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SYSTEMS TO OPTIMIZE COMFORT AND DEVELOPMENTS OF CAR SEAT

Abstract:
Optimizing comfort of car seats is currently of great importance. Trend in the development and construction of seats shows that not only the safety of passengers, but also mainly on the comfortable cushion layer strong emphasis. Thus recent developments seats is based on systems and optimizing comfort. Mechanical properties of materials, from which car seat is made, therefore, play a major role in the overall assessment of comfort. Comfort layer of rules includes PU materials, fabric and wire. Mechanical properties of PU material, fabric shall be measured experimentally on test equipment. Obtained experimental data are the basis for virtual simulation in FEM. To optimize comfort is important to examine the contact pressure, which can be used to find comfort criteria for comparing the seats.

Keywords:
car seat, Comfort, constact pressure, MKP

INTRODUCTION

Quality and safety of seating on the automobile seat depends mainly on material characteristics of the comfort layer. Human body is in permanent contact with the seat. Optimalization of the comfort layer is very significant for seat producers. Viscous-elastic behavior of the polyurethane foam (PU foams) is very important for the development and optimization of automotive seating comfort. Getting results is very time-consuming and financially demanding, because it is the experiments on humans. The main aim of this letter is describe optimizing of the comfort layer by using finite element simulations. FEM is significant, because the system helps in optimizing comfort.Virtual testing makes possible to modify properties of foam cushion to analyze and optimize pressure distribution. Analyses allow investigations of parameters that are hard to measure. It is possible to use common polyurethane materials or sandwich structure which have get better contact pressure distribution. There is possible to optimize static comfort during the seat development (predicting the whole seat behavior). Comparing results test, collect results to optimize seat. The covering material is on all types of seats pre-stressed and it is very significant to static comfort. Differences between pressure peaks on the covered and uncovered seats are between 30 – 60% (experience from real testing [3], [6]).

By using FEM simulation are producers of automobile seats able to save time and money during the seat development. We want to build for the future data of the mechanical properties

through experimental measurement and evaluation of the data for comfort seats to the virtual simulation. Then we will be able compare different automobile seats in real tests and make virtual simulations.

METHODOLOGY OF SIMULATION TESTS

Experimental measure

Virtual Simulations are built based on experimental data measured in specialized test equipment. Mechanical properties of upholstery fabrics from the tensile test are obtained from the test facility (fig.1).

Fig.1 Experimental tests of Cover-Textil fabric

Fig.2 Tests car seat from PU foam

Mechanical properties PU foam were measured on the standard sample (stadard Cube of dimensions 100x100x50) [3], [7], [8] and particular by experimental tests for to testing car seat facilities (fig.2).

Simulation tests

Simulation models were created in an environment of FEM. The model was made of PU material, from a sandwich material. Models were tested from Cover-Textile Fabric and without the Cover-Textile Fabric.

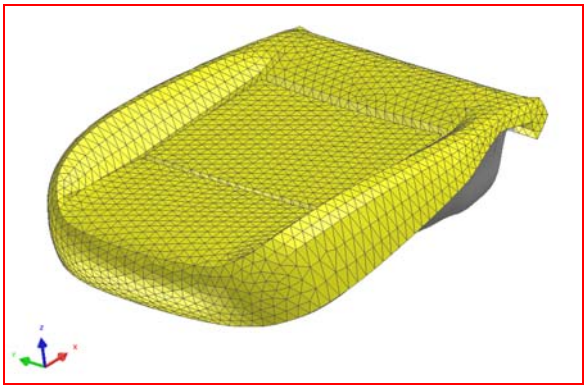

Fig. 3 Model uncovered seat

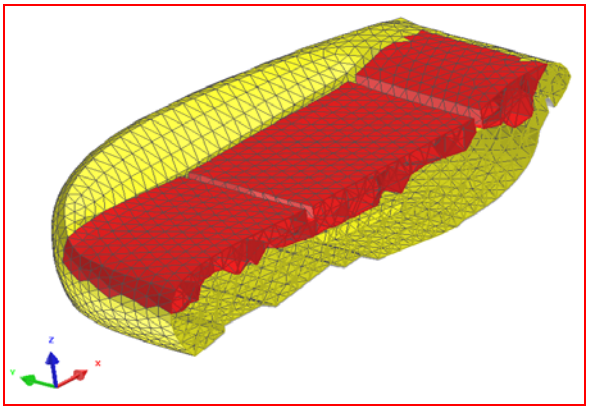

Fig. 4 Model sandwich seat

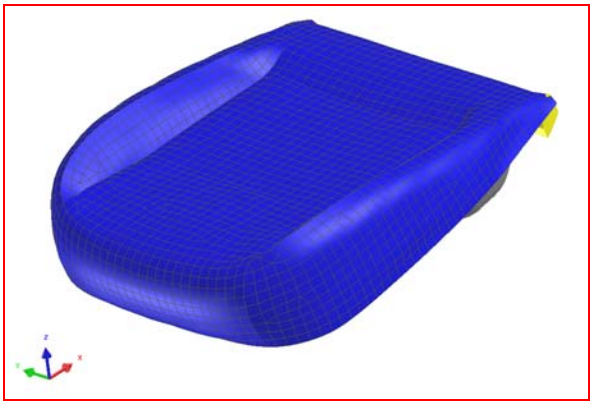

Fig. 5 Model covered seat

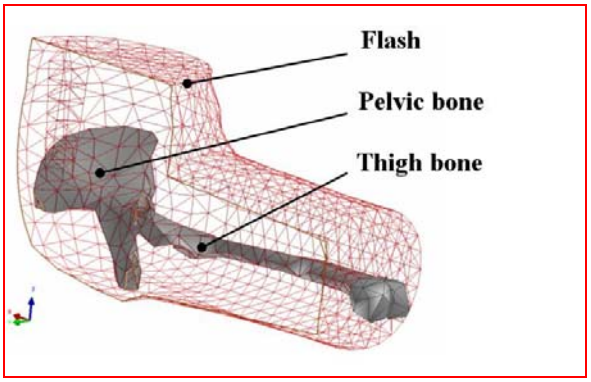

Fig. 6 Virtual human body

Both sandwich seats contain two different types of polyurethane foam. The main part of the foam is common material used in standard seats and the soft foam in the contact area.
The virtual human body model contains parts of skeleton like pelvic bone and thigh bone (Fig.6). This part of skeleton is fleshed by human body tissue. Characteristics of the tissue are optimized from the letters [2], [3] and [4].

Tab. 1 Characteristics of the human body model

Part	Material model	Density ρ [kg/m ^ 3]	Young's modulus E [GPa]	Poisson number μ [-]
thigh bone	Elastic Plastic	1000	0.250	0.3
pelvic bone	Elastic Plastic	1000	0.250	0.3
flesh	Elastic	1200	8.E-5	0.4

The lower plate is fixed in all degrees of freedom. The mass of the human body model is 61 kg. Initial position of the human body is optimized to get no penetration with seat. There is defined gravity acceleration field on the whole human body. The result analysis is done after equilibrium of the human body on the seat.

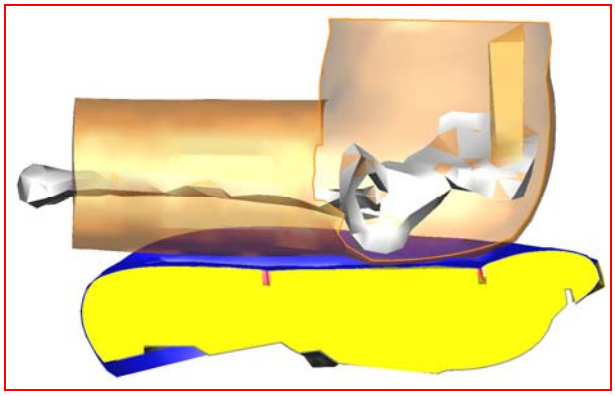

Fig. 7 Initial position

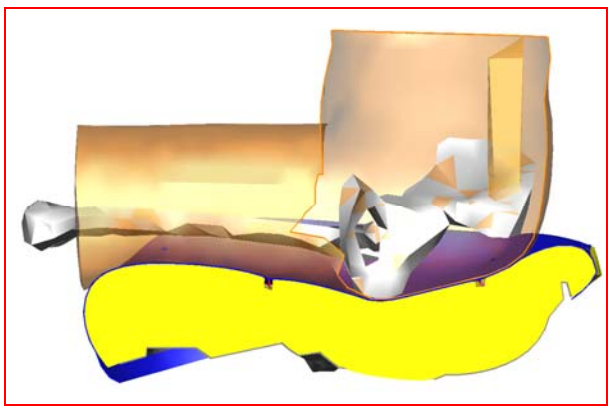

Fig.8 Result position

Material characteristics virtual models

Virtual simulations are made in PAM COMFORT from ESI GROUP. Solver of PAM COMFORT is based on PAM CRASH explicit integration scheme and is optimized for comfort static and dynamic simulations. Explicit method (Explicit Solver) and the mathematical relationships were referred to in Article [7], [8].
PU Foam characteristics are included as static stress-strain curves (Fig. 9). Measure and simulation described in detail in Article [3], [7]. Static characteristics are analyzed by using special methodology to describe creep and stress relaxation. Textile fabric characteristics in directions loading are included as stress-strain curves (Fig.10). As the material properties are given further variables such as density, Young's modulus, viscoelastic coefficients, stiffness damping, coefficient, absorption Energy and other factors.

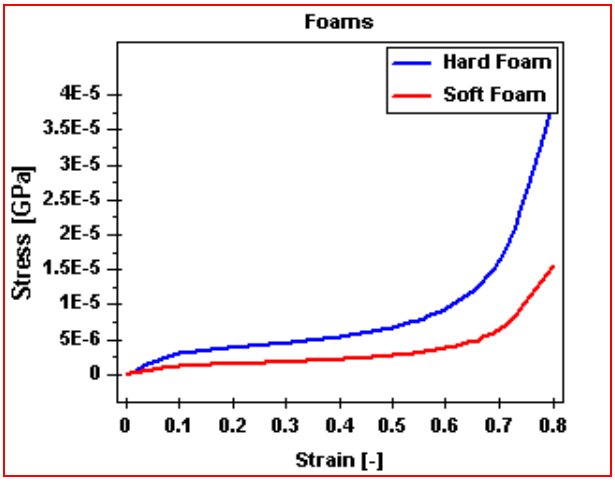

Fig. 9 Covered seat

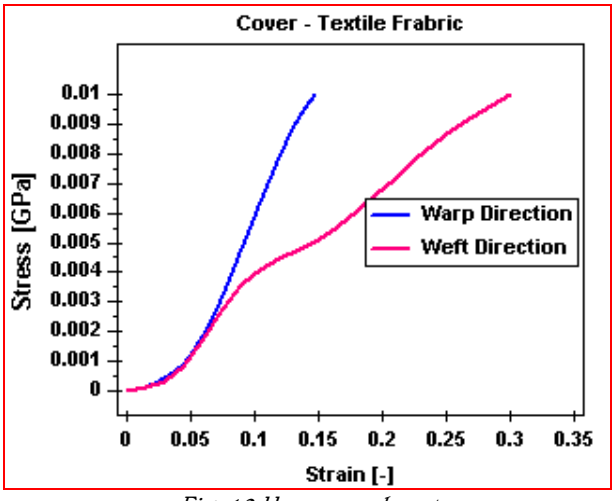

Fig. 10 Uncovered seat

RESULTS OF THE SIMULATIONS

Simulation analysis uses contact pressure to compare different types of seats (Compare comfort, optimalization design, construction geometry, developments ...).
Differences between maximum contact pressure seat (PU foam) and sandwich seat is c. 14%. This is due to layering of the material. Contact peak pressure by using sandwich seat is lower. Soft foam in contact area increases contact area and the static comfort. There is high dependency of the covering material. Increment of the peak pressure values is c. 62%.The covering material has important influence to seat stiffness and to static comfort. Therefore it can be assumed that values of contact pressures obtained from simulation model are suitable and can be used for the evaluation of these materials and seats.
The Fig. 11 and 12 is seen compression virtual Human body for uncovered seat and seat Sandwich. The resulting values maximal contact pressures for compared uncovered seat and seat Sandwich in Table 2.

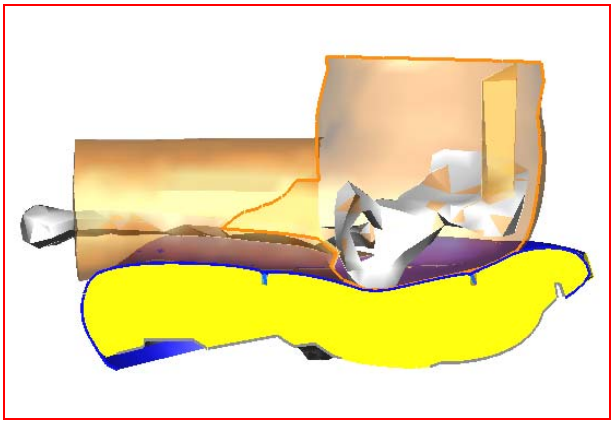

Fig. 11 Compression seat (uncovered seat)

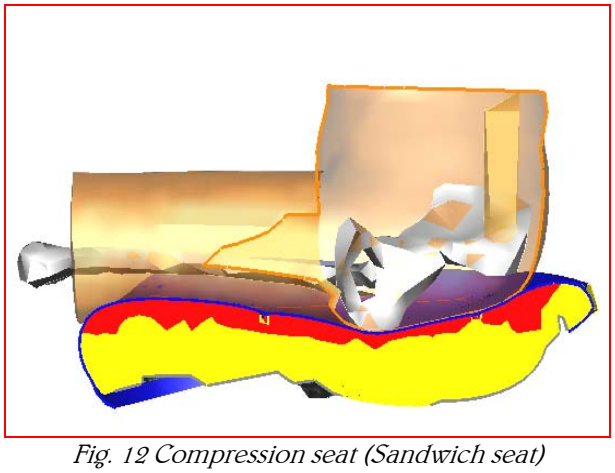

Fig. 12 Compression seat (Sandwich seat)

Tab. 2 Results – Contact Pressure

Virtual Seat	*Maximum of Contact Pressure [GPa]*
Uncovered	*1.15E-5*
Uncovered Sandwich	*1.01E-5*
Covered	*1.87E-5*
Covered Sandwich	*1.73E-5*

All Results simulation for optimize and compares contact map (contact zone) seats with human body which is performed using contact pressure are to fig. 13-16.

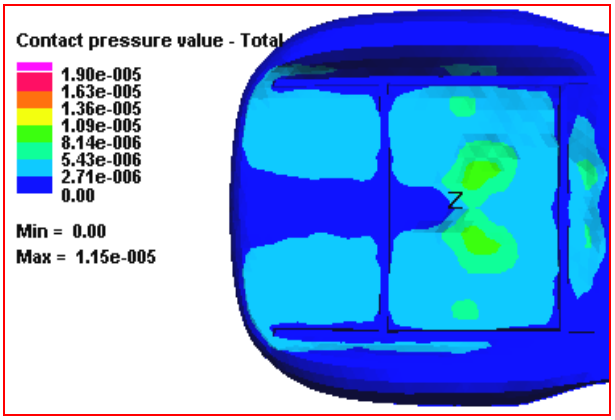

Fig. 13 Uncovered seat

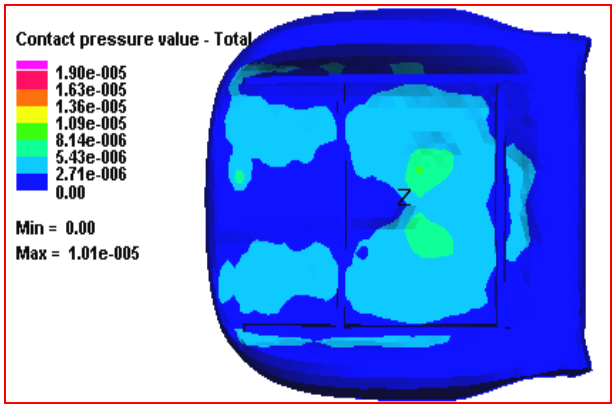

Fig.14 Uncovered sandwich seat

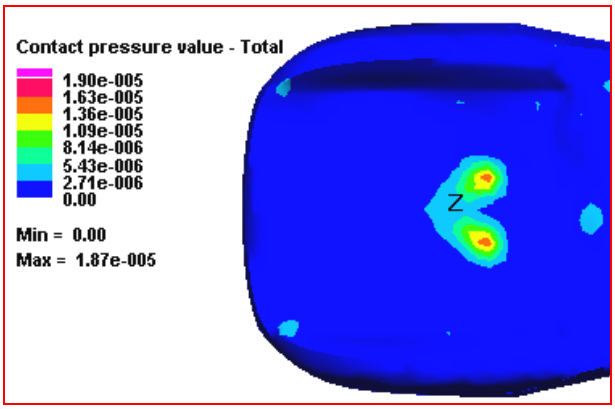

Fig. 15 Covered seat

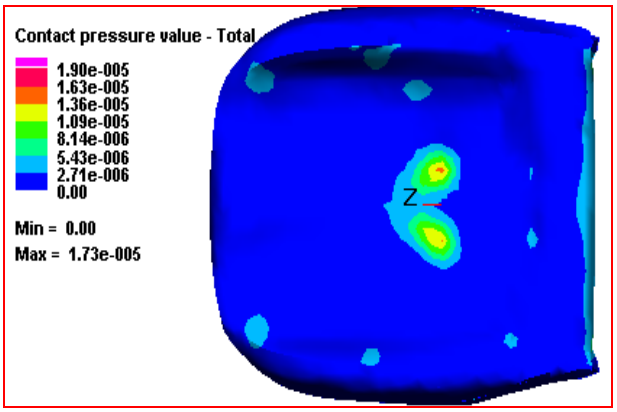

Fig. 16 Covered seat

CONCLUSION

An evaluation properties of seats, especially a pressure distribution in the contact zone, during the interaction between the sample and load is very important for the comfort. It is possible to use FEM simulations to predict comfort analysis. It is necessary to use the same testing signal in real experiment and in simulations. It is possible to predict dynamic behavior of the automotive seats before the prototype is made and optimizing mechanical characteristics of used materials and optimizing comfort layer of the seat cushion. By using FE model is possible to compare comfort layers with different shapes of seat cushion. During the seat development is important to include covering material influence to static comfort analysis. The sandwich structure is useful to get lower peak of contact pressure and increases the static comfort. FEM simulations will be very helpful to optimize characteristics of the comfort layer. It is possible to use different types of foam, covering materials, levels of pre-stress of textile fabric without the real seat prototype. Also It exists special device for measurement of contact pressures, for example X-sensor, which is very suitable for comparison with the virtual simulation, but its price is very high.
FEM Simulations as important system for Optimization for Comfort and Development.

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