International Journal of Applied Research 2015; 1(12): 809-813

International Journal of Applied Research

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2015; 1(12): 809-813
www.allresearchjournal.com
Received: 10-09-2015
Accepted: 12-10-2015

J Rajesh
M.Tech Student,
Department of Mechanical
Engineering Chirala
Engineering College, Chirala

Metla Suresh
Assistant Professor
Department of Mechanical
Engineering Chirala
Engineering College, Chirala

Correspondence
J Rajesh
M.Tech Student,
Department of Mechanical
Engineering Chirala,
Engineering College, Chirala

Vehicle Crash analysis of race car using LS-DYNA

J Rajesh, Metla Suresh

Abstract

Safety, for both occupants and pedestrians, has become a very crucial aspect for automobile manufacturers around the world, and none can deny it, when it comes to safety. But when it comes to ensure the driver's safety in case of high speed crashes, special impact structures are designed to absorb the race car's kinetic energy and limit the decelerations acting on the human body. This study covers the static analysis of an F1 race car chassis with three different materials at different velocities using Ansys. From the results of static analysis the best material is chosen out of three materials and the crash behaviour of the front nose cone of the F1 racing car has been done with frontal impact analysis. Finite element models for dynamic simulations with the explicit solver LS-DYNA are developed. The main objective of the work is to simulate the race car to find the stresses and deformation of front nose.

The aim of the following study is to apply the FE code LS-DYNA for the crushing simulation of an F1 racing car front impact structure against a rigid wall, side impact in a crash against another car and also for the roll over test.

Keywords: Crash Analysis, Static Analysis, race car, LS-DYNA

1. Introduction

1.1 Frontal Impact Test

The greatest was considered to be achievable through a new frontal impact test, more representative of the impact conditions of car-to-car frontal impact and car-to-rigid wall frontal impact. The accident studies indicated the importance of intrusion in the production of fatal and serious injuries and demonstrated the importance of replicating, in the dynamic test, the dynamics of structural deformations occurring in accidents. It quickly became apparent that an offset impact into a deformable barren greatly improved the replication of deformations in these accidents. A test program designed to enable the development of a test procedure that would achieve the objectives.

The test program selected car-to-car impacts between three different vehicle models as the baseline and compared car to barrier impacts against these baseline results. The initial deformable barrier face was based on the mobile deformable barrier face. Previous research had indicated that this was a reasonable representation of car-to-car impacts and that the principal effects were not too sensitive to the actual stiffness of the deformable element. Deformable barrier tests were performed at appreciable overlap, with both the initial barrier face design and an alternative design with a second stiffer element behind the element used in the initial design. Additional tests with a further revised barrier face design, incorporating a wide bumper element ahead of the element used in the initial design, and tests at appreciable speed were added following analysis of the results of the first phases of testing.

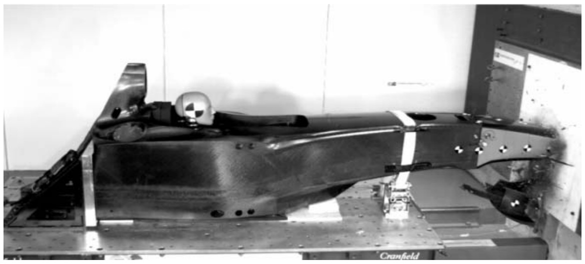


Fig 1: Frontal impact crash test setup

1.2 Side Impact Test

Based on the most harmful event, side impact accounts for 25 percent of fatalities for passenger car and light truck crashes. For passenger cars, side impact accounts for approximately 30 percent of the fatalities in passenger car crashes. Likewise, side impact accounts for roughly 15 percent of light truck fatalities. Since the use of dynamic Federal safety standards in side protection began, in recent years occupant protection in side impact crashes has received increasing interest. This interest comes from both the consumers and the automotive industry. In comparison with frontal collisions, the space between the occupants and the intruding element in side crashes is extremely small. In addition, the side impact crash occurs much more rapidly. Consequently, occupant protection in side crashes presents a challenge to engineers designing a vehicle for safety. Significant research work, both theoretical and experimental in nature, has been performed to characterize the safety performance of vehicles in side crashes. They found that these vehicles varied dramatically in their ability to protect the occupant in the struck car. They were able to identity a design parameter - the door effective padding thickness (DEPTH) -that strongly correlated with occupant thoracic injury potential.

Fig 2: Side impact on a crash with another vehicle

1.3 Roll over Impact Test

Rollover continues to be a serious highway threat. Rollover crashes involve the most complex vehicle and occupant motion among the four major crash modes: front, side, rear, and rollover. The forces involved prior to and during a rollover crash are complicated and dynamic. These crash forces are applied to the vehicle structure in a variety of locations, and at a variety of magnitudes and directions. Crash energy is removed more slowly in a rollover crash - and the crash motion occurs over a much longer period of time. A major difference between rollovers and planar crashes is that rollovers generally occur at higher speeds. The complexity of rollover events make the characterization of these accidents much more difficult than for planar crashes. For planar crashes, delta-V has been widely accepted as a measure of the crash severity. Techniques and computer analysis are available for estimating planar crash severity, based on energy dissipation from the observed vehicle damage or post-crash trajectory. There is no similar accepted estimate for rollovers accident severity. Past studies of rollover crashes suggest that the initial speed, number of quarter turns, extent of damage, and characteristics of the tripping mechanism are significant accident parameters which influence the severity of the occupant/vehicle interactions and the resulting outcome.

The rollover stability factor is one half the vehicle's track width divided by the vehicle's center of gravity height. The rollover stability factor is now required on the window sticker of new vehicles to provide consumer information on the relative risks of rollovers. This simple geometric static stability metric which does not consider the dynamics of the steering and suspension systems. The critical sliding velocity is a measure of the minimum lateral velocity required to initiate rollover, when the vehicle is in a tripping orientation. It is determined by equating the vehicle kinetic energy prior to a tripped impact to the potential energy required to raise the vehicle cg above a critical pivot point.

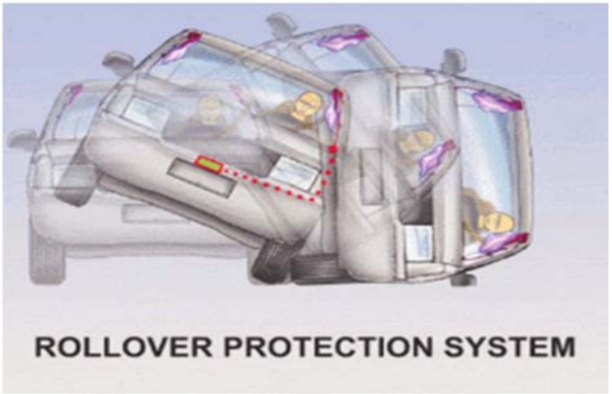


Fig 3: Roll over protection system

2. Modeling

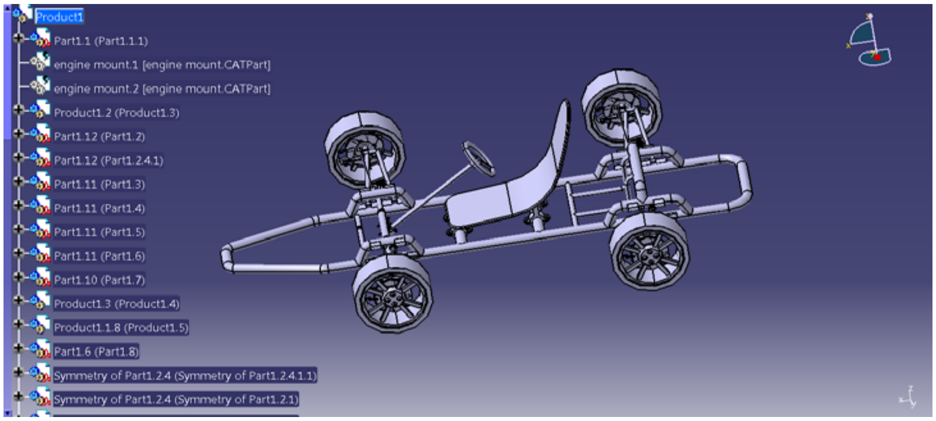


Fig 4: Assembly of race car chassis

3. Static Analysis

To do the crash analysis of race car, first the static analysis of chassis has been analyzed using different materials, after finding the best material among the three materials, from steel IS3074, aluminium 6061 and Carbon fibre reinforced plastic (CFRP). In this static analysis the deformation and stresses areobtained by applying the force on the chassis to calculate forces the following formula is used

$F= 0.5 * P * V^2 * A * Cd$

where F is force,
P is the density of air,
V is the velocity of race car,
A is the area of the front cone of race car,
Cd is the drag coefficient.

3.1 Steel

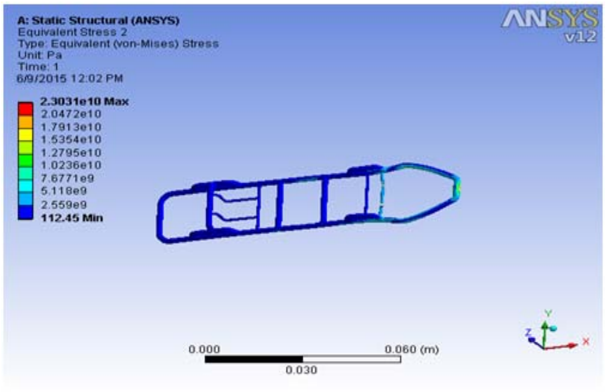


Fig 5: shows Von mises stress at14946N

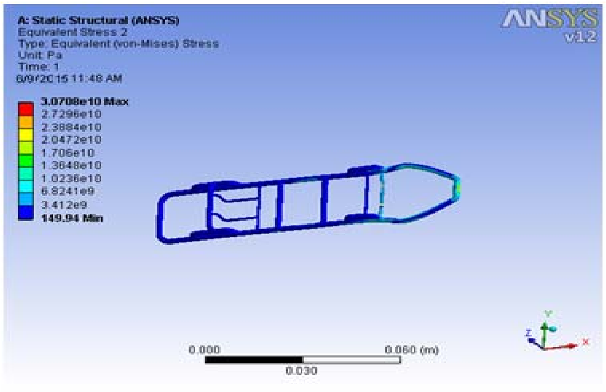


Fig 6: shows Von mises stress at 19928N

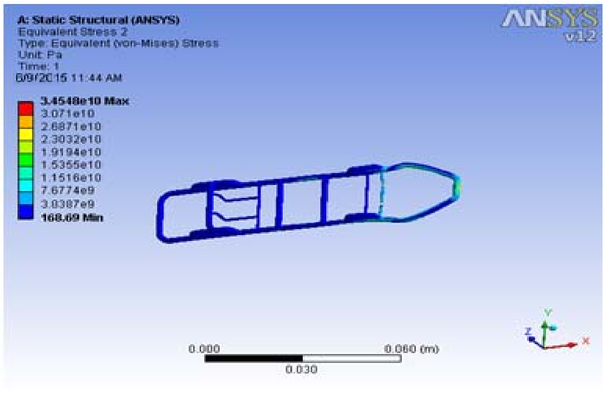


Fig 7: shows Von mises stress at 22420N

3.2 Aluminium 6061

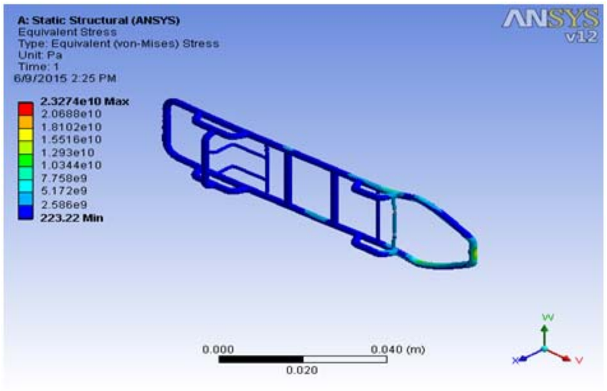


Fig 8: shows Von mises stressat 14946N

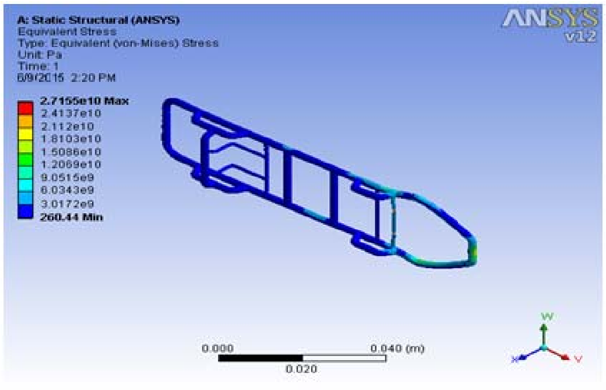


Fig 9: shows Von mises stress at 17438N

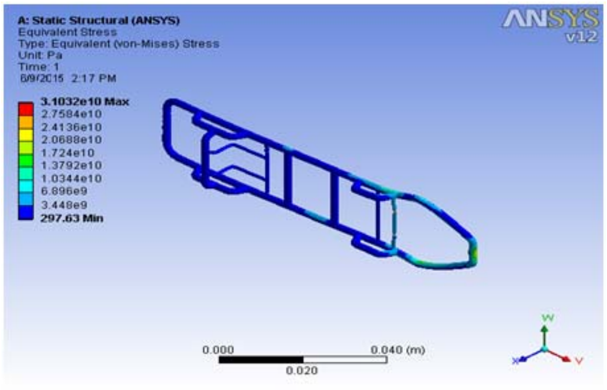


Fig 10:shows Von mises stress at 19928N

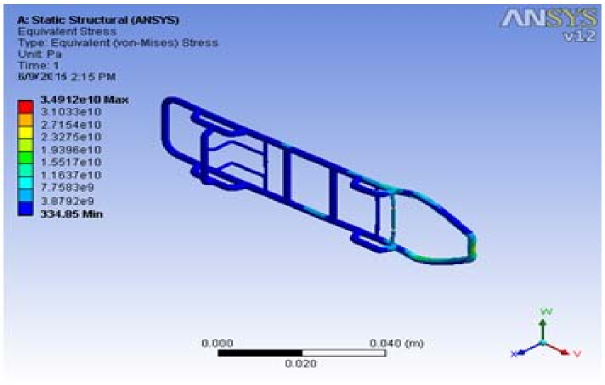


Fig 11: shows Von mises stress at 22420N

3.3 CFRP (Carbon Fibre Reinforced Plastic)

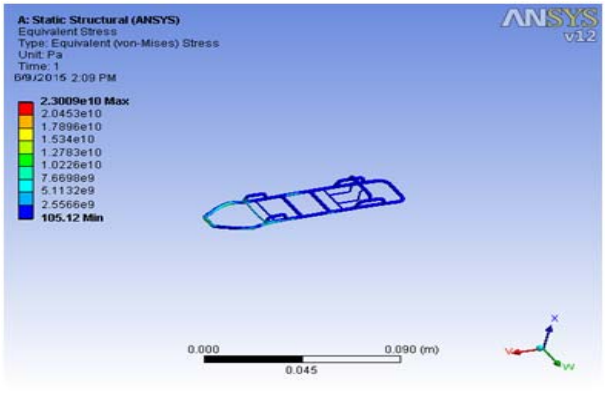


Fig 12: shows Von mises stress of chassis at 14946N

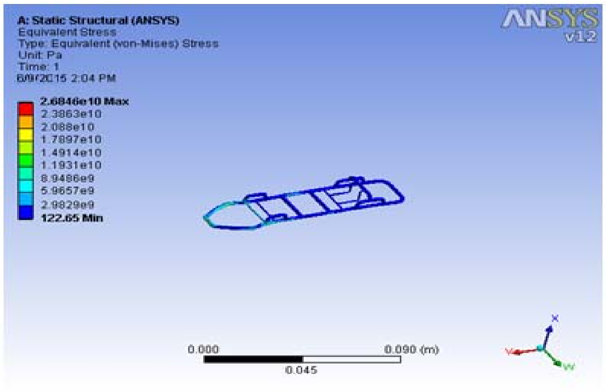


Fig 13: shows Von mises stress at 17438N

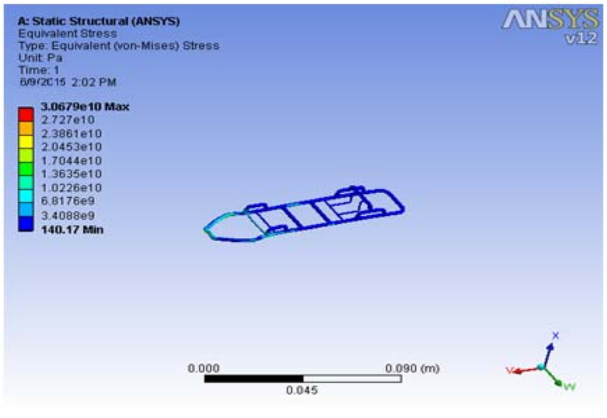


Fig 14: shows Von misses stress at 19928N

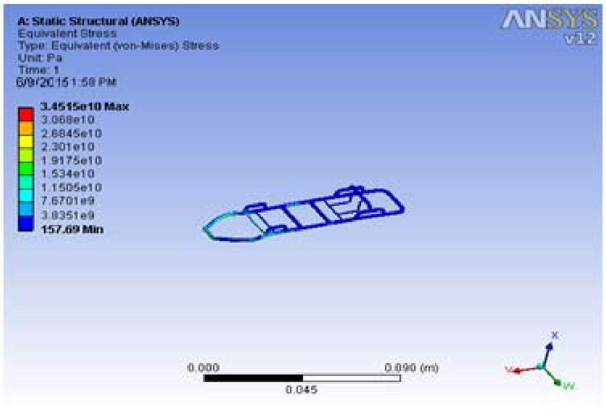


Fig 15: shows Von mises stress at 22420N

Table 1: Von Misses Stresses for Different Materials at Various Forces.

Materials	Forces (N)				
	14946N	17438N	19928N	22420N	24911N
Steel(Pa)	2.3031E10	2.6871E10	3.0708E10	3.4548E10	3.8387E10
Aluminium 6061(Pa)	2.3274E10	2.7155E10	3.1032E10	3.4912E10	3.8791E10
CFRP(Pa)	2.3009E10	2.6846E10	3.0679E10	3.4515E10	3.835E10

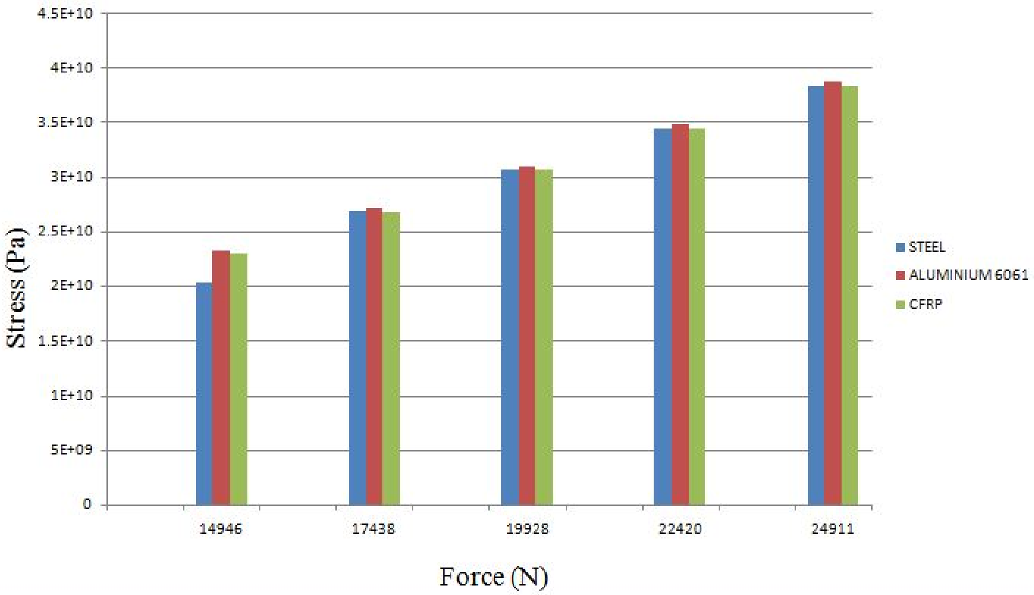
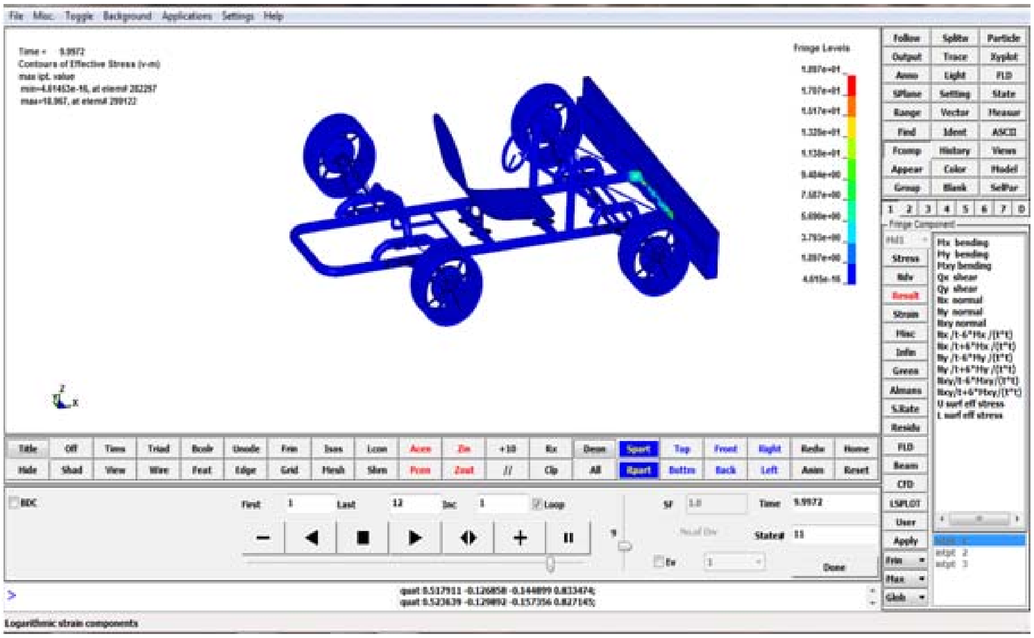


Fig 16: comparison of stresses for different materials at various forces



Time = 9.9972
Contours of Effective Stress (v-m)
max ipt. value
min=4.61463e-16, at elem# 282297
max=18.967, at elem# 299122

Fig 17: von mises stress of arash analysis

From the above figure when the car is hitting the barrier, the stresses are to be analyzed i.e. the

- Maximum stress is 18.967 N/mm^2 at element 299122
- Minimum stress is 4.615 e-16 N/mm^2 at element 282297.
- Generally von mises applies best to the ductile materials.
- Here the car is hitting the barrier with a speed of 60 mile per hour i.e. 96 kmph.

4. Conclusion

In this work two different types of analysis was done.

1. Static analysis
2. Frontal crash analysis

The conclusions obtained from above two analyses are given below

1. From the static analysis it is observed that the chassis material steel IS3074 is having good ability to with stand more force when compared to aluminium 6061(at 60-100kmph)
2. The finite element simulation of frontal crash analysis at 96kmph was done which shows the failure of front nose of race car, the stresses and deformations are analyzed.

In future the static analysis can be done for some other materials at different velocities, and crash test also can be done for side impact and roll over of race car at different velocities.

5. References

1. Eddington B, Gardner S, Heimbs S, Key J, Middendorf P, Strobl F. Crash Simulation of an F1 Racing Car Front Impact Structure, 7th European LS-DYNA Conference, 2009.
2. Obradovic J, Boria S, Belingardi G. Lightweight design and crash analysis of composite frontal impact energy absorbing structures, Italy: University of Camerino, 2011.
3. LS-DYNA, Keyword User’s Manual, Version 970, LSTC, 2003.
4. Sapuan S, Ham M, Ng KW, Woo KM, Ariffin CK, M.K. A, Baharudin BTHT, Faieza, AA, Supeni EE, Jalil NAA. Design of Composite Racing Car Body for Student Based Competition, Scientific Research and Essay. 2009; 4(11):1151-1162.
5. Siegler BP. The application of Finite Element Analysis to Composite Racing Car Chassis Design. Sports Engineering. 1999; 2(4):245-252.
6. Evin E, Tomas M. Comparison of Deformation Properties of Steel Sheets for Car Body Parts. Procedia Engineering, 2012; 48:115-122.