INTRODUCTION

Car accidents are happening every day. Most drivers are convinced that they can avoid such troublesome situations. However the statistics shows that ten thousand dead and hundreds of thousands to million wounded each year. Hence, improvement in the safety of automobiles is prerequisite to decrease the numbers of accidents. Automotive bumper system is one of the key systems in passenger cars. Bumper systems are designed to prevent or reduce physical damage to the front or rear ends of passenger motor vehicles in collision condition. It protects hood, trunk, grill, fuel, exhaust and cooling system as well as safety related equipment such as parking lights, headlamps and taillights, etc. A good design of car bumper must provide safety for passengers and should have low weight. Different countries have different performance standards for bumpers. Under the International safety regulations originally developed as European standards and now adopted by most countries outside North America, a car's safety systems still function normally after a straight-on pendulum or moving-barrier impact of 4 km/h (2.5 mph) to the front and rear, and to the front and rear corners of 2.5 km/h (1.6 mph) at 45.5 cm (18 in) above the ground with the vehicle loaded or unloaded. In North America (FMSS: Federal Motor Vehicle Safety Standards) and Canada (CMVSS: Canadian Motor Vehicle Safety Standards), it should be meet 4KMPH pendulum and barrier impacts. The function of automotive bumpers has changed considerably over the past 70 years. The later performance is achieved by a combination of careful design, material selection to obtain a particular balance of stiffness, strength and energy absorption. Stiffness and Energy absorption are essential criterion. Stiffness is important because vehicle design consideration limits the packaging space for the bumper design to deform under load and Energy absorption is important because bumper must limit the amount of the impact force transmitted to the surrounding rails and vehicle frame. Automotive bumper plays a very important role in absorbing impact energy (original purpose of safety) and styling stand point/aesthetic purpose.

LITERATURE REVIEW

1. "Crashworthiness assessment of front side members in an auto-body considering the fabrication histories" H. Huh, K.P. Kim, S.H. Kim, J.H. Song, H.S. Kim, S.K. Hong, in this paper is concerned with crash analysis of a front side member in an auto-body considering the effect of fabrication. The front side member is fabricated with sheet metal forming processes that induce forming histories such as plastic work hardening and non-uniform thickness distribution. Numerical simulation is carried out with LS-DYNA3D in order to identify the forming effect on the crashworthiness. The analysis results demonstrate that the design of auto-body members should be carried out considering the forming history for accurate assessment of crashworthiness.

2. "Crashworthiness design of transient frame structures using topology optimization" Claus B.W. Pedersen aim of this paper is to present topology optimization as a method to obtain conceptual designs for crashworthiness. The topology optimization formulation uses rigorously computed sensitivities. The large displacements and plasticity of the 2D beam elements are modelled with the co-rotational formulation and the plastic zone formulation, respectively. In this paper examples are presented to show the results of combining topology optimization and crashworthiness optimization. This work presents a combination of crashworthiness optimization and topology optimization applied to conceptual design.

3. "Data analysis for parallel car-crash simulation results and model optimization" Liquan Mei*, C.A. Thole, this paper discusses automotive crash simulation in a stochastic context, whereby the uncertainties in numerical simulation results generated by parallel computing. Since crash is a non-repeatable phenomenon, qualification for crashworthiness based on a single test is not meaningful, and should be replaced by stochastic simulation. The paper has shown that data mining algorithms can be useful in describing the in deterministic behavior of parallel crash simulations and identifying the origin of the scatter of simulation results. This indeterminacy was either due to the parallel computer architectures or buckling and certain contact in some critical cases.

4. "Lightweight design of vehicle parameters under crashworthiness using conservative surrogates" Ping Zhu*, Feng Pan, Wei Chen, Felipe A.C. Viana, Lightweight design of vehicle structures parameters under crashworthiness is hard to accomplish because of the complexity of simulations required in crash analysis. To reduce the computation demand, surrogates (metamodels) are often used in place of the actual simulation models in design optimization to fit the mathematical relationship between design variables and responses. The authors examine the applicability of safety margins for surrogate-based optimization applied to lightweight design of vehicle structures under crashworthiness. The approach is based on biasing surrogate of the expensive constraints such that optimization ideally evolves in the feasible region of the design space. We propose a scheme for updating the safety margin according to the results of the optimization in each cycle.

PROBLEM DEFINITION

The design of the Bumper poses challenges while meeting the objective of energy absorption as well as manufacturability and aesthetics. The material of the bumper, thickness, its mating relationship with the...
Chassis needs to be addresses during its design phase. The regulations followed by the OEM’s across the globe also needs to be referred for ensuring compliance during Testing phase. The new model of the car (1600 cc) to be launched by the client of the Sponsoring Company awaits a suitable rear bumper to be taken up for Design and Finite Element Analysis further. The problem for evaluating its behavior and predicting its performance during impact shall be taken up in the scope for this dissertation work.

**Objectives:**
- To study existing passenger car front bumper in Indian market for possible design modifications
- Carry out design improvements in rear bumper of car
- Carry out impact analysis to study performance of modified bumper against existing rear bumper

These changes could be in the form of Material change, thickness change, geometry change or change in the boundary conditions.

**METHODOLOGY:**

**Finite Element Method**

Many problems in engineering are governed by differential or integral equations. The solution to these equations would provide an exact, closed-form solution to these equations to the particular problem being studied. However, complexities in geometry & in boundary conditions that are seen in most real world problems usually means that an exact solution cannot be obtained or obtained in real time. The FEM is one such approximate solution technique.

**Steps for finite element analysis:**
- Preprocessing
  - Creating the model.
  - Defining the element type
  - Defining material properties
  - Meshing
  - Applying loads
  - Applying boundary conditions
- Solution: Solving the pre-processed geometry using a suitable Solver
- Post processing: Review of results such as deformation plot, stress plot, etc

**Validation:**

Both physical (destructive testing), as well as computer based analysis is expedited by the company. Physical testing (alternatively, miniature or representative test specimen only) to be carried out to confirm FEA results and substantiate the computer model. This would be backed up by a Test Report from the Sponsoring Company.

**REFERENCES**


2. Crashworthiness design of transient frame structures using topology optimization Claus B.W. Pedersen Department of Mechanical Engineering, Solid Mechanics, Technical University of Denmark, Nils Koppels Alle, Building 404, DK-2800 Kgs, Lyngby, Denmark Received 17 December 2002; received in revised form 6 August 2003; accepted 5 November 2003.

3. Data analysis for parallel car-crash simulation results and model optimization, Liquan Mei, C.A. Thole College of Science, Xi’an Jiaotong University Xi’an, 710049, PR China b Fraunhofer Institute for Algorithms and Scientific Computing, Schloss Bilinghoven, 53754 St. Augustin, Germany Received 16 July 2005; accepted 28 November 2007 Available online 15 December 2007

4. “Lightweight design of vehicle parameters under crashworthiness using conservative surrogates” Ping Zhu, Feng Pan, Wei Chen, Felipe A.C. Vianaaa State Key Laboratory of Mechanical System and Vibration, Shanghai Jiao Tong University, Shanghai 200240, PR China b Shanghai Key Laboratory of Digital Autobody Engineering, School of Mechanical Engineering, Shanghai Jiao Tong University, PR China c Shanghai Hengstar Technology, Shanghai 201203, PR China d Department of Mechanical Engineering, Northwestern University, Evanston, IL 60208-3111, USDA Department of Mechanical and Aerospace Engineering, University of Florida, Gainesville, FL 32611-6250, USA.