International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST229176

A Review on modern vehicle Virtual Crash Test to Understand the Effect of Impact on Passengers

Akshay Dehankar, Yogesh Ingole, Abhijit Turkane, Aniket Nandurkar
Department of Mechanical Engineering, Jawaharlal Darda Institute of Engineering and Technology, Yavatmal, Maharashtra, India

Article Info
Volume 9, Issue 2
Page Number : 289-294

Publication Issue
March-April-2022

Article History
Accepted : 01 April 2022
Published : 09 April 2022

ABSTRACT

Modern vehicles are much safer, lighter, faster and drive convenient as far as older vehicles are concerned. They are more stable and having better safety features. Now a days everyone is giving more importance to the passenger safety. In order to avoid the passenger threats during vehicle crash, we need to understand the collusion effects on vehicle body and passenger cabin. It can be studied well with the help of crash test where vehicle is allowed to hit an obstacle with a particular speed and due to hitting vehicle damage and effect of collusion on the cabin is observed. But physical crash test is much costlier and consumes money, effort, material and much more things.

To avoid this virtual crash test is preferred in industry. It is a simple computerised crash test simulating process in which virtual model of vehicle is allowed to hit a virtual obstacle with a known speed virtually on computer. The effects will be generated by finite element analysis module in the form of deformation and stresses on virtual parts. It also shows the bending and cracks on parts. Hence this virtual crash test is Having 95 % accurate results. It also avoids physical damage on vehicle, saves efforts and money.

In this paper we have studied the various literatures available based on this crash test. Authors opinions are understood and based on their opinions a standard conclusion is drawn. This study will help to conduct virtual crash test with the help of FEA package and CAD Tool.

Keywords : Crash Test, FEA Package, CAD Tool

I. INTRODUCTION

In response to the need to improve crashworthiness, various countries have proposed and implemented a variety of test methods in order to provide regulations and safety information. Recently, offset crash tests have come into widespread use in addition to full frontal crash tests or oblique impact tests. In actual

accidents, chassis deformation and intrusion into the cabin has been observed in many cases. In addition, passenger deaths have been reported in conjunction with chassis and cabin deformation. Therefore, with the primary objective of securing cabin space and thereby reducing passenger deaths, a great deal of research has been conducted on offset crash tests, as well as on the body frame structure in order to improve passenger survivability. Full frontal crashes are considered useful for evaluating the performance of safety devices which restrain passengers during a crash. Offset crashes are considered appropriate for evaluating cabin deformation caused by the impact loads on the vehicle during a crash. As has already been described in a wide range of literature on the subject, in a certain sense, these two test methods involve evaluating mutually contradictory phenomena. This is an extremely serious and difficult problem for automobile development engineers who are attempting to improve crashworthiness. Issues which will be critical in discussions of vehicle crashworthiness in the future are:

(1) Does each of these evaluation techniques provide methods and criteria which are suitable for increasing vehicle crashworthiness?

(2) Which of these test methods is useful in developing and evaluating a vehicle?

A variety of configurations and conditions have been proposed, especially for offset crashes, so further research and discussion are needed. An area which is currently a main focus of concern is the types of considerations that are needed for vehicle designs which will provide compatible crashworthiness for both small cars and large cars. This issue is especially important for vehicles which are evaluated with these methods. This research seeks to verify how crash test methods, either full frontal or offset frontal crashes, are associated with actual accidents. This research also discusses what needs to be done in the future.

Safety is one of the design considerations in automobile community. Therefore, crash test is an important step to validate the novel car design. However, high cost in experimental testing limits the number of crash tests, and adequate data might not be obtained consequently. Alternatively, numerical modelling and simulation have been widely used to study car crash in addition to experimental testing. As a powerful numerical tool, finite element method (FEM) [1] plays an vital role in crash test simulations.

II. LITERATURE SURVEY

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. A 2002 Ford explorer was modeled in the 3D modeling software CREO and then imported into ANSYS for mesh generation and FEM analysis. Various incoming speeds were considered when the car was modeled to crash into a wall. It was observed that when the car with an incoming speed of 100mph, the car was totaled. The maximum deformation in numerical simulation agreed with the one from a real life testing. [1]

Michael S. Varat, Stein E. Husher, “Crash Pulse Modelling for Vehicle Safety Research”. Computer simulation, component testing, and sled tests often require the generation of suitable, derived acceleration time histories to define a collision event. These time histories have shape, amplitude, and duration characteristics. Suitable, derived acceleration time histories should be based on a particular vehicle’s response in a staged full scale crash test. A staged crash test includes instrumentation in order to measure acceleration time histories, force time histories and other engineering parameters. Analytical techniques are developed to derive acceleration time histories at different collision severities based on the measured acceleration time history in a particular crash test. [2]

Tomiji Sugimoto, Yoshiji Kadotani, Shigeru Ohmura, “The Offset Crash Test -A Comparative Analysis of Test Methods”. This research will discuss the issue of

how the currently used frontal crash tests correlate to actual accidents. The following data will be presented in relation to this:

1. Results of offset crash tests now being conducted, and results of vehicle-to-vehicle crash tests, especially results of crash tests in which the vehicles have different weights.
2. Why do such differences occur?
3. Differences between the results of tests with moving deformable barriers (MDB) which are being studied by the National Highway Traffic Safety Administration (NHTSA)and results of vehicle-to-vehicle crash tests.
4. Results of modifications to test methods The following aspects of the abovementioned issues will be discussed:
1. Important items and information to be considered in studying crash test methods to be used in the future.
2. Information which needs to be taken into consideration in developing cars in the future. [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 previous testing programs and field experience in demonstrating that maintenance repair increases as barrier flexibility increases. Maintenance of the rigid CMB barrier would require at most an occasional light sand blasting job to remove unsightly tire scrub markings. The findings of this study indicate that the CMB barrier would best serve the public in narrow medians of roadways located in urban developments and carrying high speed and high traffic volume. Information is presented on the safety, economic, and aesthetic considerations for each of the three barriers investigated. [4]

Witold Pawl us& Hamid Reza Karimi & Kjell G. Robbersmyr, "Investigation of vehicle crash modelling techniques: theory and application". Creating a mathematical model of a vehicle crash isa task which involves considerations and analysis of different areas which need to be addressed because of the mathematical complexity of a crash event representation. Therefore, to simplify the analysis and enhance the modelling process, in this work, a brief overview of different vehicle crash modelling methodologies is proposed. The acceleration of a colliding vehicle is measured in its centre of gravity—this crash pulse contains detailed information about vehicle behaviour throughout a collision. A virtual model of a collision scenario is established in order to provide an additional data set further used to evaluate a suggested approach. Three different approaches are discussed here: lumped parameter modelling of viscoelastic systems, data-based approach taking advantage of neural networks and autoregressive models and wavelet-based method of signal reconstruction. The comparative analysis between each method's outcomes is performed and reliability of the proposed methodologies and tools is evaluated. [5]

Tso-Liang Teng1, Peng-Hsiang Chang2, Cho-Chung Liang3 and Da-AnFung3, "Application of crash pulse on the car crashworthiness design". Crash pulse is an acceleration curve measured in the car during a crash test. The shape, time duration, and maximum acceleration of crash pulse may influence the predicted motion of the occupants. The characteristics of crash pulse measured during crash tests can be further used to analyse the crashworthiness of a given vehicle design. Thus, the dummy installation steps can be skipped entirely. This study comprised two parts. First, frontal crash pulse data were analysed to determine the relationship between crash pulse curves and occupant injuries and identify the types of pulse associated with minimal occupant injury. Second, crash pulses obtained from frontal crash simulations using different bumper and crossmember designs were correlated to original crash pulse curves to assess car crashworthiness and suggest design improvements. Dummy injuries were not directly considered. However, to verify the effectiveness of using crash pulse curves to evaluate design crashworthiness, crash simulations were conducted

with dummies, and the severity of dummy head damage was recorded. According to comparison results, the evaluation results of car bumper and crossmember design using head injury criterion value with employing crash pulse on crashworthiness design result are identical. It reveals the feasibility of car crashworthiness design based on the crash pulse. [6]

T. Ananda Babu 1 D. Vijay Praveen 2 Dr.M.Venkateswarao 3, "Crash Analysis Of Car Chassis Frame Using Finite Element Method". In this project impacts and collisions involving a car frame model are simulated and analysed using ANSYS software. The chassis frame forms the backbone of a heavy vehicle; its principle function is to safely carry the maximum load for all the designed operating conditions. The frame should support the chassis components and the body. It must also withstand static and dynamic loads without undue deflection or distortion. The given model is tested under frontal collision conditions and the result ant deformation and stresses are determined with respect to a time of 80 Mille sec for ramp loading using ANSYS software. The crash analysis simulation and results can be used to assess both the crashworthiness of current frame and to investigate ways to improve the design. This type of simulation is an integral part of the design cycle and can reduce the need for costly destructive testing program. [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 article 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. The ultimate focus of this work is material optimization for Bumper by performing impact analysis with the help of ANSYS. The entire analysis process comprises of two stages, which are conceptual design of Bumper and preparation of Bumper for numerical analysis. The optimization of this work is based on structural parametric results, in which total deformation, equivalent stress induced are primarily involved. The reference component's modeling process is completed by means of CATIA, and then the impact analysis is carried by ANSYS Workbench 16.2, in which the materials used for bumper are Steel and Glass fiber based composite with the constant boundary conditions [speed = 13.3 m sec-1]. Finally suitable material is finalized for car bumper. [8]

Woon Kim, Raul Arbelaez, Jack Jensen, "Impact of Speeds on Drivers and Vehicles — Results from Crash Tests". A series of crash tests requires an appropriate facility and specialized equipment, along with detailed preparation work for setup and execution. The test design includes a consideration of various parameters including but not limited to test type, impact speed, vehicle type, barrier type, and dummy type. This section presents the setup of each parameter for this study following the IIHS test protocol (IIHS, 2017) and the rationale for the selected setup. For this study, a moderate overlap frontal impact test was conducted following the IIHS test protocol version XVIII (IIHS, 2017) for all three tests, except we increased the impact speed in Tests 2 and 3. In this crash mode, 40% of the maximum width of the test vehicle crashed into a deformable barrier on the driver side with the forces concentrated on the driver side of the vehicle. Figure 1 illustrates the vehicle aligned with the barrier from the overhead view. This test setup simulates a head-on, partial-overlap crash between two vehicles of the same weight and size travelling at the same speed. [9]

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". The objective of this work is to simulate a frontal impact crash of an automobile and validate the results. The aim is also to alter some of the materials of the components with a view to reduce the forces experienced during the crash. Computer models were used to test the crash characteristics of

the vehicle in the crash. The model used here was that of a Chevrolet C1500 pick-up truck. The software used for the simulation is LS-DYNA. It is widely used by the automotive industry to analyse vehicle designs. It accurately predicts a car's behaviour in a collision. The results obtained by the simulation were then validated by comparing it with the test results of the same test performed by the NCAC (National Crash Analysis Centre).[10]

Giridhar Aramane, "ROAD ACCIDENTS IN INDIA – 2019". As per the Road Accident Report for 2019, a total number of 449,002 accidents took place in the country during the calendar year 2019leading to 151,113 deaths and 451,361 injuries. In percentage terms, the number of accidents decreased by 3.86 % in 2019over that of the previous year, while the accident related deaths decreased by 0.20 % and the persons injured decreased by3.86. The decline in road accidents, killings and injury reported during the calendar year 2019appear to have been a result of the Motor Vehicle Act implemented in States from September Ist2019 which focused on road safety and included, inter-alia, stiff hike in penalties for traffic violations as well as electronic enforcement. The other trends noted in 2019 were very similar to those recorded in the previous years. National Highways which comprise of 2.03 percent of total road network, continued to account for a disproportionate share of 35.7 per cent of deaths in 2019 pointing to need for improved enforcement and correctives to be put on National Highways. State Highways which account for3.01% of the road length accounted for 24.8 percent of deaths. Other Roads which constitute about95 % of the total roads were responsible for the balance 39% deaths respectively, and electronic monitoring of the same. [11]

Juncheng Yao 1, Bo Wang 1, Yujie Hou 1 and Liang Huang 2, "Analysis of Vehicle Collision on an Assembled Anti-Collision Guardrail". The result shows that the assembled anti-collision guardrail proposed in this paper can better change the trajectory of a moving vehicle and can prevent the vehicle from falling off the bridge. From the car body collision results, the assembled anti-collision guardrail for bridges proposed in this paper can reduce vehicle damage and can protect the driver effectively. From the analysis of the main girder stress on the bridge, an anti-collision guardrail installed on an existing bridge will not cause damage to the main girder during a collision. In order to study the influence of the four parameters on the anti-collision effect, we carried out a comparative calculation of multiple working conditions. The results show that the new type of assembled anti-collision guardrail has good protective performance under different working conditions. [12]

III. CONCLUSION

By studying all above references and literatures we have found that the virtual crash test will be the best suitable method for studying the impact on vehicle during crash and also the effect of collusion on the passenger cabin. There are also physical crash test is available but it will be more costlier, time consuming and can waste material, efforts. Most of the authors have discussed the failure effect of vehicle during crash and the strength improvement of vehicle. But the cost of crashing vehicle is also too high which can be reduced by using virtual; crash test.

IV. 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 Pulse Modelling 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 l-0-08

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

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

[6]. Tso-Liang Teng1, Peng-Hsiang Chang2, Cho-Chung Liang3 and Da-AnFung3, "Application of crash pulse on the car crashworthiness design". Advances in Mechanical Engineering2017, Vol. 9(9) 1–8_ The Author(s) 2017DOI: 10.1177/1687814017700096journals.sagepub.com/home/a de

[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 – 2012ISSN: 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]. Giridhar Aramane, "ROAD ACCIDENTS IN INDIA – 2019".Ministry of Road Transport & Highways, Government of India, Transport Bhawan, 1, Sans ad Marg, New Delhi - 110 001Office 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. Sensors2021, 21, 5152. https://doi.org/10.3390/s21155152

Cite this article as :

Akshay Dehankar, Yogesh Ingole, Abhijit Turkane, Aniket Nandurkar, "A Review on modern vehicle Virtual Crash Test to Understand the Effect of Impact on Passengers", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 9 Issue 2, pp. 289-294, March-April 2022. Available at doi : https://doi.org/10.32628/IJSRST229176
Journal URL : https://ijsrst.com/IJSRST229176