NVH simulations for car seat

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1 Introduction

Increasing requirements of the car's seat structures drive Faurecia Automotive Seating to develop robust FEA methods able to predict vibration test results. In the scope of OEM interest there is not only value of first resonance frequency but also higher frequency range or amplitude level for defined excitations.

2 Methodology

The article describes the methodology developed at Faurecia for NVH challenges using LS-Dyna code. Having in mind limited time during development process of new product, first and key objective was to use minimum energy to create NVH FEA model from FEA model used for crash purpose. The challenge was to validate methodology that will allow to convert highly nonlinear crash model to linear behavior in NVH domain. In the same time be able to get reliable output form Modal Analysis in order to take design decisions and solutions. Each element of the seat like: tracks, recliners or high adjuster, fasteners (screws, bolts, welds) or other kinematic connections have been "modified" to linear behavior.

Fig.1: Typical connections for car seat.

3 Validation

To validate NVH FEA models, several correlations with real tests have been performed following classical system engineering approach. Methodology was validated in few steps: sub-systems of backrest, cushion and tracks then whole metal frame seat and finally trimmed complete seat. Modes shapes correlations between real and virtual tests were done by calculating MAC (Modal Assurance Criterion) between modes calculated by LS-Dyna (d3eigv files) and modes extracted from Experimental Modal Analysis (Universal Files). Frequency Responses Functions (FRF) from hammer tests were also compared with Ls-dyna models using **`*FREQUENCY_DOMAIN_FRF`** cards.

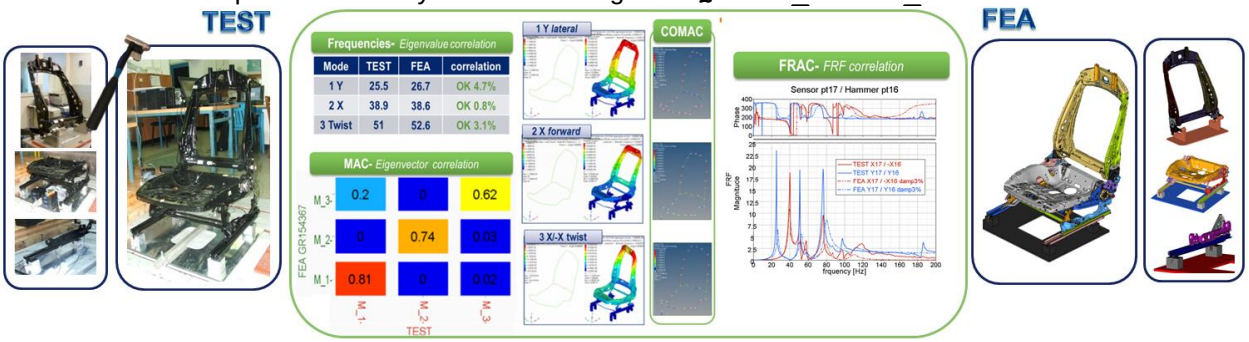
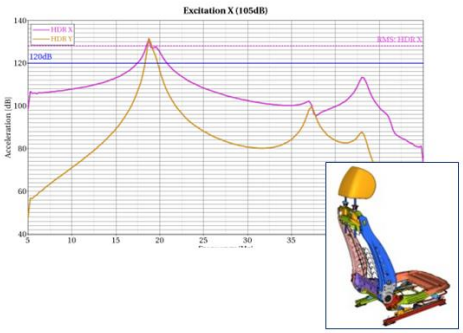


Fig.2: Validation of FEA results.

4 Application

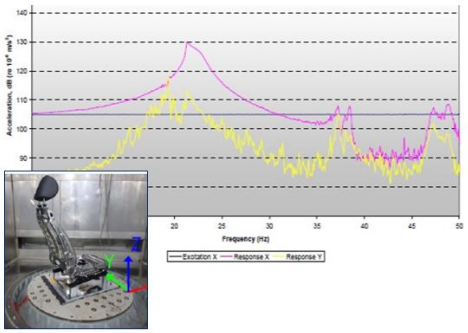
Modal Analysis result is used during development process to check linear behavior of structure in frequency domain. Identification of critical areas by strain energy allow to avoid potential problems at early stage of project.
The user can generate the Super-Element by ***CONTROL_IMPLICIT_MODES** and deliver reduced model of Complete Seat in the Nastran *.DMIG* file format which can be used as input to ***ELEMENT_DIRECT_MATRIX_INPUT**.

Additionally some OEM require also to respect acceleration amplitudes level on seat frames while excited by ground signal (from theoretical acceleration spectrum to real life road signals). Using ***FREQUENCY_DOMAIN_RANDOM_VIBRATION** card, several shaker tests have been successfully correlated. The presentation will show issues encountered during correlations focusing specifically on management of damping.



105dB	RMS	
	X/X	Y/Y
FEA [dB]	118.3	123.1
TEST [dB]	118.6	123.7

120dB	RMS	
	X/X	Y/Y
FEA [dB]	131.8	136.0
TEST [dB]	130.7	136.1



5 SUMMARY

Despite plenty of non-linearity inside real Complete Seat, developed methodology shows good correlation level for Modal Analysis inside useful frequency range. It is successfully used during development and validation phase of project.
Additionally model is used for Frequency Response Simulations and give satisfied results.
Methodology is spread to electronics devices and mechatronics where there are trials to predict noise coming from resonance between high-adjuster actuator and frame structure.

6 Literature

[1] Livermore Software Technology Corporation (LSTC): LS-DYNA Keyword User`s Manual, LS-DYNA R7.1 May 26, 2014
[2] Livermore Software Technology Corporation (LSTC): LS-DYNA Database Binary Output Files for Frequency Domain Analysis, Revised January 2015
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[4] Randall J. Allemang: " The Modal Assurance Criterion –Twenty Years of Use and Abuse", University of Cincinnati, Sound and Vibration, August 2003