DIFFERENT TYPE OF MATERIALS AND FOAM APPLICATION ON VEHICLE ROLLOVER ANALYSIS OF BUSES[1]

*Otobüs Devrilme Analizlerinde Değişik Özellikteki Malzeme ve Köpük Uygulaması **

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ÖZET

Devrilme kazası, araç içerisindeki yolcular ve mürettebatın güvenliğini tehdit eden en ciddi tehlikelerden bir tanesidir. Geçmiş yıllarda yapılan gözlemler, kaza sonrasında deforme olan araç gövdesinin yolcuların hayatını ciddi biçimde tehdit ettiğini göstermiş, böylece devrilme mukavemeti araç üreticileri için üzerinde dikkatle durulması gereken bir husus haline gelmiştir. Günümüzde bir Avrupa yönetmeliği olan "ECE-R66" sayesinde bu tür devrilme kazalarının yol açabileceği felakete varan sonuçlar engellenebilmekte ve araç yolcularının güvenliği temin edilmektedir. Bu çalışmada değişik özelliklerde malzeme uygulamasının devrilme analizi üzerindeki etkileri incelenmiştir

Anahtar Kelimeler : Devrilme, ECE-R66, Yaşam Alanı, LS-DYNA, Araç Güvenliği

ABSTRACT

A roll-over event is one of the most crucial hazards for the safety of passengers and the crew riding in a vehicle. In the past years it was observed after the accidents that the deforming body structure seriously threatens the lives of the passengers and the rollover strength has become an important issue for vehicle manufacturers. Today the European regulation "ECE R66" is in force to prevent catastrophic consequences of such roll-over accidents thereby ensuring the safety of vehicle passengers. In this study effects of different type of materials application on vehicle rollover analysis were investigated.

Key Words : Roll-over, ECE-R66, Residual Space, LS-DYNA, Vehicle Safety.

Introduction

The risk of fatal injuries is more in rollover than any other type of accident. Bus and coach manufacturers are focusing more on passenger safety in case of catastrophic rollover accidents. Thus rollover strength has become important issue for all bus manufacturers.

There are many tragic bus accidents. Although bus rollovers are not as common as other kinds of accidents, they are very serious. According to the worldwide rollover accident statistics from 1973 to present, there have been more than 570 bus rollover accidents. For this reason, the Economic Commission for Europe enforced Regulation No. 66 for the Bus Strength of Superstructure in 1987 (ECE R66) in order to provide protection to bus and coach occupants during

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rollover accidents through the provision of a survival space (JASIC, 2006). Nowadays, ECE R66 is almost a gold standard for all motor coaches. It allows bus manufacturers to assess crashworthiness in rollover events in real tests or by computer simulation. Thus, the design requirement must strictly satisfy ECE R66 while the vehicle's structural design has to carry the required load with minimum component weight without fail. The process of producing the best bus superstructure has been called structural optimisation.

Material and Method

Preperation of the Model: CATIA, which stands for Computer Aided Three-dimensional Interactive Application, is the most powerful and widely used CAD (computer aided design) software of its kind in the world. CATIA was created by Dassault Systems of France and is marketed worldwide by IBM. Non commercial vehicle was designed with CATIA.

Finite Element Modeling: Engineering analysis of mechanical systems have been addressed by deriving differential equations relating the variables of through basic physical principles such as equilibrium, conservation of energy, conservation of mass, the laws of thermodynamics, Maxwell's equations and Newton's laws of motion. However, once formulated, solving the resulting mathematical models is often impossible, especially when the resulting models are nonlinear partial differential equations. Only very simple problems of regular geometry such as a rectangular of a circle with the simplest boundary conditions were tractable. ANSA is an advanced multidisciplinary CAE pre-processing tool that provides all the necessary functionality for full-model build up, from CAD data to ready-to-run solver input file, in a single integrated environment. ANSA is the users' favorite due to its wide range of features and tools that meet their needs. The list of productive and versatile features is long and the alternative tasks and processes to be completed using them are countless.

Non Linear Structural Analysis: Nonlinear analysis of structures has become increasingly important in the study of structural response to hazardous loads. Such analyses should include the effects of significant material and geometric nonlinearities, various phenomenological models of structural components and the energy and momentum transfer to different parts of the structure when structural components fracture. LS-DYNA was developed by LSTC (Livermore Software Technology Cooperation). LS-DYNA is a multifunctional applicable explicit and implicit FE program to simulate and analyse highly nonlinear physical phenomena pertaining to real-world problems. Usually those phenomena are subjected to large deformations within a short time duration, e.g. crashworthiness simulations. The significant features of LS-DYNA are the fully automatic definitions of contact areas; the large library of constitutive models; the large library of element types; and the special implementation for the automobile industry.

Results and Discussion

Side walls of the vehicles has an important role for the rollover analysis results. In the first analyse ST-37 grade steel will be used on the side walls. Rollover analyse has been runned for Model-1 by using SMP (Shared Memory Parallel) version of LS-DYNA.

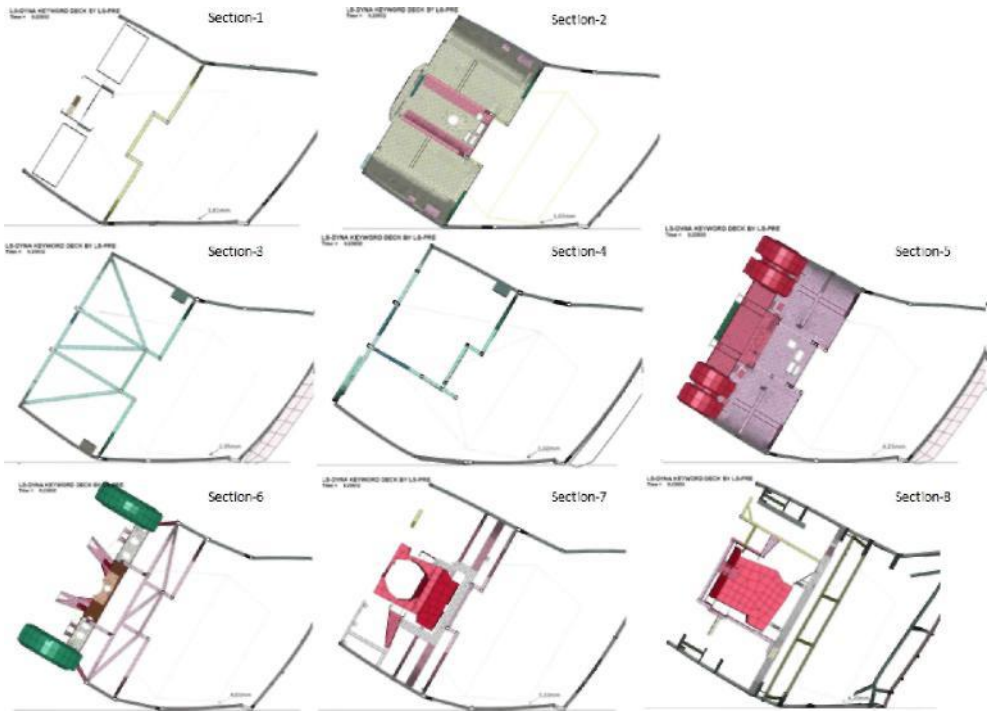

Figure 1. Analyse results by using St-37 grade steel on side walls.

In the second analyse ST-44 grade steel will be used on the side walls. Rollover analyse has been runned for Model-1 by using SMP (Shared Memory Parallel) version of LS-DYNA.

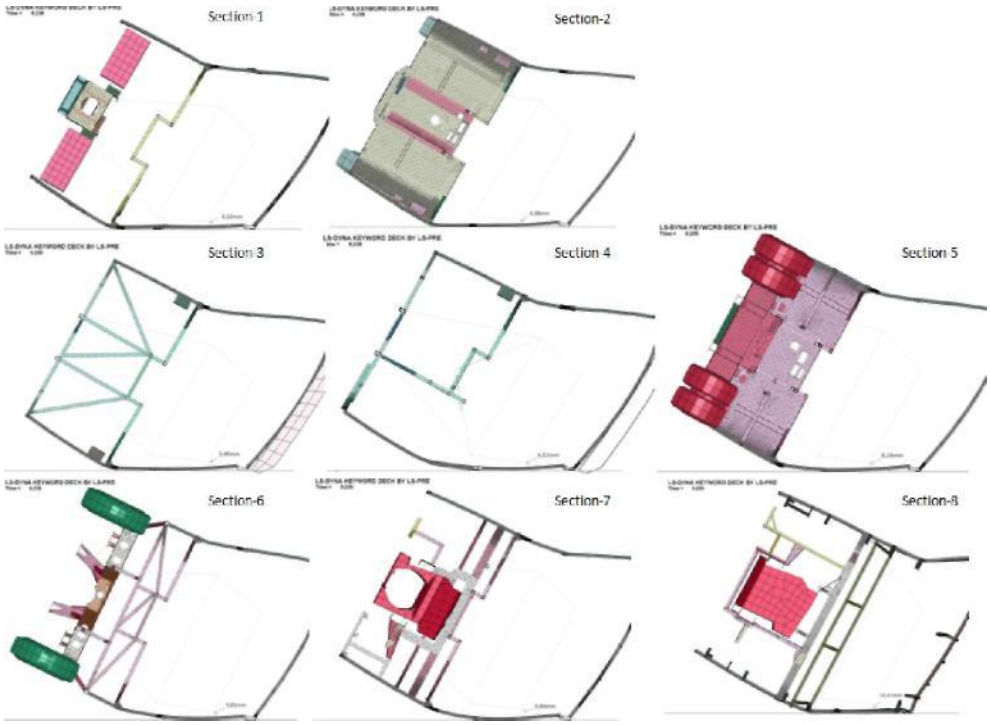

Figure 2. Analyse results by using St-44 grade steel on side walls.

Conclusions and Recommendations

For analysing the effects of using different materials on vehicle rollover analysis two analyse has been made with the Model. In the first analyse St-37 grade steel has been used on side walls of the non-commercial vehicle. And in the second analyse St-44 grade steel has been used on side walls of the same noncommercial vehicle. St-44 grade steel has better mechanical properties than St-37 grade steel which means St-44 grade steel is stronger then St-37 grade steel. This difference directly effects on the rollover analyse results as shown in Table 1. The vehicle which St-44 grade steel used on side walls is safer than the vehicle which St-37 grade steel used on side walls during rollover crashes.

Table 1. Comparison of analyse results.

Model-1	**Closest Distance Between Residual Space and Side Wall Profile**	
Section	**St-37 used on Side Walls**	**St-44 used on Side Walls**
1	1,81mm	4,52mm
2	1,65mm	4,38mm
3	2.95mm	5,45mm
4 5	3.02mm	6,12mm
	4,23mm	8,28mm
6	4,81mm	9,01mm
7	5,33mm	9,89mm
8	6,20mm	10,47mm

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