"ANALYSIS OF FRONTAL IMPACT ON A CAR AFTER CRASH USING FEA"

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ABSTRACT

With the enhancements in streets and execution of new plan advances to autos, vehicle wellbeing has tracked down an enormous turn in nowadays. That being said vehicle local area is putting forth its ceaseless attempt to improve car security to decrease injury and passing definitely. In the current work one such exertion is displayed via completing accident investigation of vehicle at various speeds utilizing ANSYS Explicit Dynamics approach. Primary Steel divider was utilized as the deterrent and aluminum amalgam was picked as the body material for vehicle model. It was seen that at low speed lion's share of the effect power was consumed by the forward portion of the vehicle with slight twisting. In any case, at high speed, sway brought about perpetual twisting of the vehicle model. The degree of plastic misshapening of the vehicle expanded with expansion in speed with forward portion of the vehicle engrossing the significant piece of the effect energy, Bumper, hood, A column and wind safeguard were the significant parts to go through plastic distortion. Likewise from the energy charts unmistakably inside energy expanded definitely and the motor energy diminished over the span of effect. After the effect the vehicle body bounce back and recovers its active energy, while the inner energy diminishes.

Keywords: Bumper, Hood, FEA, car, Car crash

INTRODUCTION

As long there have been roads there have been crashes. As vehicle innovation improved and speeds expanded, these accidents turned out to be increasingly ruinous. While the execution of fold zones, driver confines, steel bar entryways, and airbags have served to bring down the expense in human misfortune to these accidents, a more complete vision is required, a view that hopes to stay away from the accident out and out. With the advancement of society, individuals have expanding request of vehicles. Auto collisions are going on consistently. Most Drivers are persuaded that they can stay away from such problematic circumstance. In any case, the statics shows that many are dead and thousands to millions are harmed each year. Vehicle body light weighting and crash-value are two significant parts of plan. During a car accident, a few sections toward the front of auto body may have plastic deformity and assimilate a great deal of energy. Underlying individuals from the vehicles are intended to expand this energy retention effectiveness and hence to improve the security and unwavering quality of the vehicle. Consequently, improvement of security of auto is must.

Fig. Real world Car After Crash

Accident Analysis

In the course of recent years, since the presentation of the European front facing sway enactment and Euro NCAP, the front facing sway crashworthiness of vehicles has improved essentially.
The goals of the mishap investigation were:

- To decide whether similarity issues recognized in past examinations [1, 2] are as yet significant in the current vehicle armada.
  - Structural Interaction
  - Frontal Force Matching
  - Compartment Strength (specifically for light vehicles)
- To decide the current idea of tenant wounds and injury components.

The examination was acted in two sections. First and foremost, a general examination was performed, utilizing information that could be broke down measurably, to examine compartment strength issues, tenant injury examples and injury instruments. Also, an itemized case examination was performed, utilizing all information accessible including photographic proof, to research primary communication and front facing power/ compartment strength coordinating with issues. To guarantee that the consequences of the work were significant to the current armada just vehicles which were agreeable with UNECE R94 or had an identical wellbeing level (for example new vehicles) were chosen for the examination.
The mishap information bases utilized for this examination were:

1. UK Cooperative Crash Injury Study (CCIS)
2. German In-Depth Accident Survey (GIDAS)

The accompanying standards were utilized to choose the information tests utilized in this investigation:

1. Car engaged with huge front facing sway
2. UNECE Regulation 94 agreeable or identical wellbeing level.
3. Front seat grown-up tenants (for example more than 12 years of age).

The subsequent information test sizes are appeared (Table 1). The explanation that CCIS had more instances of interest than GIDAS is that CCIS utilizes a defined mishap inspecting method which favours mishaps in which there were lethal or genuine wounds. The GIDAS examining methodology is intended to deliver an example illustrative of the public information. Additionally, it ought to be noticed that for a mishap to be incorporated in the CCIS study a more current vehicle (not more established than 7 years at the hour of the mishap probably been included. The consequence of this is that the CCIS information test doesn't address the public information correctly. The principle inclination is that more established tenants are over-addressed somewhat.

Table : Number of occupants in CCIS and GIDAS data samples

Database	Fatal	MAIS 2 + Survived	MAIS 1
CCIS	83	466	1236
GIDAS	16	155	701

Objectives

Crash re-enactments are utilized to research the security of the vehicle inhabitants during sway toward the front construction of the vehicle in the front facing sway, the sidelong design of the vehicle in a side crash, the backside design of the vehicle in a back sway. Crash Simulation can likewise be utilized to survey injury for the person on foot. Be that as it may, the fundamental targets can be given as,

• To guarantee the wellbeing of driver.
• Selection of material based on strength.
• Minimizing the heaviness of the vehicle without trading off with wellbeing.
• To decrease the expense for real accident testing.
• The results can be utilized to get to both the crashworthiness of casings and to examine the approaches to improve the plan.

Scope

The primary motivation behind an accident investigation is to perceive how the vehicle will act in front facing or sideways impacts. Vehicle body light weighting and crashworthiness are two significant angles which are thought of while planning any vehicle. The undercarriage outline shapes the foundation of vehicle. Its principle work is to convey most extreme burden for all planned Operating condition. This is the piece of planning Cycle which can lessen the requirement for exorbitant ruinous program. This technique has an incredible breadth in all auto industry as it lessens the expense of genuine accident testing of the vehicles. Because of investment of different organizations the clients have an assortment of vehicles to pick. Henceforth, every one of the organizations are receiving this technique for reproduction to limit the load just as to make the vehicle safe.

Benefits

An accident recreation produces results without genuine ruinous testing of another vehicle model. Along these lines, tests can be performed rapidly and modestly in a PC, which licenses streamlining of the plan before a genuine model of the vehicle ha been produced. Utilizing a recreation, issues can be settled prior to investing energy and cash on a genuine accident test. The incredible adaptability of printed yield and graphical presentation empowers originators to tackle issues and would have been almost outlandish without the assistance of the PC.

LITERATURE REVIEW

The Evolution of Car Safety Features

Travelling by the car is now easier and safer than ever. From the very first automobile to self-driving cars, technology has evolved which has made crashing far less likely.

From **1900-2000s**

• 1911- Rear view mirrors were used for the first time in the opening Indianapolis 500 race by Ray Harroun, who attached it to his Marmon Wasp.
• 1914-Florence Lawrence invented the earliest turning indicators. This was Originally called an “Auto-Signalling Arm” on the back of the fender which could be raised or lowered by electrical push buttons.
• 1921-Benjamin Katz invented the headrest to reduce the harm caused by Whiplash in rear- end accidents. Hydraulic Brakes were also used in road cars for the first time by Frederick Duesenberg.
• 1927- Laminated glass or safety glass was used in windshields to prevent them from shattering on impact.
• 1934- General Motors performed the first ever Crash test.
• 1947-The Tucker Sedan was the first car with padded dashboard which aimed to reduce face and chest damage when hit from-on.

Fig. The Tucker Sedan Car with Padded Dashboard

• 1949- The first ever crash test dummy was created by Samuel W. Alderson, called Sierra Sam, which was used for aviation. Alderson then created a crash test dummy for motor vehicles in the early 50s.
• 1951-Walter Linderer created the airbag, which could be released by the driver or by contact to the car bumper.
• 1952-Mercedies Benz engineer Bela Barenyi invented the crumple zone concept, designed to absorb the force of impact in the crash.
• 1953-Jaguar and Dunlop make a breakthrough with more reliable caliper- Type disc Brakes, helping the small company to win the 1953 24 hour Le Mans.

Fig. Volvos Three-Point Seatbelt

• 1959-Volvo introduce Nils Bohlin’s three-point seatbelt, strapping over the lap and shoulder for the first time to provide extra protection. It remains one of the most effective car safety features ever created.
• 1966-Cars built in Europe must now have a front seat belt fitted. Padded Dashboard become mandatory, as well as front and rear lap belts and white reserve lights. The Jensen FF became the first car to feature the anti-lock braking system that was previously used in aircrafts.
• 1968-The First Federal Motor Vehicle Safety Standards in the us make it Mandatory to have collapsible steering columns, side marker lights, and front seat shoulder belts in all vehicles. Volvo introduces front seat head restraints to protect the head and neck in rear collision.
• 1974-General Motors provide optional Airbags for the driver and passenger’s seats.

• 1978-Mercedes introduce the first electronic anti-lock braking system in Mercedes-Benz S-Class.
• 1987- Fitting of rear seatbelts become compulsory in the UK. Mercedes-Benz, Toyota, and BMW introduce traction control, designed to keep traction whilst accelerating.
• 1991-Volvo introduces its side impact protection system, designed to spread the force of impact over the entire side of the car rather than one section.
• 1993-The Australian New Car Assessment Program runs crash tests and uses the results to provide the rating system that ranks the passenger safety of vehicles in serious front and side collisions.

• 1994-Volvo introduces side impact air bags.

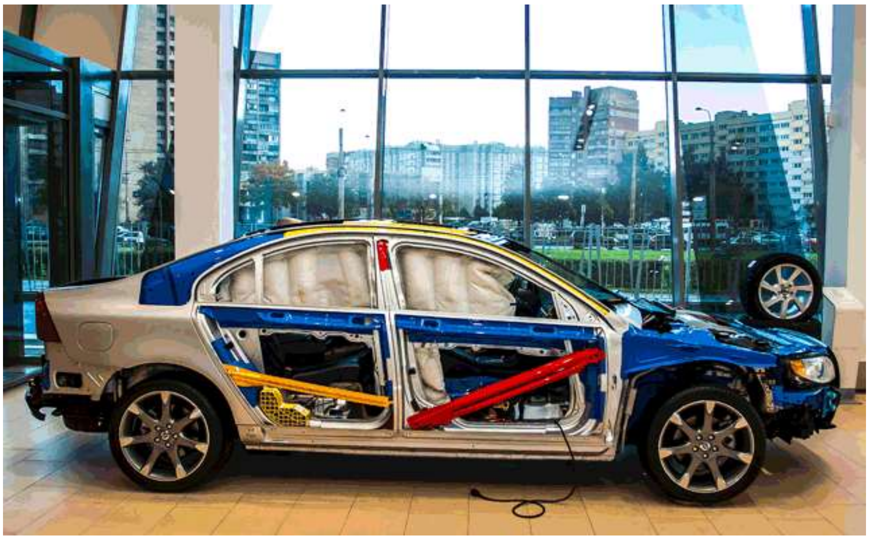

Fig. Mercedes-Benz Electronic Stability Control

• 1995-Mercedes-Benz and Bosh introduce electronic stability control (ESC), helping to improve vehicular stability.
• 1996-Mercedes-Benz introduce the Brake Assist System (BAS) and Kia's Sportage SUV has the first knee airbag.
• 2000-Iteris developed the Lane Departure Warning System for trucks in Europe, which used visual, audible, vibration warnings to alert the driver if they are leaving their lane.

First Crash Test at Mercedes-Benz

The First accident test throughout the entire existence of Mercedes-Benz occurred on tenth September 1959,when a test vehicle was sped up head-on towards a fixed snag. Wellbeing research at the brand unexpectedly entered another period, for the present the conduct of vehicles and tenants in the auto collisions could be examined in the sensible conditions utilizing test vehicles and life sized models. In the many years that followed, Mercedes-Benz Continued to set new norms in a line of examination that applied all through the business and in this way accomplished enduring upgrades in vehicle.

In spite of the fact that in any case crash testing stayed on a moderately limited scale, from the 1960s onwards the method turned out to be progressively settled as a solid instrument for streamlining and testing vehicle wellbeing. What's more, at Mercedes-Benz through crash testing was applied not exclusively to traveller vehicles, yet additionally vans, business vehicles and even mentors.

Fig. First Crash Test at Mercedes-Benz

TYPES OF CRASH TEST, DEFINITIONS AND METHODOLOGY

Types Of Crash Tests

In order to assure safety for different modes of transports or its related components and system, proper design standards are maintained and destructive tests are performed to check for crashworthiness. This procedure of testing the automobiles and their component by destructive method is known as crash test. Proper design standards are maintained and the destructive tests are performed to check for crashworthiness. This procedure of testing the automobiles and their component by destructive method is known as crash test.

The types of tests are as follows

Frontal Crash Tests-

This is the most widely recognized sort of crash test. In this technique Vehicles are made to hit strong divider, typically comprised of cement, at various paces. This sort of Crash Test can likewise be done between two vehicles impacting one another. In the test a vehicle goes at 64 kmph towards an obstruction with a deformable face made of aluminium honeycomb. The boundary face is a little more than 2 feet tall. A Hybrid sham addressing a normal size man is situated steering the ship. A little less than half of the all out width of the vehicle strikes the obstruction on the driver side. The powers in the test are like those that would result from a front facing counterbalance crash between two vehicles of a similar weight, each going just shy of 40mph.

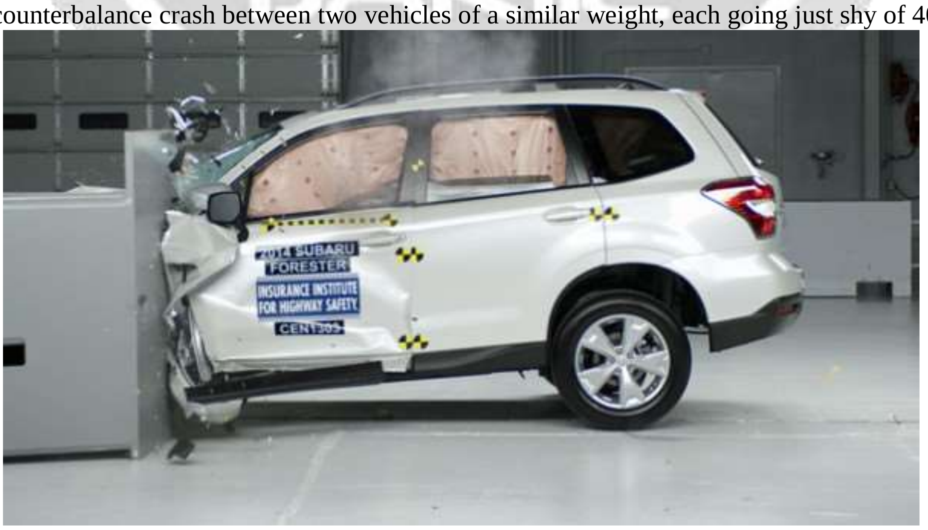

Fig. Frontal Crash Test

Side Crash Test-

Side impact crash tests consist of a stationary test vehicle struck on the driver's side by a crash cart fitted with an IIHS deformable barrier element. The 1,500 kg moving deformable barrier (MDB) has an impact velocity of 50 km/h (31.1 mi/h) and strikes the vehicle on the driver's side at a 90-degree angle. The longitudinal impact point of the barrier on the side of the test vehicle is dependent on the vehicle's wheelbase. The impact reference distance (IRD) is defined as the distance rearward from the test vehicle's front axle to the closest edge of the deformable barrier when it first contacts the vehicle. Evaluation testing of the impact configuration has been previously reported .

The MDB alignment calculation was configured to maximize loading to the occupant compartment and allow alignment of the driver dummy head with the flat portion of the barrier face. For most vehicles the MDB alignment also aligns the rear dummy head with some portion of the barrier. If the alignment calculation allows the flat portion of the MDB face to overlap either the front or rear tires, the impact alignment may be modified to prevent direct loading to these structures early in the crash. To date only one such vehicle has been tested by IIHS, the smart for two (186 cm wheelbase). Currently there is no set alignment rule for vehicles that fall into this category, therefore impact alignment will be determined on a case-by-case basis. Manufacturers may contact IIHS for impact point determination and/or confirmation of impact point during the vehicle development process.

IRD calculation:

- ✓ If wheelbase < 250 cm, then IRD = 61 cm
- ✓ If 250 cm ≤ wheelbase ≤ 290 cm, then IRD = (wheelbase ÷ 2)– 64 cm
- ✓ If wheelbase > 290 cm, then IRD = 81 cm

The MDB is accelerated by the propulsion system until it reaches the test speed (50 km/h) and then is released from the propulsion system 25 cm before the point of impact with the test vehicle. The impact point tolerance is ± 2.5 cm of the target in the horizontal and vertical axes. The impact speed tolerance is 50 ± 1 km/h. The MDB braking system, which applies the test cart's service brakes on all four wheels, is activated 1.0 seconds after it is released from the propulsion system. The brakes on the test vehicle are not activated during the crash test.

Fig.Side Crash Test

The MDB consists of an IIHS deformable aluminium barrier and the cart to which it is attached. The crash cart is similar to the one used in Federal Motor Vehicle Safety Standard (FMVSS) 214 side impact testing but has several modifications .The wheels on the cart are aligned with the longitudinal axis of the cart (0 degrees) to allow for perpendicular impact.

Roof Strength Test-

Electronic Stability control is essentially lessening rollovers, particularly deadly single vehicle ones. At the point when vehicles do move, side drapery airbags help ensure individuals inside, and belt use is fundamental. Not-withstanding, for these wellbeing advancements to be best, the rooftop should have the option to keep up the tenant endurance space when it hits the ground during a rollover. More grounded rooftop squash less, lessening the danger that individuals will be harmed by contact with the actual rooftop. More grounded rooftop can likewise forestall tenants, particularly the individuals who aren't utilizing seat straps, from being launched out through windows, windshields or entryways that have broken or opened in light of the fact that the rooftop has twisted.

In the test, the strength of the rooftop is controlled by pushing a calculated metal plate down on one side of the rooftop at a lethargic yet steady speed and estimating the power needed to smash the rooftop. The power applied comparative with the vehicle's weight is known as the solidarity to-weight proportion. The pinnacle solidarity to-weight proportion recorded whenever before the rooftop is squashed 5 inches is the critical estimation of rooftop strength. A decent appraising requires a solidarity to-weight proportion of in any event 4. All in all, the rooftop should withstand a power of in any event multiple times the vehicle's weight before the plate squashes the rooftop by 5 inches. For a worthy rating, the base expected solidarity to-weight proportion is 3.25. For a minor rating, it is 2.5. Anything lower than that is poor. Pinnacle power for Vehicle An is 7.26. Since that number is higher than 4, the vehicle is appraised acceptable. Pinnacle power for Vehicle B is 2.31. Since that number is lower than 2.5, the vehicle is appraised poor.

Fig.Roof Strength Test

In each test, the rooftop is squashed 5 inches. The power utilized by the machine to accomplish that level of squash. To exhibit how rooftop strength can change and what those distinctions mean for individuals inside a vehicle during a rollover, IIHS directed a show in which two vehicles with various rooftop strength appraisals were exposed to indistinguishable power. This video shows what happened when the 2009 Volkswagen Tiguan, appraised useful for rooftop strength, and the 2008 Kia Sportage, evaluated poor, were each exposed to a pulverize power of 15,000 pounds.

Methodology

Crash-testing requires some of the test vehicle to be obliterated over the span of the tests and is likewise tedious and uneconomical. One new late pattern that is acquiring immense notoriety is PC mimicked crash-testing. Here rather than a genuine vehicle, a FE (Finite Element) model of the vehicle is produced and is utilized to do the various tests that were completed prior to utilizing real vehicles. There are a few programming bundles that are prepared to deal with the accident testing of vehicles, however perhaps the most well known is ANSYS. We are utilizing ANSYS programming for the accident re-enactment. A static just as unique investigation is finished utilizing the product. A frame is planned and is tried by recreation and the outcomes are utilized to advance the vehicle in body plan and security. The examination of the vehicle is determined at a speed of 40 km/h. The genuine speed of the vehicle can shift with the planned speed.

Methods Accident Data

For the mishap examinations, information from the German inside and out mishap study (GIDAS) was assessed with an attention on MAIS 2+ harmed belted first line vehicle occupants1 in front facing sway mishaps. To guarantee that lone UN-R 94 consistent vehicles were incorporated, just vehicles with a date of first enrolment in 2003 or later were thought of. Moreover just totally coded and reproduced mishaps up to 2013 were remembered for the investigation to ensure that EES as well as delta-v was accessible. The GIDAS testing strategy is unequivocally clarified. The last informational index comprised of 98 cases including 112 front seat inhabitants with MAIS 2+ wounds. The mishap seriousness was assessed utilizing the reproduced delta-v and EES esteems. The misshaping of the vehicle was grouped utilizing the cover and the CDC arrangement. The cover is in rate and note that the cover is coded autonomously from the contribution of the vehicle corners (e.g., a focus shaft sway with a post having a breadth of 20% of the vehicle width is coded as 20% cover). That differentiation was important to isolate between mishaps with a little cover at the edge of the vehicle and shaft impacts. For the examination it was assessed which sort of front facing sway test methodology would cover best the mishap situation. Here the four prospects shaft, little cover, half cover and full front facing were thought of. The mishap situations were recognized by isolating between balance crash (30 % to 50 %) and enormous cover crash (80% to 100%), see likewise Figure 2. All cases were physically checked concerning the deformity grouping with the assistance of the mishaps pictures.

The collision opponents were classified, on the one hand, as vehicles and, on the other hand, as fixed structures (e.g. road side barriers, walls), poles (trees, traffic lights, street lamps) and others. The injury severity was coded for the whole person by the official police classification (not injured, slightly injured, severe injured

Vehicle acronym	DS	VU	SI	VT	VX
Test mass	1164 kg	1050 kg	1181 kg	1900kg	2400kg
ODB	Euro NCAP	Euro NCAP	Euro NCAP	Euro NCAP	Euro NCAP
FWRB	BASt	BASt	BASt	N.A	N.A
MPDB	BASt	BASt	BASt	FIMCAR	FIMCAR
Description	Compact car, four doors, Cheap	Super mini, two doors, new vehicle design	Compact Car, two doors, popular	Midsize SUV	SUV

(hospitalization for more than 24 hours) and fatally injured (fatality as a direct result of the accident within 30 days after the accident). All injuries were separately analysed using the AIS 2005 classification. The vehicle mass was described with the estimated crash weight of the specific vehicle at the time of the first impact.

Methods Crash Test Data

Crash test data from different vehicle models were obtained in the test configurations: offset test according to the Euro NCAP test protocol (ODB), Full Width Rigid Barrier test (100% overlap, FWRB), and against a Mobile barrier with the Progressive Deformable Barrier attached (MPDB). To evaluate the injury risks Hybrid III 50% dummies on the driver seat were used. Table is showing the vehicles used, including the acronyms, the test masses and the data source the test is obtained from.

MODELING AND DESIGN OF CAR

Mathematical Modelling (Theoretical)

We can distinguish two types of mathematical modelling of real world systems

1. Mathematical approach – dynamics of a phenomenon or system is derived from the fundamental law of physics (e.g. Newton's Laws or conservation principle).
2. System identification – experimental approach.

After examination of the system by performing on it experiments, model parameters are selected in such a way, that model's behaviour fits to the experimental data.

In this paper both methods are presented. For the analytical approach it is desirable to precisely describe the dynamics of a crash test. Due to the fact that such an event is extremely complicated from the mathematical point of view, its model is simplified. On the other hand, models derived from the identification approach do not explain the physical nature of a system – in many cases their parameters do not have any physical interpretation (they are just needed to achieve the satisfactory conformity of a model with the experimental data). Brief characteristics of three different regressive models according to Mendrok are shown below, to illustrate both of above two methods: (1) estimate the parameters of the physical Kelvin model and (2) create a parametric model which has no physical interpretation.

COMPUTATIONAL ANALYSIS OF CAR CRASH AND THEIR RESULTS

Analysis Of Car Crash

The design of the car frame was generated in the 3D modelling software CATIA V5, where the car was created as a life size model to accurately examine the effects of a car crash. The dimensions of the car were random. As mentioned before, only the frame of the explorer was generated in order to analyse how the frame structure deforms during the impact of a crash.

The geometry was exported as an IGS file from CATIA V5 and then imported into ANSYS for mesh generation and FEM analysis. Upon importing the geometry, the material was set to aluminium alloy for the car body. The mass of car is approximately 2458kg based on research. When the CATIA V5 model was transferred into ANSYS, the mass was measured to be 2327.84kg, which is accurate to the real life model. A tetrahedral mesh was generated on the car. At points of finer detail, there are more nodes and elements are smaller because the geometry is more complex and thus better approximations must be made. ANSYS gives a technology inclusive of geometry managing, meshing and submit-processing. These improvements by myself constitute a primary step in advance in course.

A. Geometry Creation

In the present work, since the main objective was to simulate the car crash to know the material behaviour at different velocities and at different intervals of time, wheels were neglected, so that the simulation becomes simple. Scaled down model of available car was chosen for analysis. The initial distance between the car model and the wall was made to be 3000 mm.

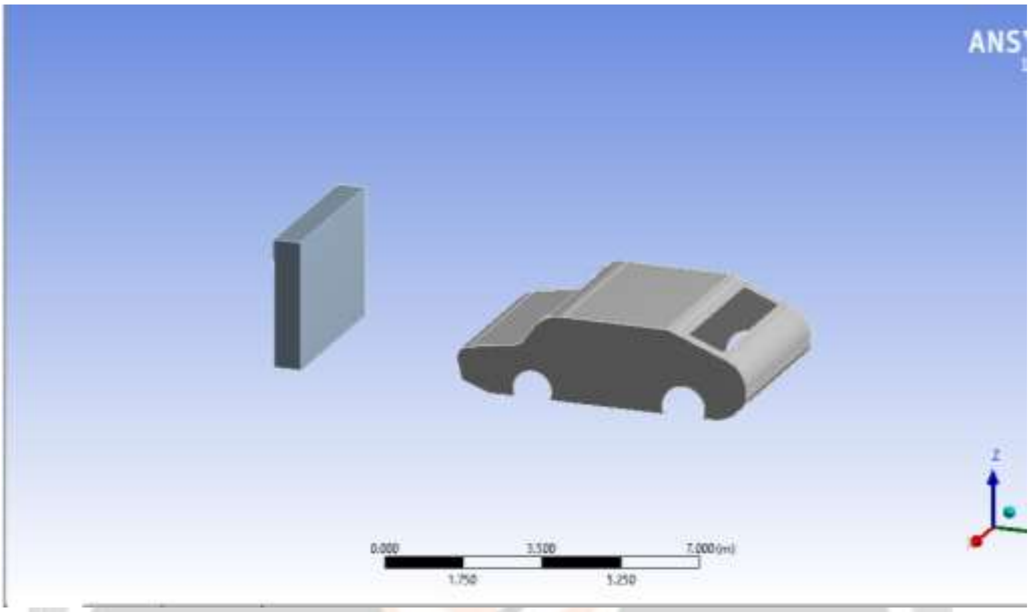

Fig. Car model with wall in Ansys

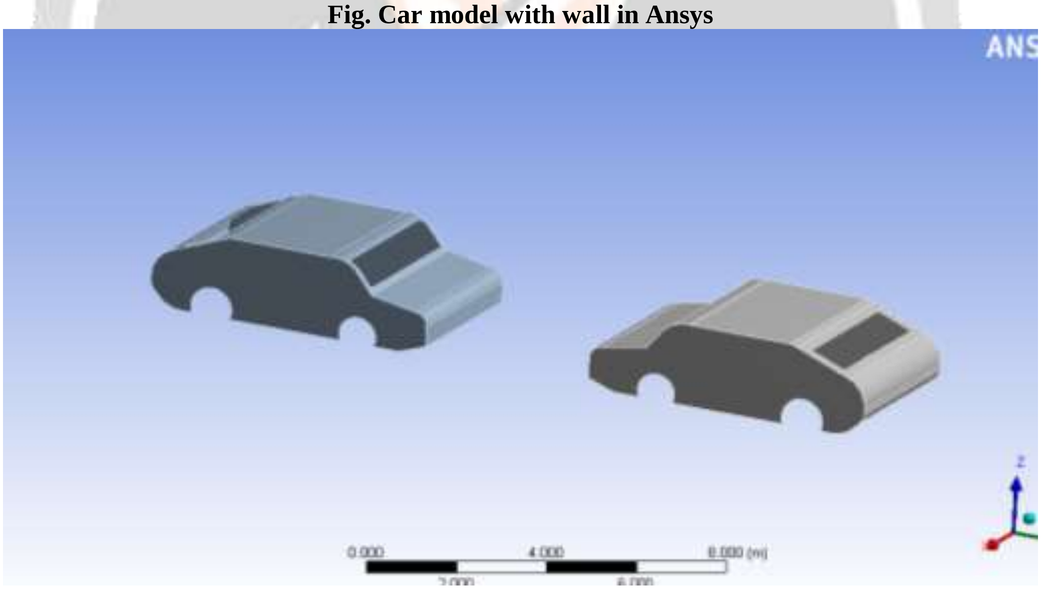

Fig.6.2. Car model with Car to Car in Ansys

B. Element Type

The element type used is SOLID 186. SOLID 186 is a higher order 3-D with 20-node having three degrees of freedom per node, solid element that exhibits quadratic displacement behaviour. This element supports large deflection, plasticity, large strain capabilities, hyper elasticity, stress stiffening, and creep.

C. Meshing

Meshing process was carried out in ANSYS Workbench. Meshing is applied by using automatic mesh. Under mesh sizing, mesh was set to fine mesh to achieve accurate and precise results. Rather than using a fine mesh all over the components, coarse mesh was used on large area and fine mesh was used at the area of stress concentration. A fine mesh was placed on the front of the car to accurately depict the event of a crash, where a wall would hit the whole front of the car rather than at different points on the fender, which is what a coarse mesh would provide. This of course is assuming that the car hits the wall directly head on at a perpendicular angle to the face of the wall.

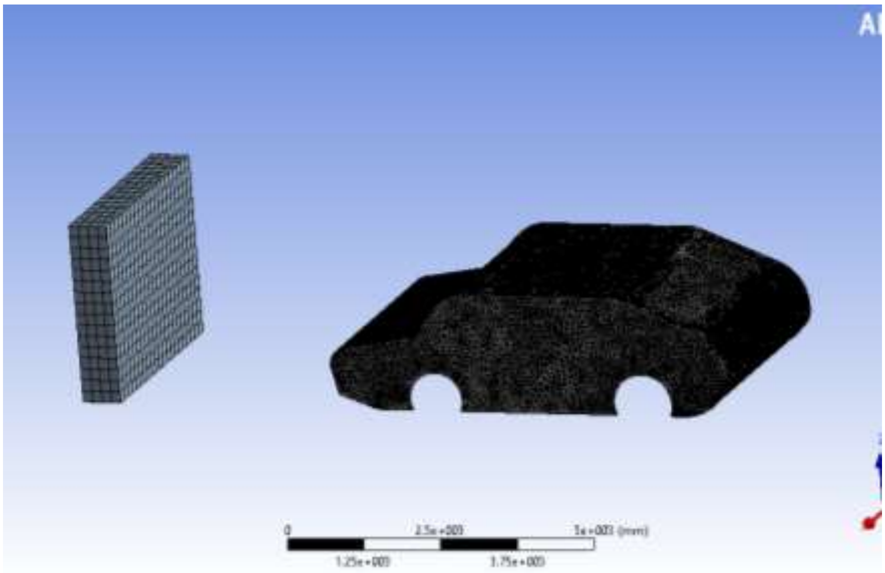

Fig.6.3. Applying Meshing to Wall

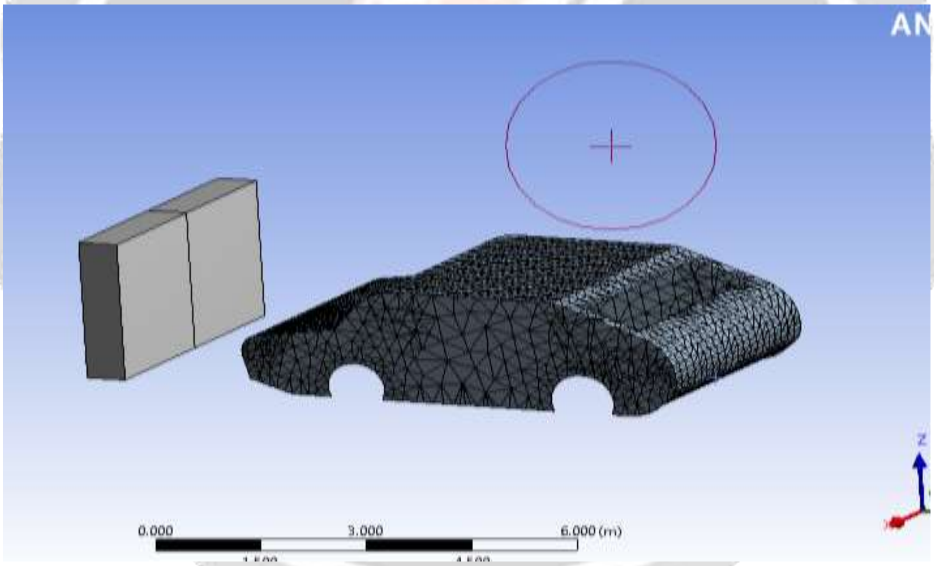

Fig.6.4. Applying Meshing to Car

After creating the car model, another car model is placed exactly opposite to the first car structure at a distance of 3000 mm. After assigning the element type of the car structure, the solid model is converted into the IGES format and imported into ANSYS Workbench. Meshing is an important process of an analysis and it should be performed on the car structure. Meshing is the process of dividing the created model in number of divisions or elements which consists of nodes. By applying meshing process, we can determine the efficiency and effectiveness of any analysis.

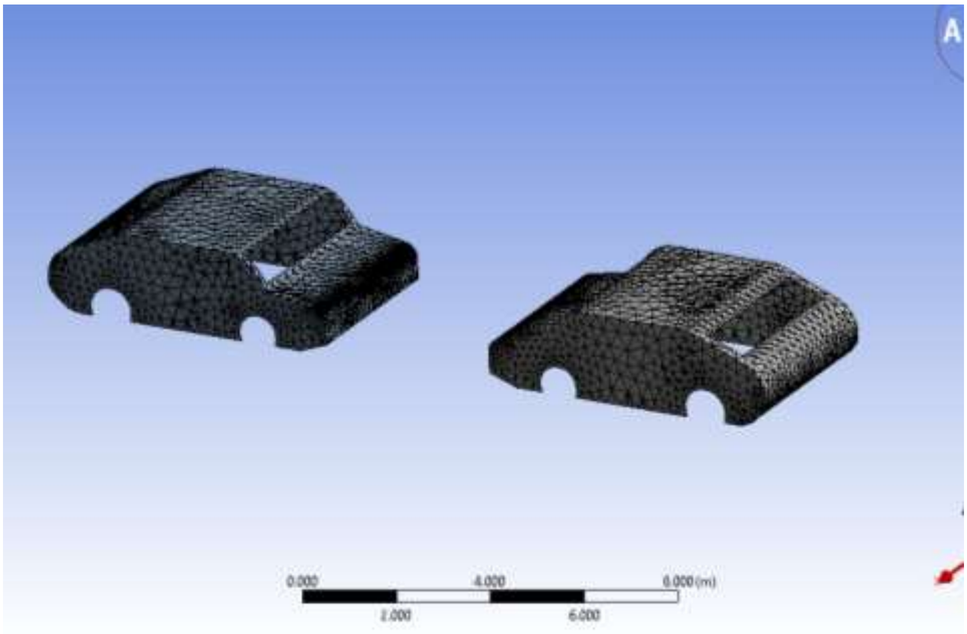

Fig.Applying Meshing for Car to Car

Conclusions

A car structure is modelled in Catia V5 a crash analysis of one car to another car with the initial velocity of 1000 m/s and car to wall with the initial velocity of 1500 m/s is performed in ANSYS software. The total deformation of the car structure is analysed. From the results, it is observed that the maximum deformations in car structures crashing a car and wall are within the limits. Therefore, the modelled car structure is safe for the passengers to travel in view of car accidents. The overall objective of the work was to simulate a Frontal crash-test and validate the results of the simulations obtained from the crash-test. Simulation was performed using the ANSYS software package.

1. The results of the simulations were validated by comparing with the results of the NCAC model simulation.
2. As was observed, the bumper, engine and the rails absorb most of the energy before the wheel impacts the wall. Almost half of the energy of the crash is absorbed by these components after about 0.04sec of the crash initiation.
3. It has been observed that there is minimum deformation of the cabin and also there was minimum intrusion of the components into the cabin. Therefore, it can be assumed that the occupants in the cabin would not be caused any injury by a component intruding into the cabin in the event of the crash.
4. Due to the limited availability of computer resources, a simpler model of the test vehicle was chosen, which ultimately caused the inaccuracies of the results. As the number of elements of the test models is lower than that of the NCAC model, therefore, there are certain inaccuracies in the results.
5. For more accurate results a more accurate model would be required but the computer resources required for the simulations would have been much higher. Therefore a compromise had to be found wherein the simulation could be performed without the result deviating too much.
6. The graphical results obtained all showed that the test models behaviour were similar to that of the NCAC model throughout the crash event.

Future Scope

The FE model can be used for further simulation of in the simulations of the offset frontal impact test, where one side of the front of the vehicle is impacted against a barrier or another vehicle. Other tests include the side impact test, where a vehicle is impacted from the side by and oncoming vehicle and oblique car-to-car impacts the two or more vehicle take part in a collision. Rollover simulation can also be carried out wherein the vehicle rolls on its sides due to the cause of an impact or other factors. The different car body structures can be modelled and different car body materials can be taken by assigning different velocities for crash analysis.

Further crash-testing involving the effects of the crash forces on the occupants of the vehicle can also be carried by using FE models of test dummies. Human-surrogate dummies called Anthropomorphic Test Devices (ATDs) could be placed inside the FE vehicle models and an entire crash test event could be simulated. The FE dummies are used to simulate the behaviour of a vehicle occupant in the event of a crash. These FE dummies can then be placed inside the vehicle and the crash-simulation performed, they can provide various insights into the dynamic behaviour of the human body in the event of a crash. This, however, requires detailed occupant compartment geometry as well as a detailed dummy model. This could easily double the FE models complexity and greatly increase the needed computer resources.

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