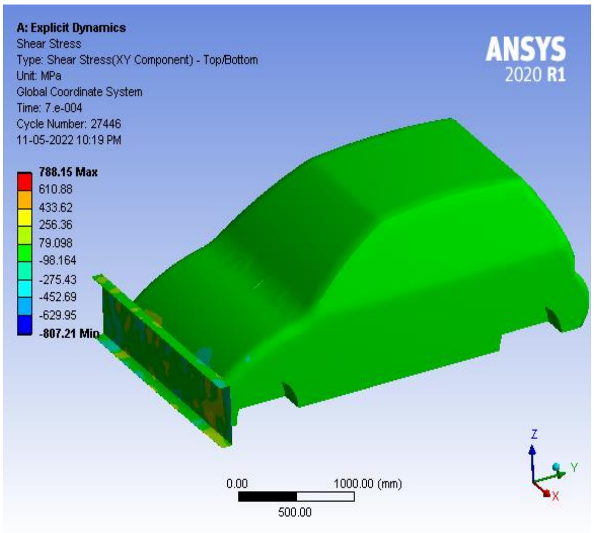

Figure 7: Shear Stresses at 65 km/hr speed

By observing all above results for 65 km/hr speed crash test, we found that, the maximum failure will accure on the abstacle. Serious damages will be observe on the car body at few spots but the impact penetration in the passenger cabin is less. Hence the body found safer at this speed.

V. RESULT SYNTHESIS

Table 4: Tabulated Results comparison of Crash Test Analysis

Sr. No.	Speed (km/hr)	Total Deformation (mm)	Equivalent Stress (PMa)	Normal Stress (PMa)	Shear Stress (PMa)
1	65	66.45	2051.3	1950.1	788.15
2	75	78.24	2297.9	2185.7	1102
3	85	90.81	2686.4	2615.3	1416

Table 4 shows the tabulated results generated due to the crash test performend at the various speeds like 65, 75 and 85 km/hr. It is found that at the speed above 75 km/hr car body damage penetration may come till cabin and can harm passenger. The safety limit will be only upto 65 kh/hr spped.

Figure 5: Comparison of Speed and deformation in all three cases

Figure 5 shows the increament in the deformation due to speed. Sequential increament in the deformation shows the possible damage. Blue color shows the speed in km/hr limit and red color shows the deformation in mm.

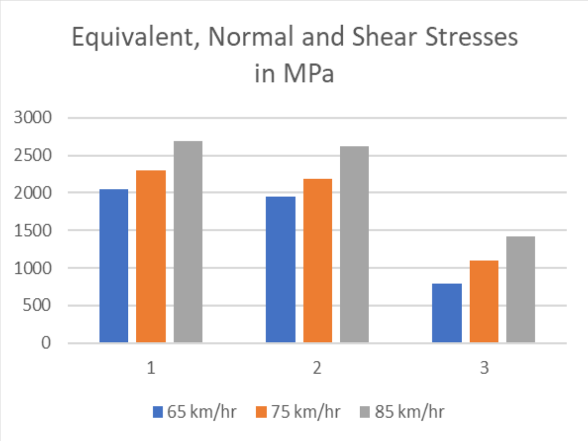

Figure 6: Stresses obtained in each case with various speed

As per the observation of stresses given in figure 6, we found Equivalent stresses are more in each cases and it will cause the damage penetration into the cabin. At the speed of 85 km/hr stress concentrations are much. Blue color shows the shear stresses, Red color shows the Normal stresses, Green color shows the Equivalent stresses.

VI. CONCLUSION

By observing all the results generated by crash test analysis at various speed like 65, 75 and 85 km/hr, it is found that the car body is stable with minor damage on few spot at 65 km/hr speed. Passengers will be safe as damage penetration will not cover cabin space. Car body become unstable at the speed of 75 km/hr. High stress values indicate the failure of both abstacle and car body. Passenger safety is not upto mark in this case. Need batter safety arrangement in cabin at this speed. At the speed of 85 km/hr, maximum damage accourse and car body is on the higher risk of damage including passengers inside the cabin. Damage penetration is higher in this case hence the safety should be taken by decreasing the speed.

As far as FEA tool is concern, it is more reliable and cheaper to conduct virtual crash test. Results generated through this type of analysis are upto mark and can be considered during design of car body process. It also saves the cost, material, time and efforts of conducting physical crash test.

VII. REFERENCES

[1]. Andrew Hickey, Shaoping Xiao, Finite Element Modeling and Simulation of Car Crash. International Journal of Modern Studies in Mechanical Engineering (IJMSME) Volume 3, Issue 1, 2017, PP 1-5 ISSN 2454-9711 (Online) DOI: http://dx.doi.org/10.20431/2454-9711.0301001 www.arcjournals.org

[2]. Michael S. Varat, Stein E. Husher, Crash PulseModeling for Vehicle Safety Research. 18th ESV Paper, KEVA Engineering, United States of America, Paper 501

[3]. Tomiji Sugimoto, Yoshiji Kadotani, Shigeru Ohmura, The Offset Crash Test -A Comparative Analysis Of Test Methods. Honda R&D Co., Ltd. Japan, Paper Number 98-S 1-0-08

[4]. T. J. Hirsch, Vehicle Crash Test And Evaluation Of Median Barriers For Texas Highways. Research Report Number 146-4 Studies of Field Adaptation of Impact Attenuation Systems Research Study Number 2-8-68-146 Sponsored by The Texas Highway Department in cooperation

[5]. Witold Pawlus & Hamid Reza Karimi & Kjell G. Robbersmyr, Investigation of vehicle crash modeling techniques: theory and application. Int J Adv Manuf Technol DOI 10.1007/s00170-013-5320-3

[6]. Tso-Liang Teng1, Peng-Hsiang Chang2, Cho-Chung Liang3 and Da-An Fung3, Application of crash pulse on the car crashworthiness design. Advances in Mechanical Engineering 2017, Vol. 9(9) 1 8 _ The Author(s) 2017 DOI: 10.1177/1687814017700096 journals.sagepub.com/home/ade

[7]. T. Ananda Babu 1 D. Vijay Praveen 2 Dr.M.Venkateswarao, Crash Analysis Of Car Chassis Frame Using Finite Element Method. International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 8, October 2012 ISSN: 2278-0181

[8]. Raj Kumar G, Balasubramaniyam S, Senthil Kumar M, Vijayanandh R, Raj Kumar R, Varun S, Crash Analysis on the Automotive Vehicle Bumper. International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 8958, Volume-8, Issue-6S3, September 2019

[9]. Woon Kim, Raul Arbelaez, Jack Jensen, Impact of Speeds on Drivers and Vehicles Results from Crash Tests. AAA Foundation for Traffic Safety 607 14th Street, NW, Suite 201 Washington, D.C. 20005 202-638-5944 www.aaafoundation.org

[10]. Tejasagar Ambati, K.V.N.S. Srikanth & P. Veeraraju, Simulation of Vehicular Frontal Crash-Test. This work reports on the simulated crash test of an automobile. International Journal of Applied Research in Mechanical Engineering (IJARME) ISSN: 2231 5950, Volume-2, Issue-1, 2012

[11]. GiridharAramane, ROAD ACCIDENTS IN INDIA 2019. Ministry of Road Transport & Highways, Government of India, Transport Bhawan, 1, Sansad Marg, New Delhi - 110 001 Office Tel.: +91-11-2331522, 23715159 Fax : +91-11-23718568, website-www.morth.nic.in

[12]. Yao, J.;Wang, B.; Hou, Y.; Huang, L. Analysis of Vehicle Collision on an Assembled Anti-Collision Guardrail. Sensors 2021, 21, 5152. https://doi.org/10.3390/s21155152

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