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Mechanical Qualification of Aircraft Stores Components to Shock Loading - An Analytical Approach

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MSC Software

Outline

- Introduction
- Background and Motivation
- Analysis procedure
- Problem description and Computations
- Results and Discussion
- Conclusions

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Introduction

- Military aircraft - carries external stores
- During hard/arrested landing – Shock occurs
- Should not lead to mechanical failure of equipments/ Line Replaceable Units (LRU) mounted inside
- Analysis carried out for Outboard pylon-store assembly and Pylon Interface Box (PIB)

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Background & Motivation

- Shock - vibratory excitation of short duration
- Different methods to define shock motion- pulse shock, velocity shock, Shock Response Spectrum
- Shock Response Spectrum (SRS) –
  - Useful tool for estimating damage potential of shock
  - A plot of the peak acceleration response of an infinite number of SDOF systems to a transient wave form

Background & Motivation(Cont.)

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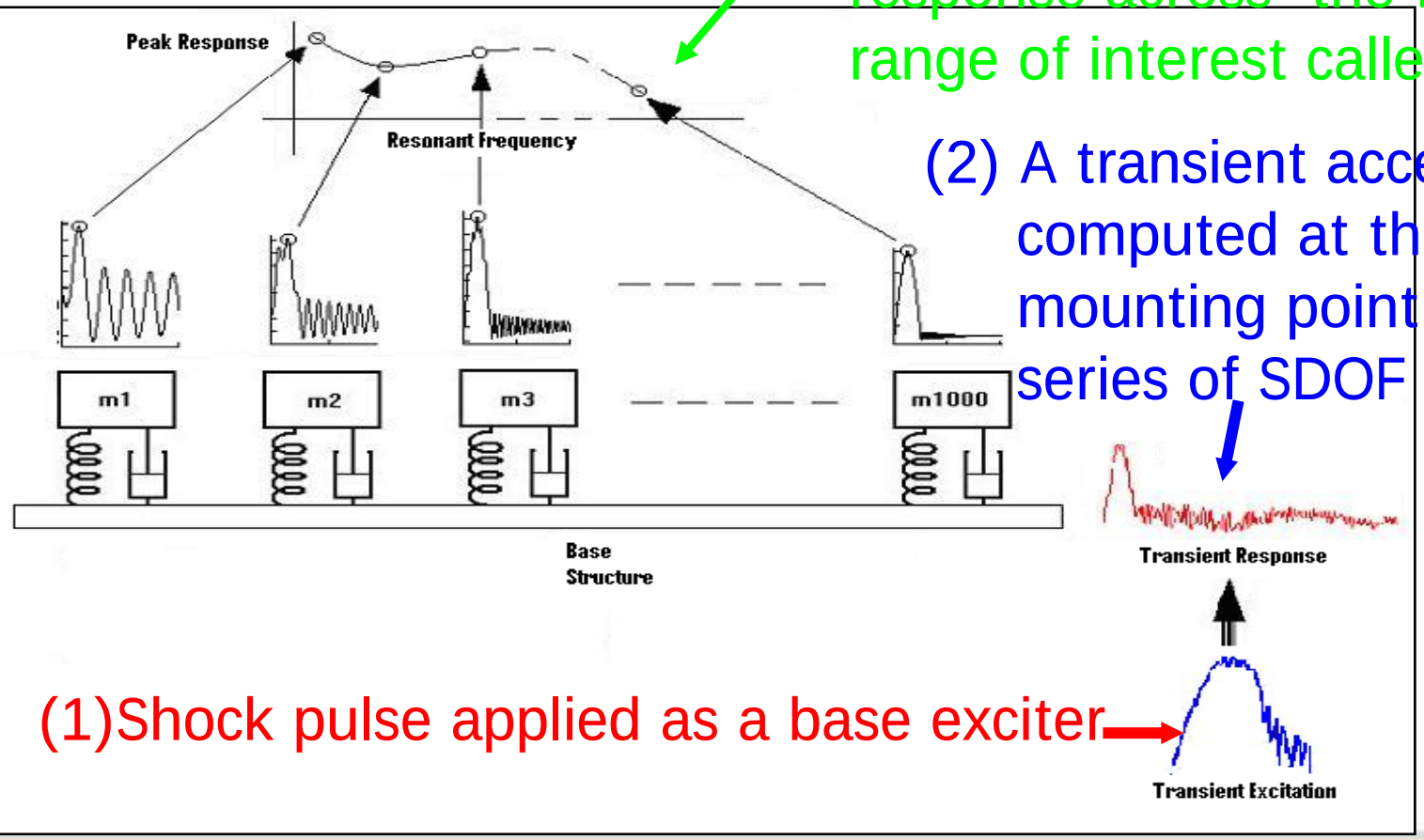
Shock Response Spectrum (SRS)

(3) The envelope of the peak response across the frequency range of interest called SRS



(2) A transient acceleration computed at the component mounting point applied to a series of SDOF systems

(1)Shock pulse applied as a base exciter

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Background & Motivation(Cont.)

- Shock tests for qualification of electronic equipment - done routinely
- Qualify equipment for shock, based on analysis – reduce testing effort & cost

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Analysis procedure

- Computation of transient acceleration response (SOL 109 or SOL 112) to the base excitation and SRS generation
- Modal analysis SOL 103 for response calculation using SRS

Problem description & Computations

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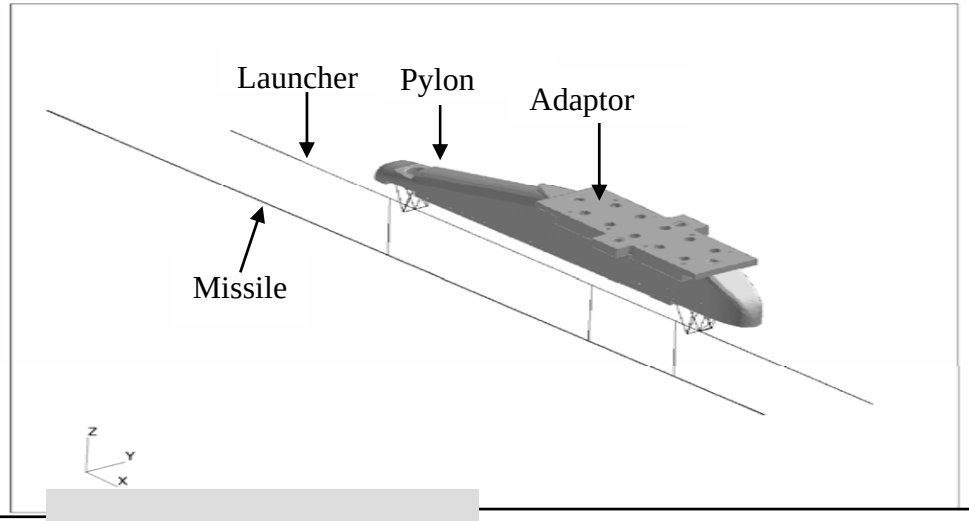
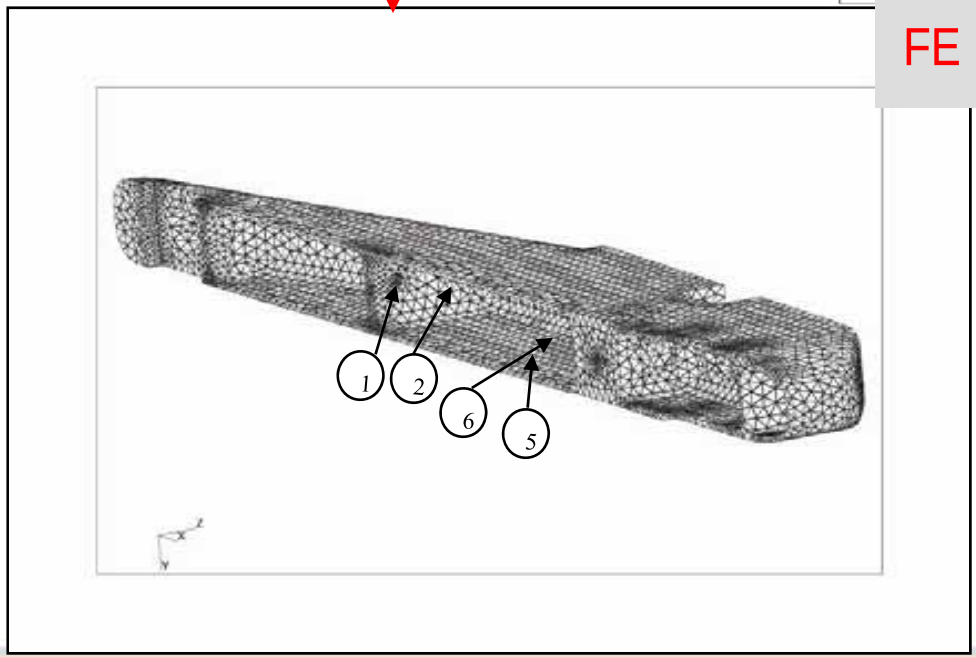
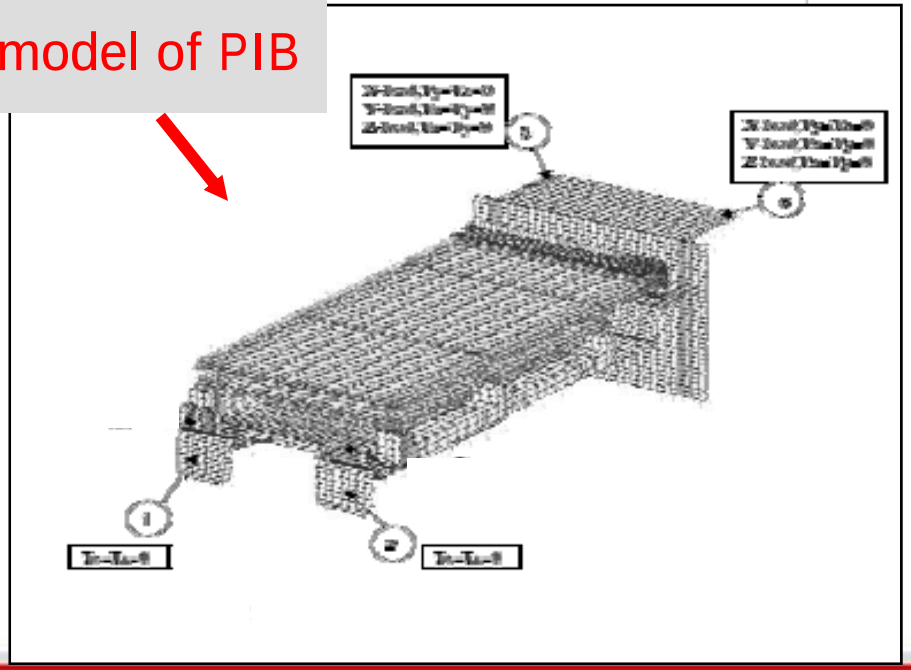
Pylon assembly →



- FE model of pylon indicating Pilon Interface Box(PIB) mounting points



FE model of PIB



Problem description & Computations (Cont.)

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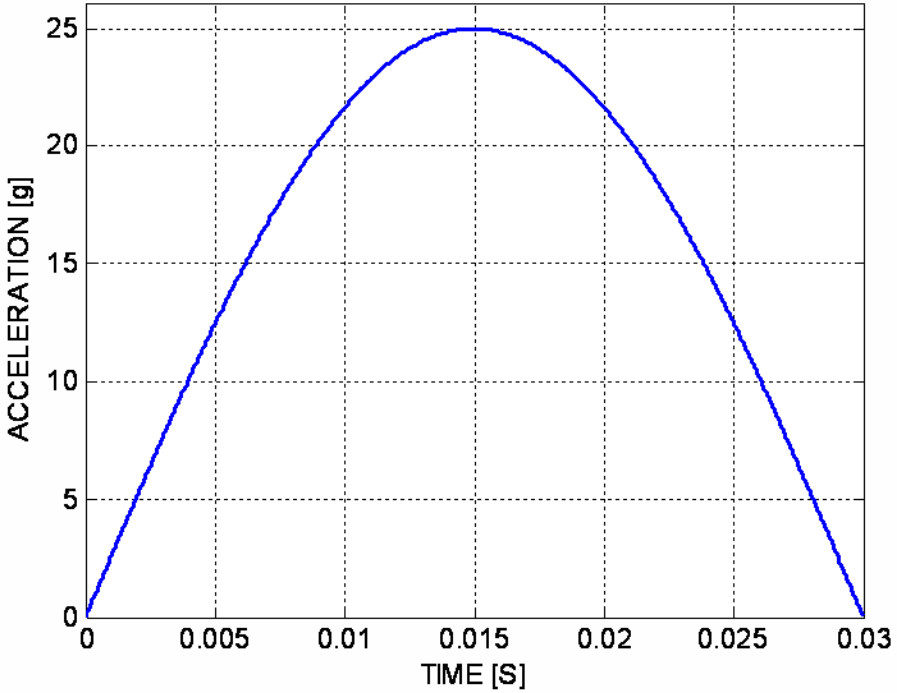
Part 1- Generation of SRS



shock input

- Maximum frequency of interest - 300 Hz
- Time step - .0003 s
- Time duration - .6 s
- Modal damping- 2% of critical

- A large mass - at eight bolt points
- Response at mounting points monitored and SRS generated

Problem description & Computations (Cont.)

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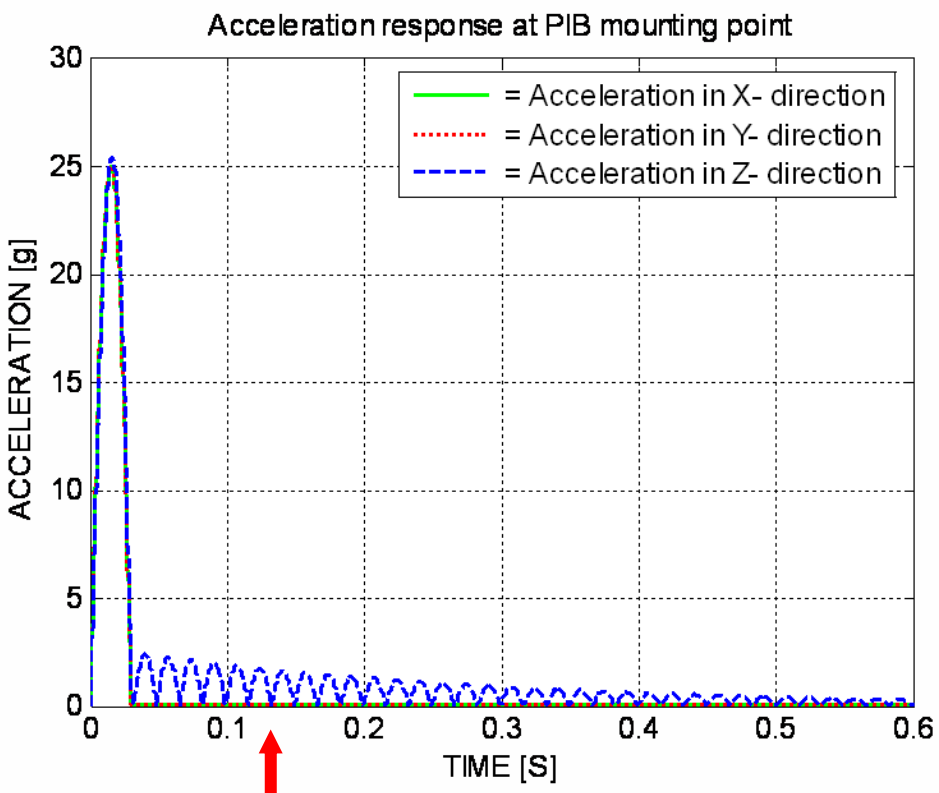
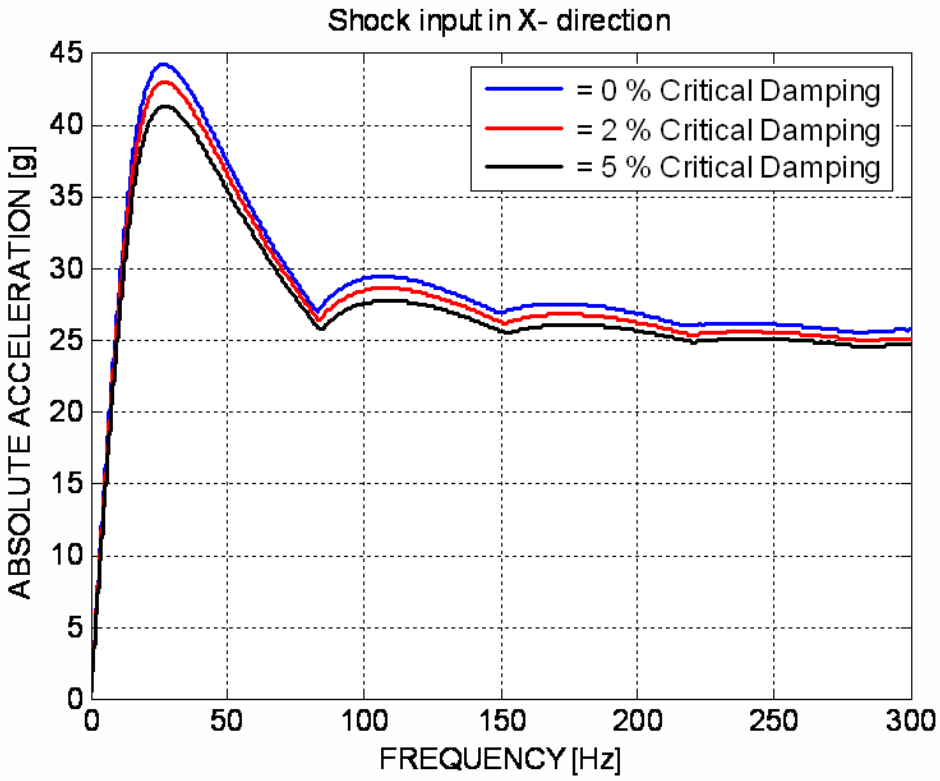


Acceleration response



Acceleration Response Spectrum in X-direction at PIB mounting points

Problem description & Computations (cont.)

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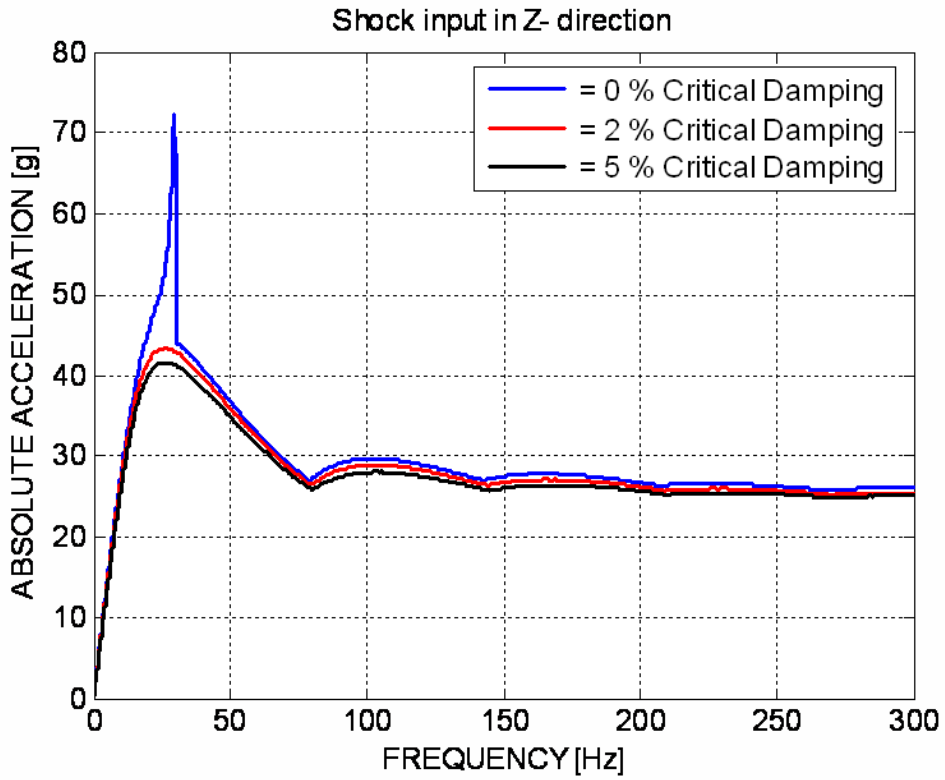
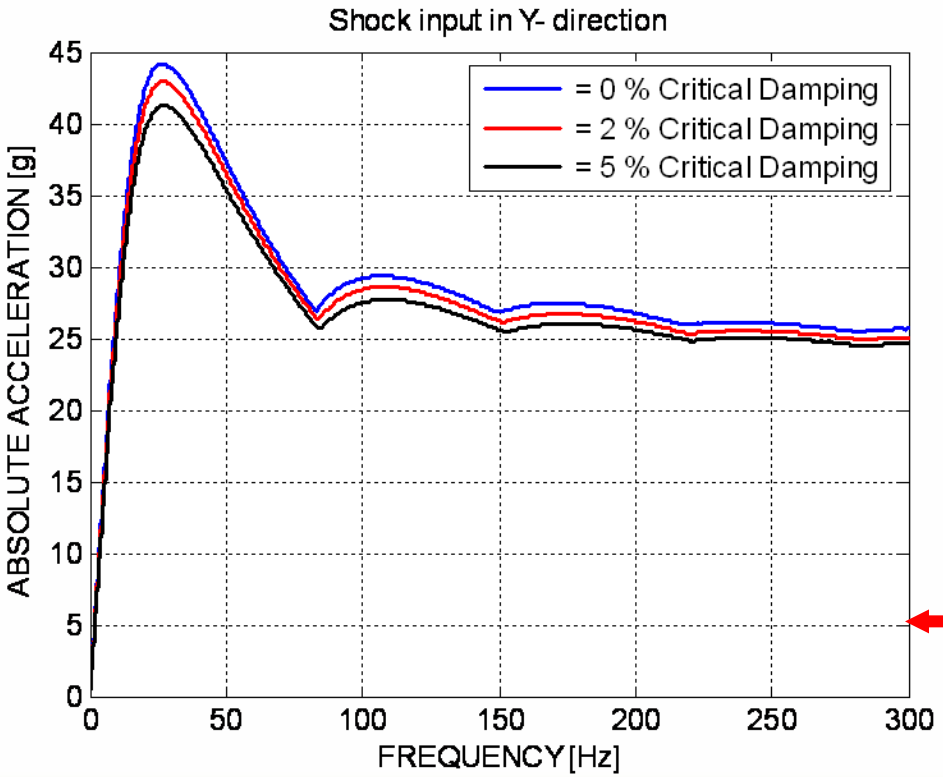
Acceleration Response Spectrum in Z-direction at PIB mounting points





Acceleration Response Spectrum in Y-direction at PIB mounting points

Problem description & Computations (cont.)

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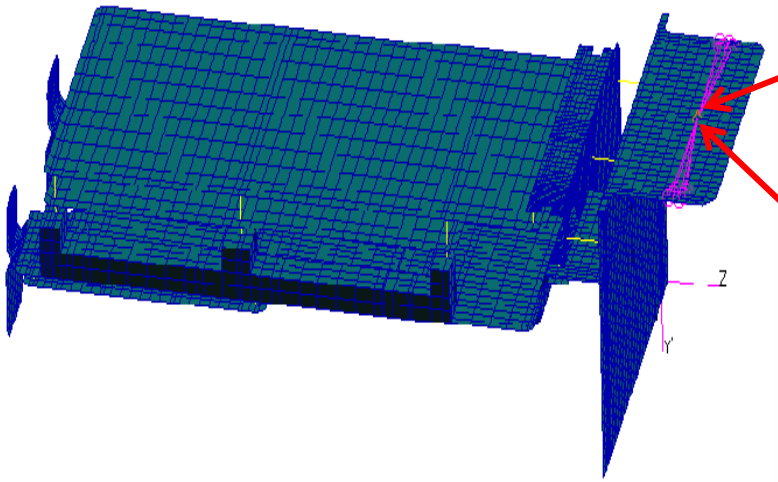
Part 2- Application of SRS to Predict Dynamic Response



The PIB mounting points connected via rigid Bar elements (RBE2) to a pilot node

SRS applied to the pilot node

- Large mass method
- Modal damping value of 2% of critical used
- Modal sol sequence (SOL 103) carried to predict Stress, Displacement and Constraint force

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Results and Discussion

Results Summary

	X- Shock	Y-Shock	Z-Shock
Von-Mises Stress (MPa)	92	62	20
Maximum Principal Stress (MPa)	101	63	23
Bar Stress (MPa)	375	260	110
Constraint Force (N)	444	57	202
Displacement (mm)	1.41	1.12	0.3

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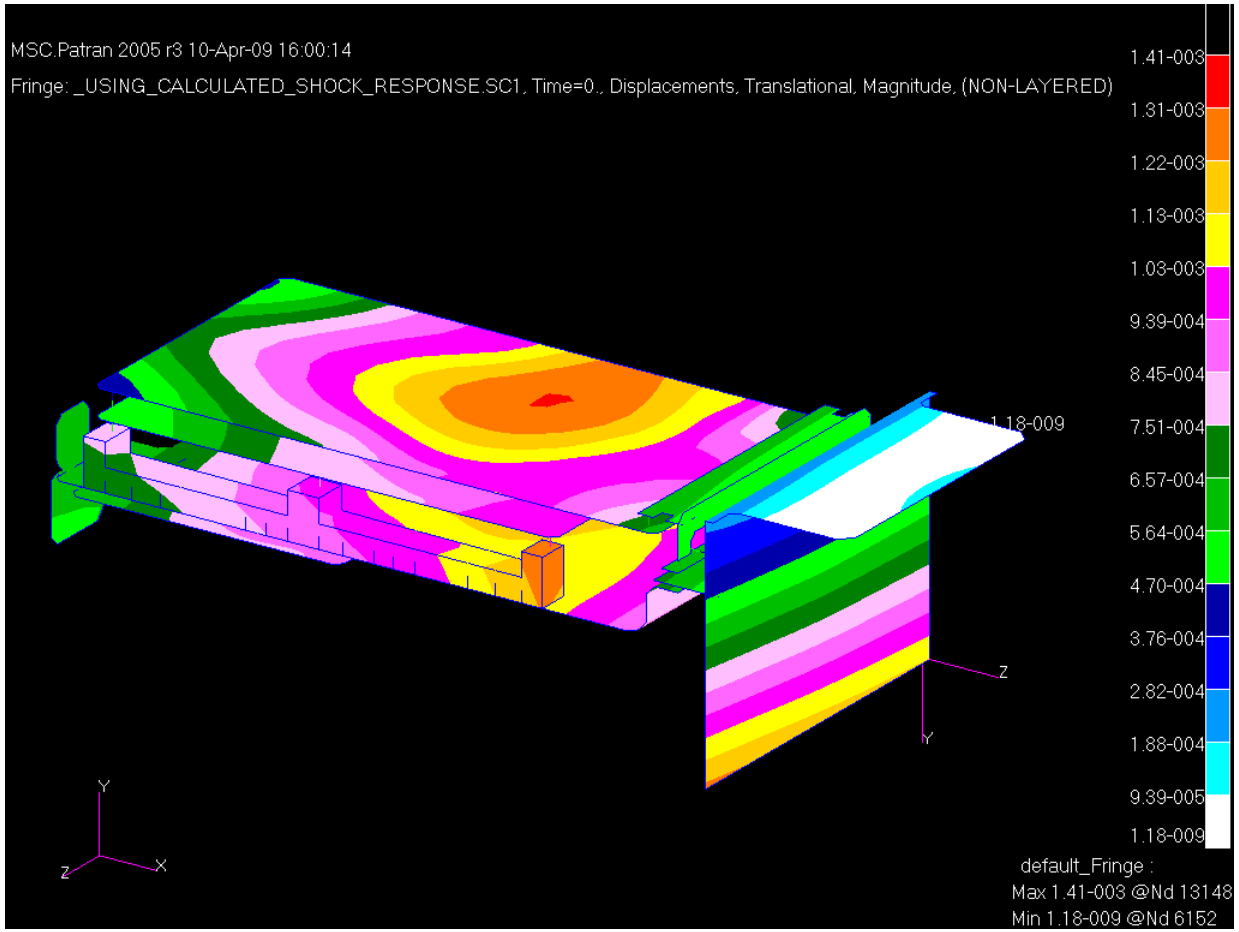
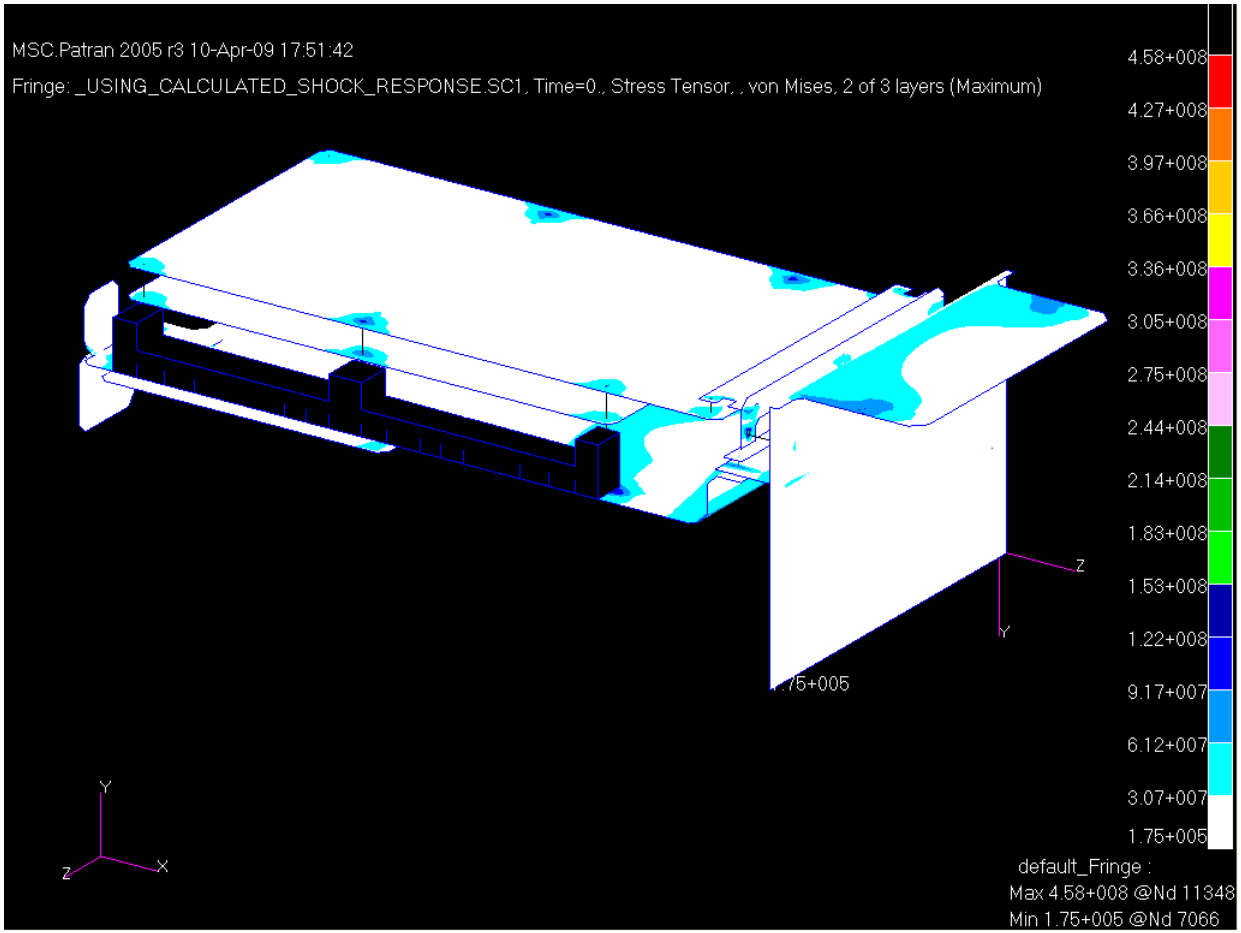
Results and Discussion (Cont.)



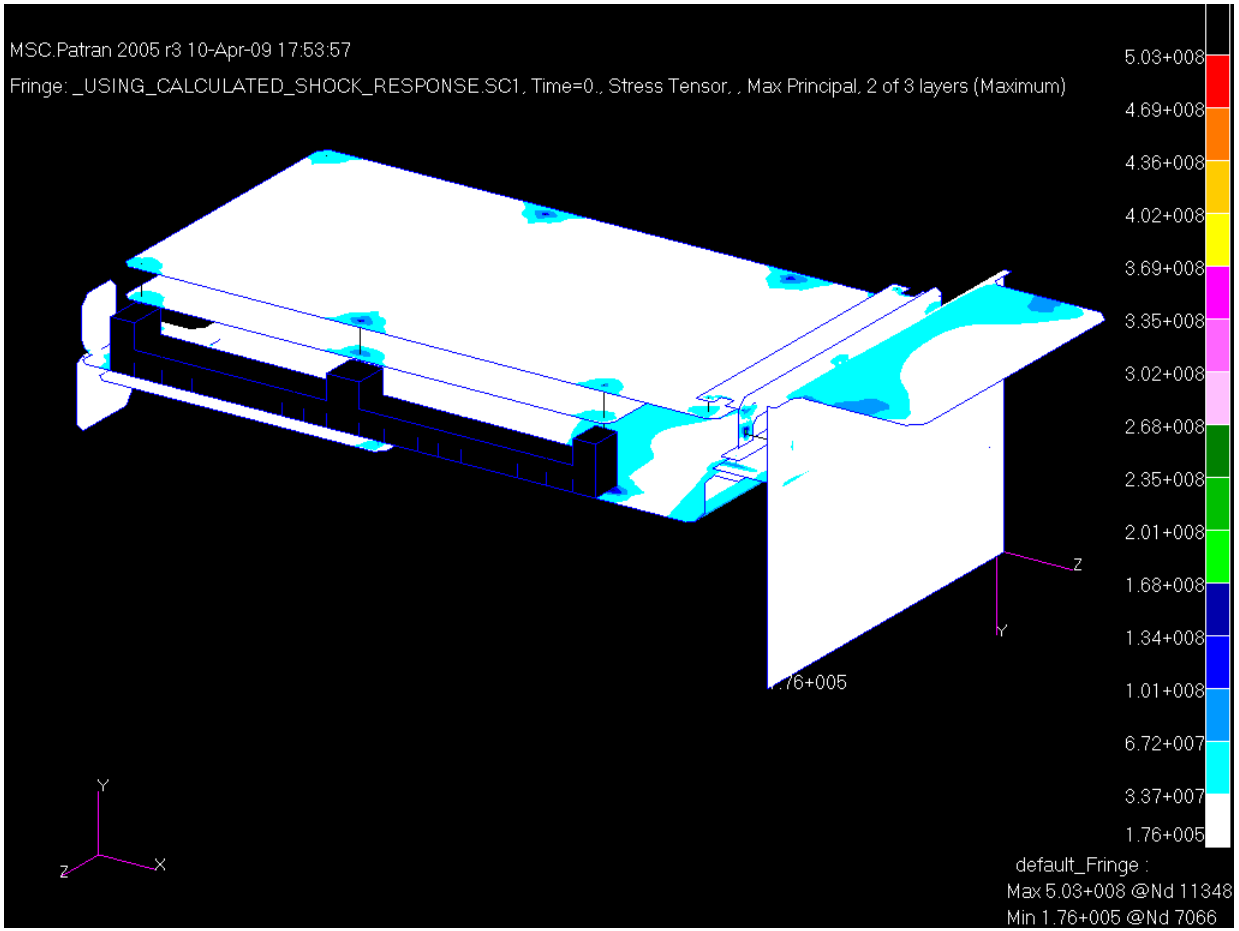
Resultant deflection plot

Results and Discussion (Cont.)



Von-Mises stress plot

Results and Discussion (Cont.)



Maximum Principal stress plot

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Conclusions

- A mechanical shock test setup simulated analytically in MSC/NASTRAN
- Shock analysis performed with the specified shock spectrum input at the mounting point of the PIB, in the X, Y, and Z directions separately

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Conclusions (Cont.)

- The stress, displacement and constraint force within the permissible limit
- The PIB assembly safe from stiffness and vibration considerations
- Such analytical simulations aid in reducing test effort and cost

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References

1-Dave S. Steinberg., “Vibration analysis of electronic equipment”, John Wiley & Sons, 1988

2-MSC/NASTRAN Advanced Dynamic Analysis User’s Guide.

3-MIL –STD – 7743F, General Specification for Testing Store Suspension and Release Equipment.

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- For further information please contact

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Thank You!