ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 6, December 2013

Finite Element Side Crash Test for First Saudi Car

Said Darwish, Ahmad Gemeal, Hussein Hussein

Abstract*—for the first Saudi car Gazal1, finite element analysis for side crash test was carried out according to ECE R95 regulations. The analysis fulfills target (max crash force 56kN versus a target of 40kN). Fixations of underbody with chassis longitudinal and cross members need to be more strengthened. Testing of car by several crash tests is essential for passenger safety.

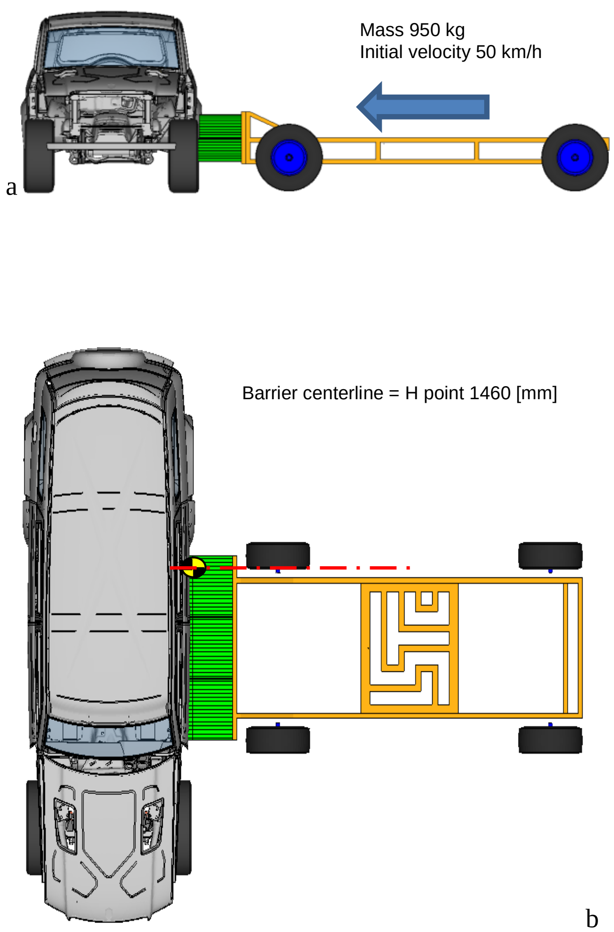
Index Terms—**ECE R95 regulations, Ls Dyna, Movable Deformable Barrier, side crash test.**

I. INTRODUCTION

After the 1st Saudi car was made in King Saud University, it was decided to perform series of finite element analysis tests upon it. One of these tests was side crash test due to its importance. It was noticed that resulting injuries from side crashes are always fainted and stay unconscious for the rest of their lives. Investigating that indicated that this is due to structure of human brain which consists of 2 halves tied together with nerves which are relatively weak from strength of material point of view. So, human body is more sensitive to side crash than front/rear crash. Structure of human brain is that which stimulated critical importance of side crash test. Another main source of difficulty in side crash is that it has very little space to dissipate crash energy compared with front and rear crashes. At beginning of side crash studies, the trend was to design passenger compartment such that it transfers crash energy to other side and deforms very little [1]. Concept of intrusion bars were introduced in doors to help in that. But, soon it was recognized that this is against the well-known rule: the more-deformation during crash, the safer are the passengers. Challenges that face crash specialists is to compromise among various criteria: dissipate crash energy in small space circumstance, transfer crash forces through compartment walls to protect passenger, decrease dynamic forces that reach human body specially, human brain. So, international standards [2] such as European standards ECE R95 regulations were developed [3]. According to which, this work was carried out on passenger car to check its side crash behavior Procedure. Crash tests are highly nonlinear and strain rate sensitive. So, they must be carried out using appropriate software for transient response e.g. LsDyna 971. Side impact test were performed according to ECE R95 regulations.

II. MODEL AND ANALYSIS

Work consists of Finite Element Analysis of side crash. This implies preprocessing of Gazal1 which is a very tedious and time consuming task. It is meshing of hundreds of parts that mainly compose the car and arranging data in data files that represent all those parts. The material stress-strain curve for various car materials has been approximated to 9 stress-strain curves at strain rates ranges from 300s^{-}to 0.3 s^{-1} for each material. Non-metallic materials were modeled in a similar way [4].Material of barrier is aluminum in the shape of honey comb. Numerical simulation of a Movable Deformable Barrier (ADM) [5]-[6] was carried out according to ECE R95 regulations and was moved to crash the car according regulations. Barrier mass 950 kg, initial velocity 50 km/h, positioned such that its centerline passes through hip point. Test setup is shown in Fig 1. Software used is LS-DYNA_971 and hardware composes of three servers: two of them are of type SUN Fire X2270 of the following specifications: N. 2 HPC Server Xeon Processor 5570 8core 16GB, Ram DDR3-1333 2 x 500GB SATA 7.2K rpm HDD And one server HP PROLIANT DL180 G6 SERVER of the following specifications:
N. 1 HPC Server Xeon Processor 5540 8core, Ram DDR3-1333 6 x 1TB SATA 7.2K rpm HDD



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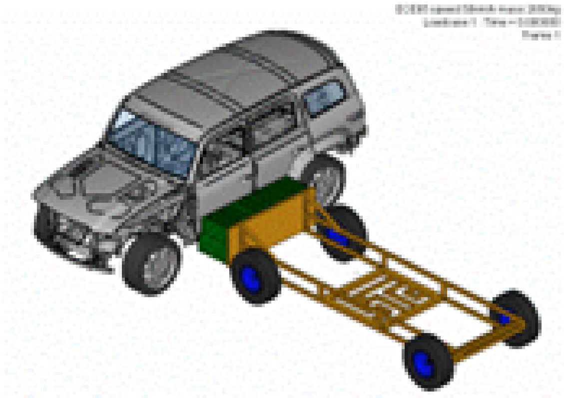

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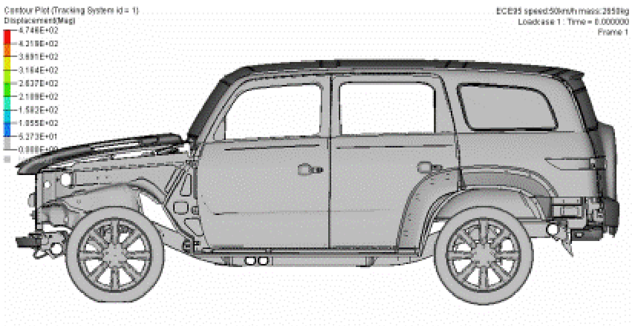
Fig 1 Analysis setup, *a)* front view for barrier, *b)* barrier centerline passes through hip point, *c)* isometric view

III. DISCUSSIONS

The analysis gave that maximum crash force is 56kN. This is in target because targeted value is 40kN according to regulations. So, the car is in target. Plastic deformation reaches a maximum of 474.6 mm with a distribution as shown in Fig 2.



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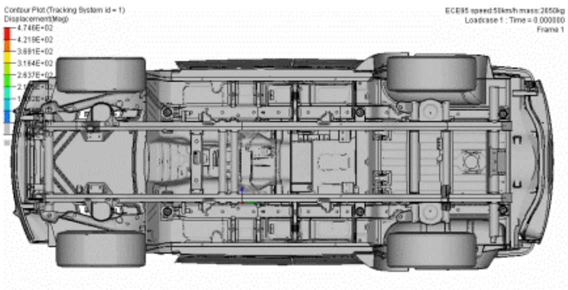

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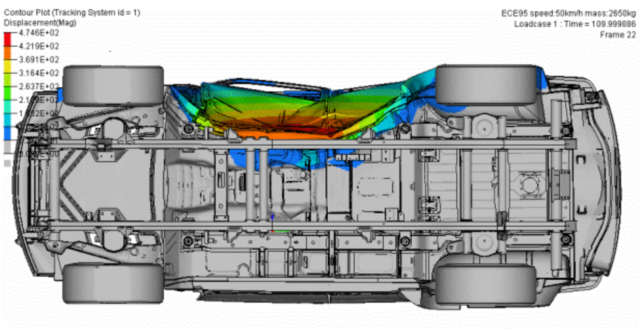

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Fig 2 Results of Side impact test, *a)*tracing displacement side view, *b)* bottom view, *middle left, c)* bottom view results for front, medium, right part of crash zone, exaggerated

IV. CONCLUSION

- Further improvements on material modeling may be needed.
- Further improvements on Movable Deformable Barrier (MDB) are also needed.

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AUTHOR'S PROFILE

Prof. Dr is Vice Dean of advanced Manufacturing Institute, King Saud University, P.O. Box 800, 11421, Riyadh, Saudia Arabia.

Dr. Ahmad M. B. Gemeal, Department of Industrial Engineering, Faculty of Engineering, King Saud University, P.O. Box 800, 11421, Riyadh, Saudia Arabia. Researcher in Central Metallurgical R&D Institute (CMRDI), Department of Metals technology, lab of plastic forming.P.O. Box Helwan 87, Cairo, Egypt.

H. M. A. Hussein obtained his BTech, MTech, and PhD from Helwan University, Cairo, Egypt. His research interests are in CAD/KB/ES applications in sheet metal, die and mould design, fixture design and planning, process planning for machined parts and sheet metal parts, and finally in bus skeleton design and welding fixture design. He has more than 25 publications, most of them in international conferences.Advanced Manufacturing Institute, King Saud University, Riyadh 11421, Saudi Arabia