APPLICATION OF MSC/DYNA IN HEAD IMPACT ANALYSIS

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ABSTRACT

The Federal Motor Vehicle Safety Standard 201 (FMVSS 201) specifies requirements to afford impact protection for occupants. It provides (see reference 1) that "when that area of the seat back that is impacted in accordance with S3.22 by a 15 pound, 6.5 inches diameter head-form at a relative velocity of 15 mph the deceleration of the head–form shall not exceed 80 g's for more than 3 ms ". This paper presents the results of a head impact simulation on an automotive seat using MSC/DYNA. The results were correlated with those from an actual laboratory test. Good correlation was achieved in the deceleration time history as well as deformation of the structure. Though simulations of the crash type have been performed on entire vehicles few have been focussed on the seat to the level of detail here.

INTRODUCTION

The purpose of this analysis was to simulate the FMVSS 201 test. The particular case considered here is the impact of the back structure of the seat by the head of a rear occupant in a frontal crash. The head is represented in the test by a sphere and is given an initial velocity of 6666 mm/s. The deceleration time history of the ball and the deformation of the back structure are of primary interest. Since the analysis is of a transient nature and involves contact and severe material and geometric nonlinearity MSC/DYNA (version 3) was used. Comparison was made with data obtained from a laboratory test.

MODELING DETAILS

Figure 1 shows the finite element model. The ball is modeled as a rigid hollow sphere of outer diameter 165.1 mm with the thickness assigned so that the mass is 6.82 kg. The material has been defined using the MATRIG card and for contact purposes only, the stiffness of aluminum has been used. The ball is brought into initial contact with the head pan. All the grid points on the ball are given an initial velocity in the negative x direction of 6666 mm/s. Contact is defined between the grids of the head pan and the surface of the sphere. The enhanced penetration check feature in MSC/DYNA (see ref 2) was used. The headpan and the backframe are modeled using shell elements. The shell elements are of the Belytschko–Tsay type with three integration points through the thickness. DYMAT24 is used to model the material properties. The yield point is 242 MPa. Isotropic hardening is assumed after yield. The controlling time step came out to be 0.52 micro second. the total number of nodes associated with the deformable structure is 1263 and that with the rigid sphere is 266.

RESULTS

Figure 2 shows the deformed shape of the structure, as simulated, side by side with a photograph of the deformed structure after the laboratory test. As can be seen the two look similar. Figure 3 shows the deceleration time history of the ball as obtained from the simulation compared with that obtained from the test. The peak deceleration in the simulation is 46 g's as compared with 42 g's in the test. The waveforms too are similar in shape. The waveform in the simulation is never positive because the headpan cannot accelerate the ball. When the deceleration is zero, the headpan and ball lose contact. The differences in the latter portions of the curve can be attributed to the fact that in the test the ball actually rotates around a pivot which is 300 mm from the center of the ball

CONCLUSIONS

Good correlation was obtained between the simulation results using MSC/DYNA and the experimental results. Both the deformed shape and the deceleration time histories compared well. MSC/DYNA was demonstrated as a usable tool in the simulation of crash events involving seat structures. The authors have performed simulations other than the one reported on seat structures and mechanisms and have obtained good experimental correlation.

REFERENCES

[1] "CODE OF REGULATIONS, 49, PARTS 400 TO 999", Office of the Federal Register, National Archives and Records Administration.

[2] MSC/DYNA User's Manual, MSC/DYNA Version 3, The MacNeal–Schwendler Corporation, Los Angeles, CA, August 1992.

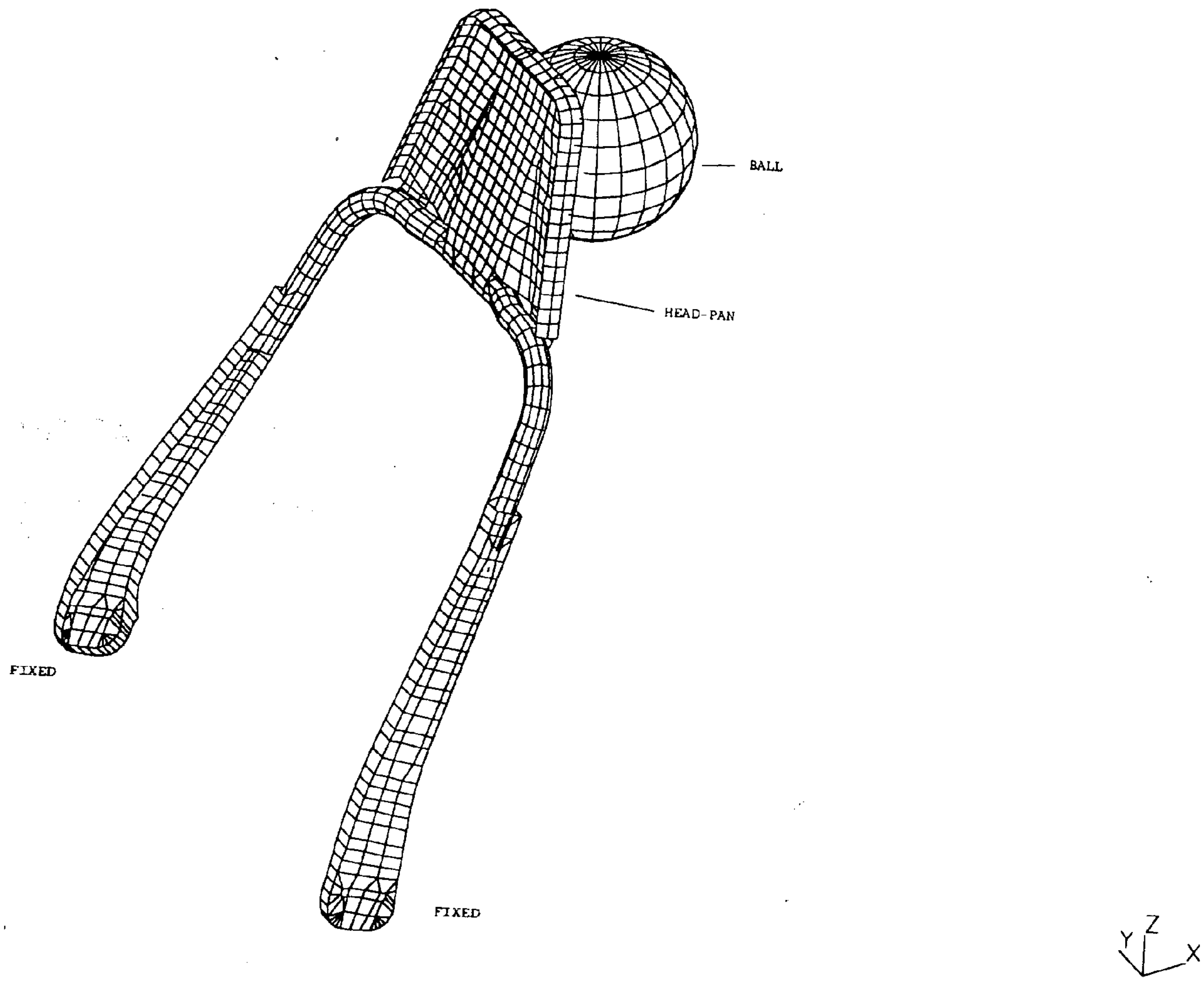

Figure 1. FE model of the back structure and ball for the simulation of the FMVSS 201 test.

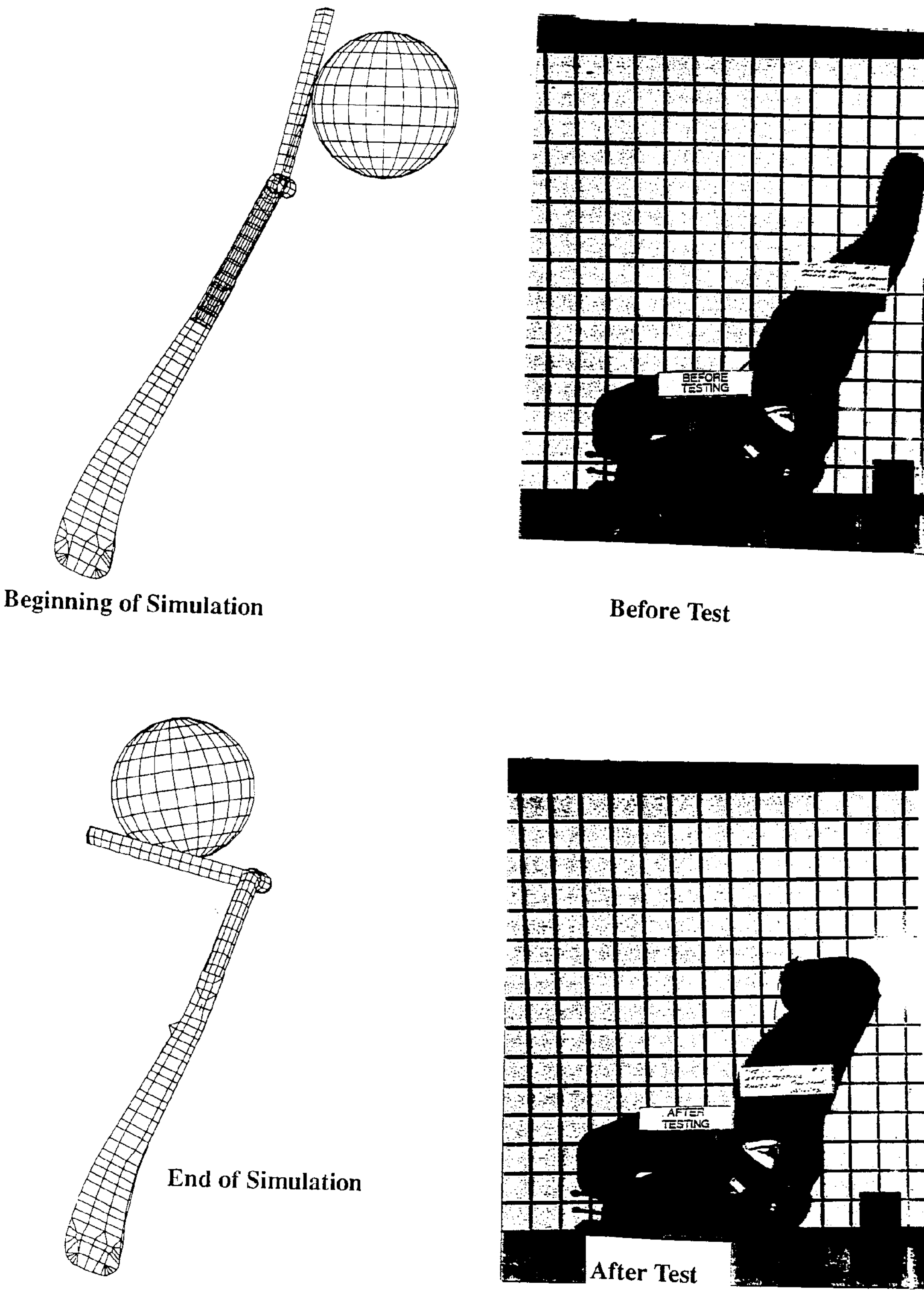

Figure 2. Comparison of the deformed shapes. Simulation and experiment

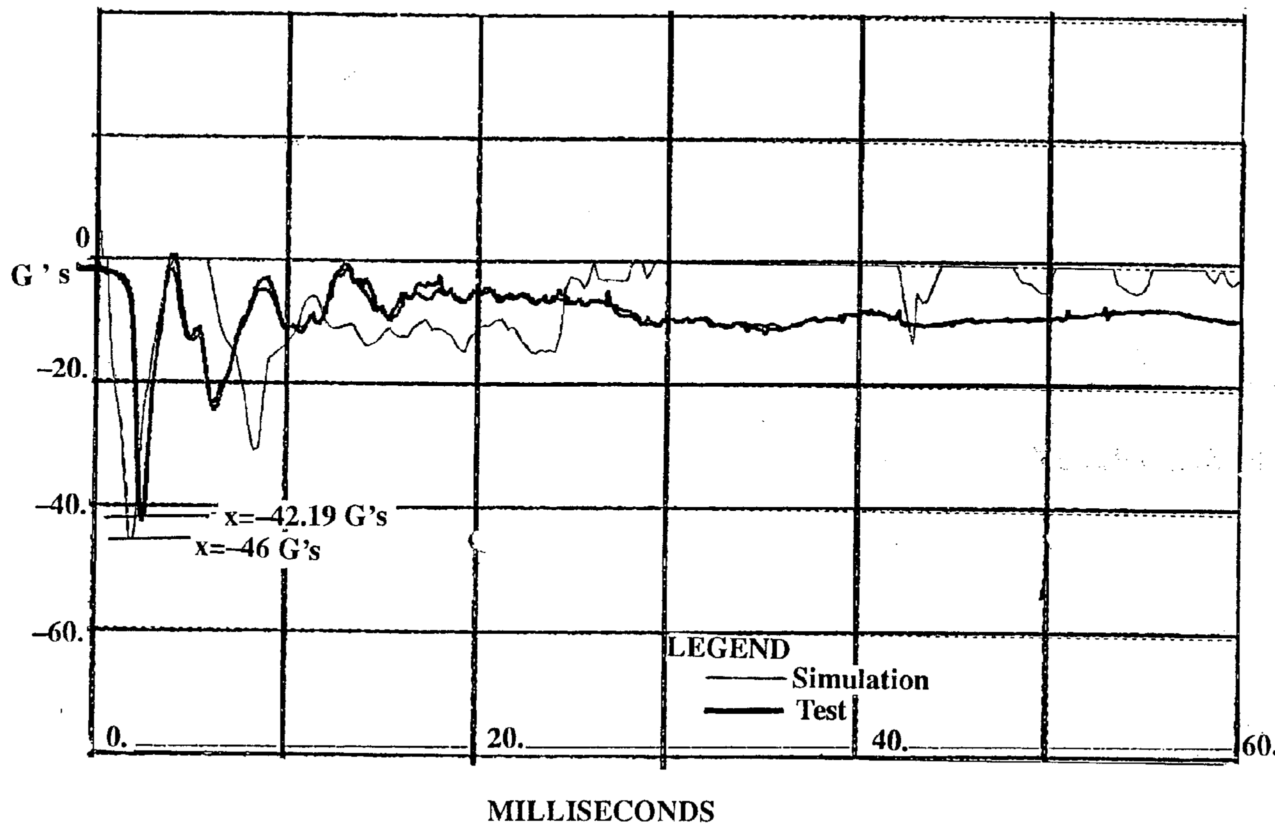

Figure 3. Comparison of test and simulation deceleration time histories