Durability Study for Tractor Seat Using LS-DYNA®

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Abstract

Today in many tractors with enclosed cabs, an extra seat named as 'instructor seat' are available. As a regular driver seat, this seat should also undergo the same testing and product validation process. This seat is incorporated to serve various purposes like enhances the training of tractor operators, facilitates communications between workers, improves the demonstration of for-sale tractors, transports workers to worksites, assists operations requiring extra help etc.

LSTC's LSDYNA introduced a powerful vibro-acoustic solver which can address almost all major problems in the frequency domain. In this paper, we used the explicit capability of LS-DYNA to model the drop of tractor Instructor seat (henceforth called a I-Seat) and then the frequency domain capability to estimate the damage of parts that undergoing steady state loading . We have used LS-DYNA's new fatigue solver capability for SSD loading to predict the damage.

Major Keywords used:
**FREQUENCY_DOMAIN_SSD_FATIGUE, *DATABASE_FREQUENCY_BINARY_D3SSD, *DATABASE_FREQUENCY_BINARY_D3FTG*

Introduction

LSDYNA is one of the most widely used finite element tool to solve complex multi-physics problems. The newly introduced vibro-acoustic solver has been gaining a lot of momentum and we have decided to use this feature for performing the durability analysis of the I-seat. This seat should pass through test specification where a manikin load of 75Kg is loaded and strapped over the seat. The seat is then sopped from a height of 100mm and this loading is periodically applied for 3000 secs. The accelerometers a located at two points (point A and point B) in the bottom plate of seat assembly.

Drop simulation

The FE model of the complete tractor seat assembly has been in LS-PrePost®. To model the real time scenario, instead of lumped mass we have modeled manikin weighing 75Kg and the also strap around the same (Figure 1.0). The testing set-up is as shown in the below image (Figure 2.0)

The initial velocity based on the drop height is calculated and applied on the assembly using *INITAL_VELOCITY_GENERATION card. The results of the drop analysis is shown in below (Figure3.0).

The dynain file which contains the all the *INITAL_STRESS_SHELL, *INITIAL_STRESS_SOLID is requested for all the parts which have to be carried forwarded to the subsequent analysis.

Steady Sate Dynamics and Fatigue Calculation

Accelerometers are located at two different locations in the bottom plate of the I-seat assembly (Figure 4.0). The accelerations measured at these accelerometers were in time domain. We have converted them into a frequency domain by using a FFT convertor.

The model is included with initial stress & strains via *INCLUDE card in LS-DYNA. The 100 Eigen modes are computed and the stress calculation on the elements is switched on by setting MSTRES=1 in *CONTROL_IMPLICIT_EIGENVALUE card. The operating frequencies are from 10-1000Hz. So a frequency range of 1-100Hz were given in the *FREQUENCY_DOMAIN_SSD_FATIGUE card.

There loading curves along with their directions were defined in the LC1 in the *FREQUENCY_DOMAIN_SSD_FATIGUE card. All the S-N curves (Figure 6.0) were defined in the *MAT_ADD_FATIGUE card and referred to all concerned materials in *MAT_ cards. Time dependent load curves were defined under LC3 in the keyword *FREQUENCY_DOMAIN_SSD_FATIGUE.

Post-processing

We have requested output at 1-100Hz at an interval of 10Hz each. This can be defined in *DATABASE _FREQUENCY_BINARY_D3SSD. this will write out a file named d3ssd where the used can plot the stress and displacement due to harmonic loading. For fatigue output the results will be written in a file named d3ftg. This file can be requested using the keyword *DATABASE _FREQUENCY_BINARY_D3FTG. The results of fatigue analysis is shown below (Figure 7.0)

Conclusion:

LS-DYNA fatigue results were well correlating with the actual failure and the application of LS-DYNA's vibro-acoustic solver are expanded to other calculations as well. I sincerely thank Yun Huang and Zhe Cui of LSTC for supporting us while executing this project.

References:

LS-DYNA Keyword Users manual, Livermore Software Technology Corporation, 2016

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