Method for Utilizing Test Modal Model within ADAMS

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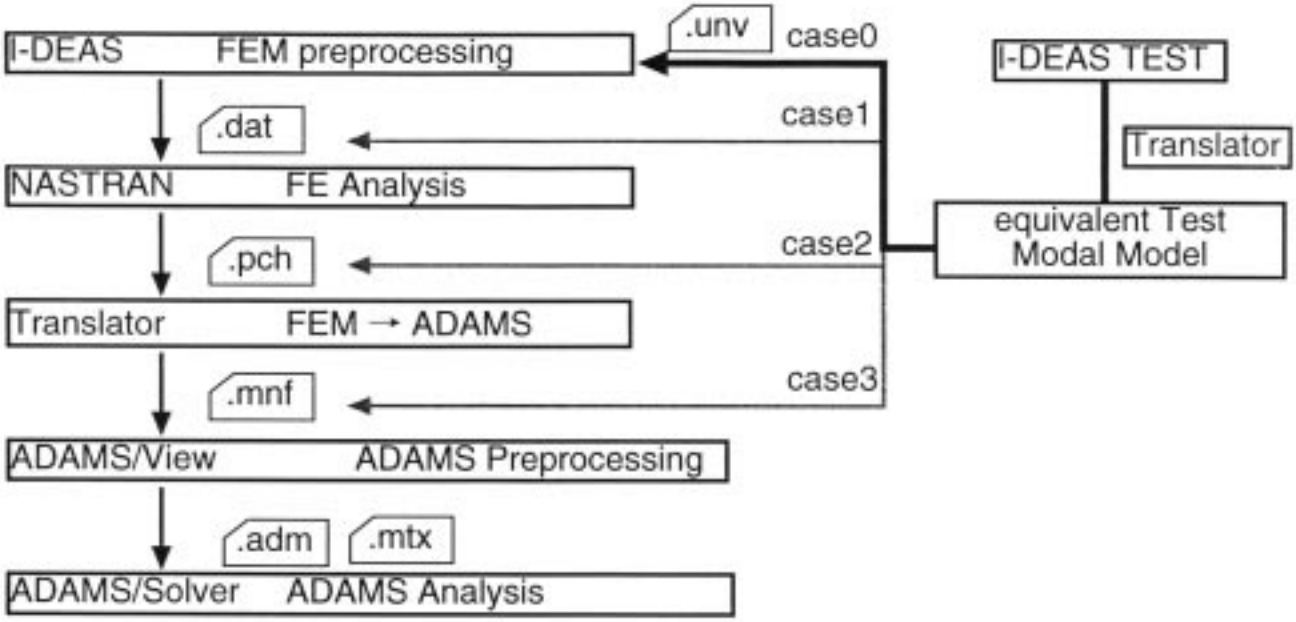
Abstract

In order to model elastic body with currently available ADAMS, it requires user to have a finite element structural model. The method described here allows user to model elastic body with a test modal model and thus eliminates a necessity of having an FE structural model.

This can be achieved by creating an equivalent FE model that represents modal characteristics obtained from structural testing and subsequent modal analysis. This equivalent FE model is then taken into ADAMS via ADAMS/FLEX, and the resulting model can be analyzed in the same way as with any elastic body model.

Approach



Comparison of each Approach

		case0	case1	case2	case3
MUST	File Format	○	○	○	×
WANT	Can be used by FE solver	○	○	×	×
	Can be used by FE Preprocessor	○	×	×	×
	Ease of use	← complicated			

case 0

- Necessary to take many steps before the analysis
- Allows test modal model to be used within FE solver

Theory

Modal Representation

$[M_m]\{q\} + [K_m]\{q\} = \{F_m\}$

$\{x_1\} = [\Phi]\{q\}$

$\{F_m\} = [\Phi]^T\{F\}$

- $[M_m]$:Modal mass
- $[K_m]$:Modal stiffness
- $\{q\}$:Modal DOF
- $\{F_m\}$:Modal force
- $[\Phi]$:Mode shapes
- $\{x_1\}$:Physical DOF

Equivalent description

Physical Representation

$[M]\{x_2\} + [K]\{x_2\} = \{F_m\}$

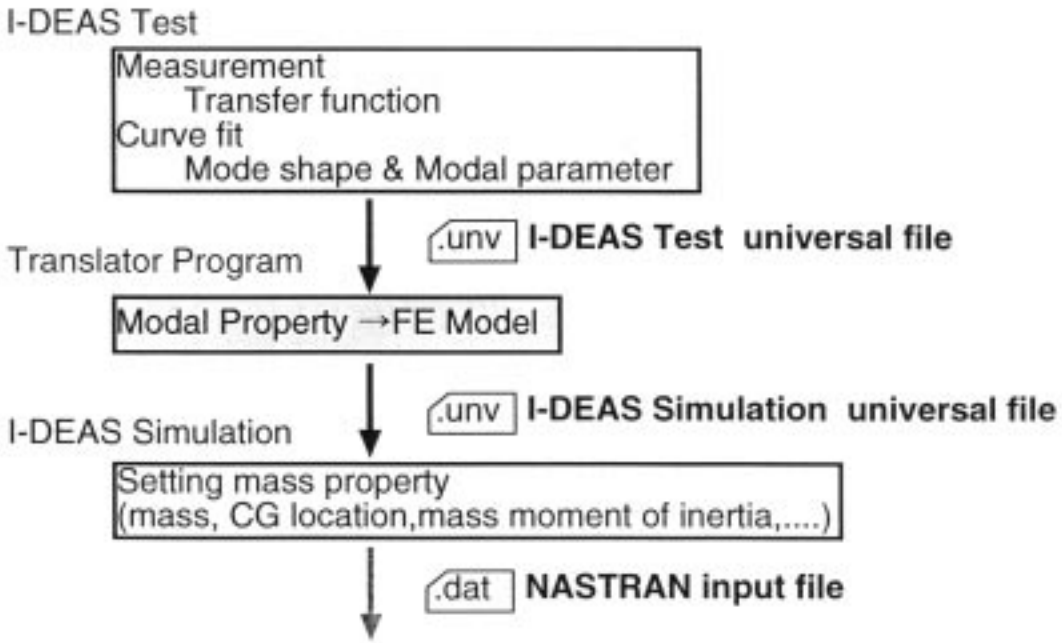
$\{x_1\} = [\Phi]\{x_2\}$

- $[M]$:Lumped masses
- $[K]$:Scalar Springs
- $\{X_2\}$:Physical DOF(virtual modal DOF)

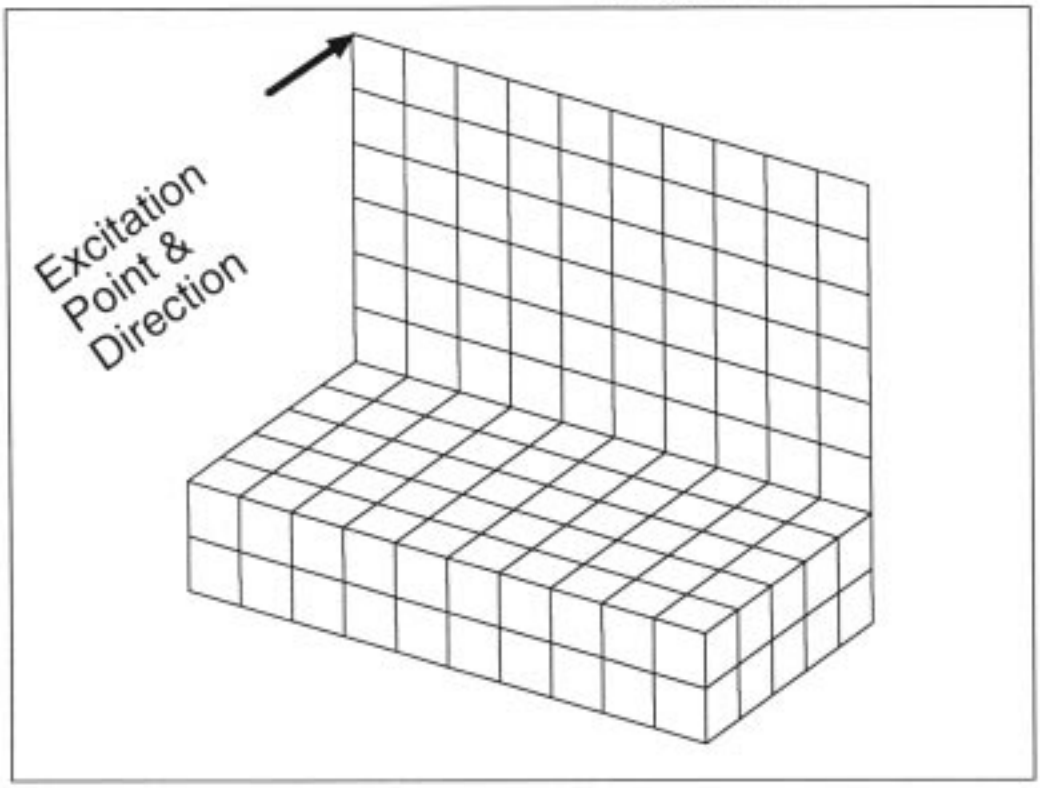
- $[\Phi]$:MPC coefficient
- $\{x_1\}$:Real physical DOF

Rigid body properties (mass/inertia) are represented by Lumped mass & Multi Point Constraint equations.

Flow of creating equivalent FEM



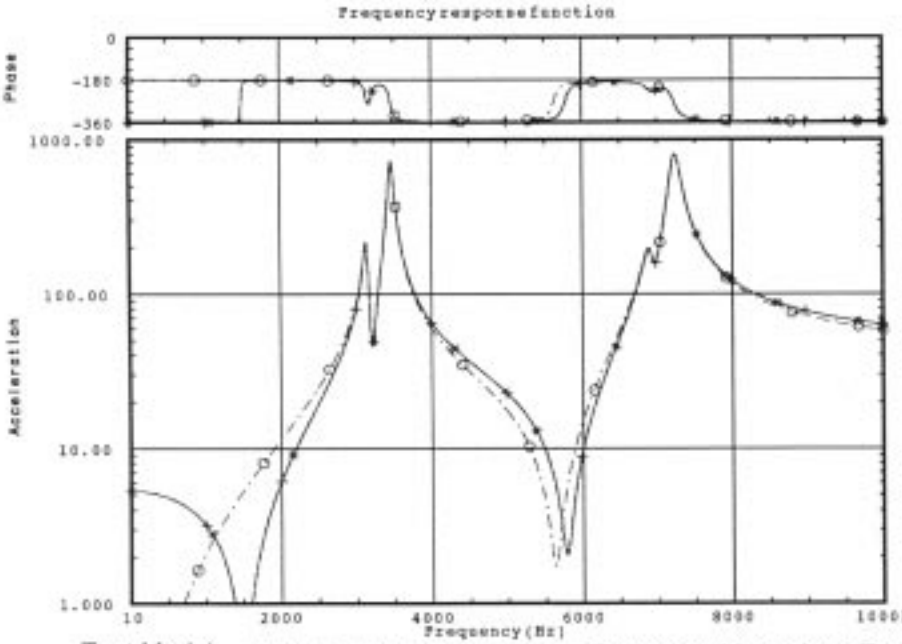
Model



NODE 264

ELEMENT
SOLID 100
SHELL 80

Validation (Component FEA)



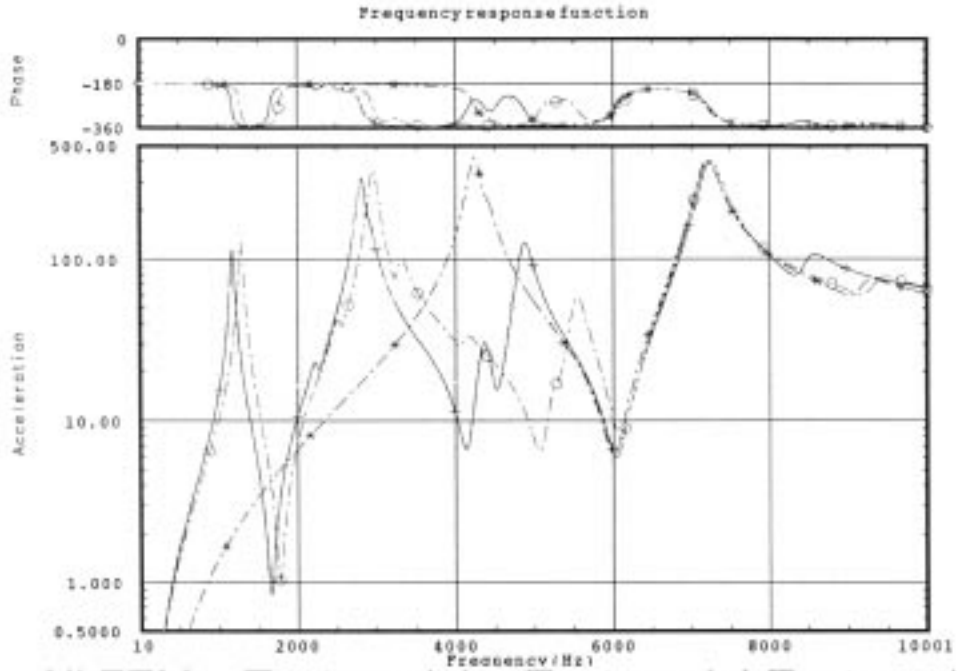
Test Modal

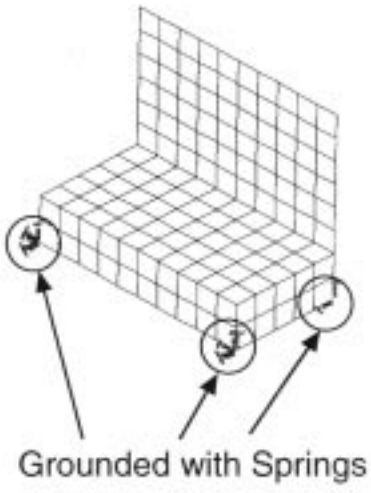
Equivalent Model from Test Modal with mass properties

Equivalent Model from Test Modal without mass properties

Equivalent FE model is able to simulate the charactaristics of the original test modal model.

Validation (Assembly FEA)





All FEM | Test modal without mass | Test modal with mass | Test modal added local K

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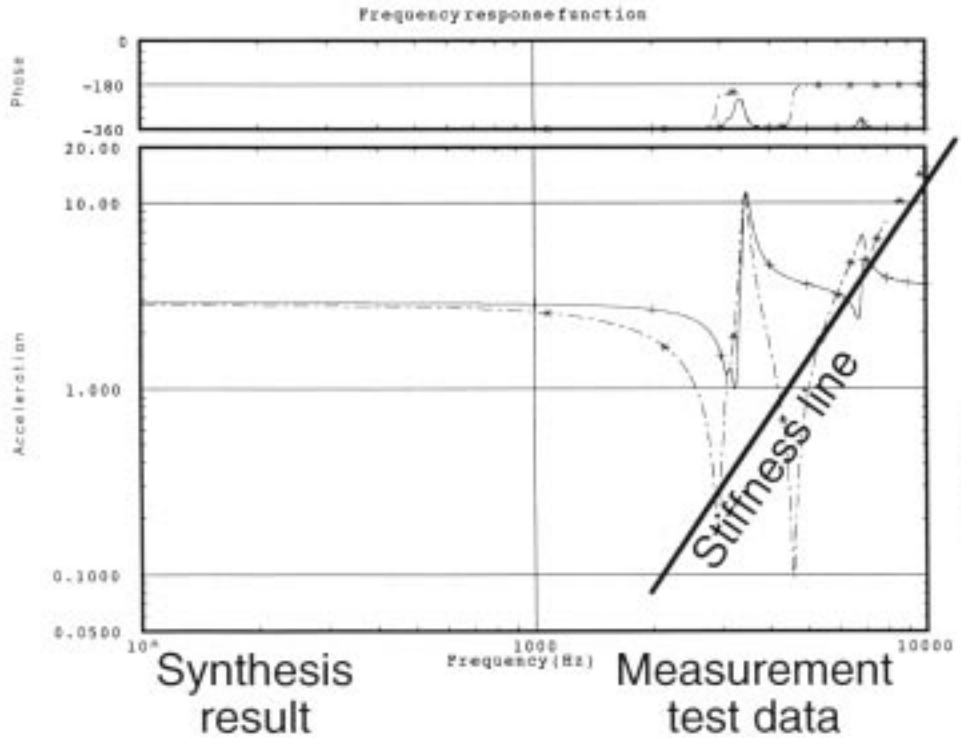
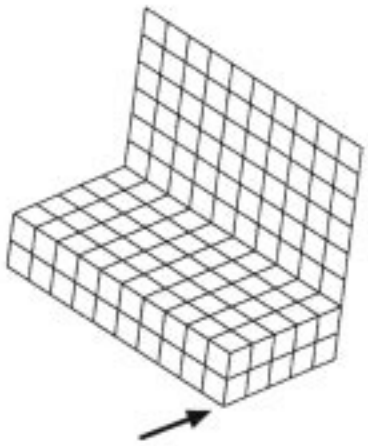
Local Stiffness





Local Stiffness can be obtained from the driving point response

Synthesis result

Measurement test data

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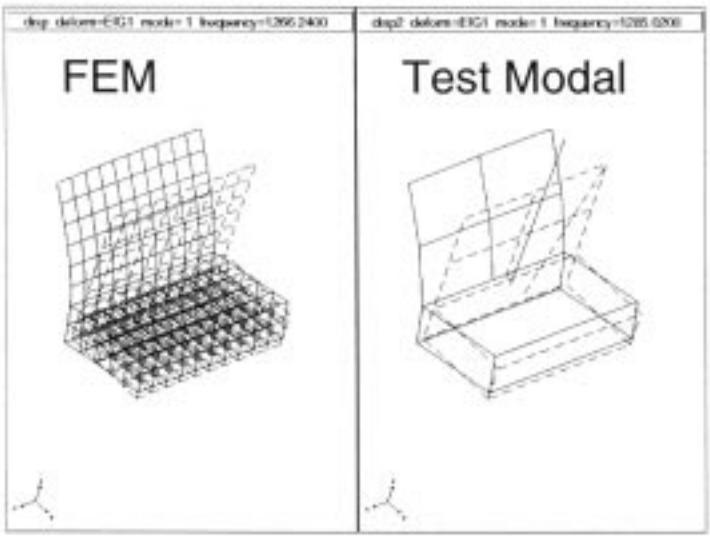
Comparison of results

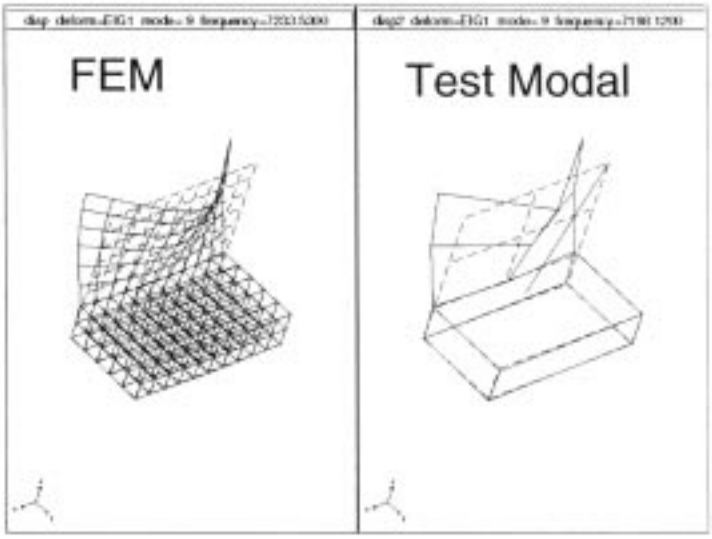
- Analysis result of model without rigid body properties (mass/inartia) deviates from the correct results.
- By accounting for the rigid body properties (mass/inartia), the model yields closer solution to the correct results. However, the result deviates largely for modes that depend heavily on local stiffness.
- By introducing local stiffness into the model, it will yield sufficiently accurate results.
- Local stiffness can be obtained from the driving point response at the connection points.

Validation (Assembly ADAMS/Linear)

Mode 1



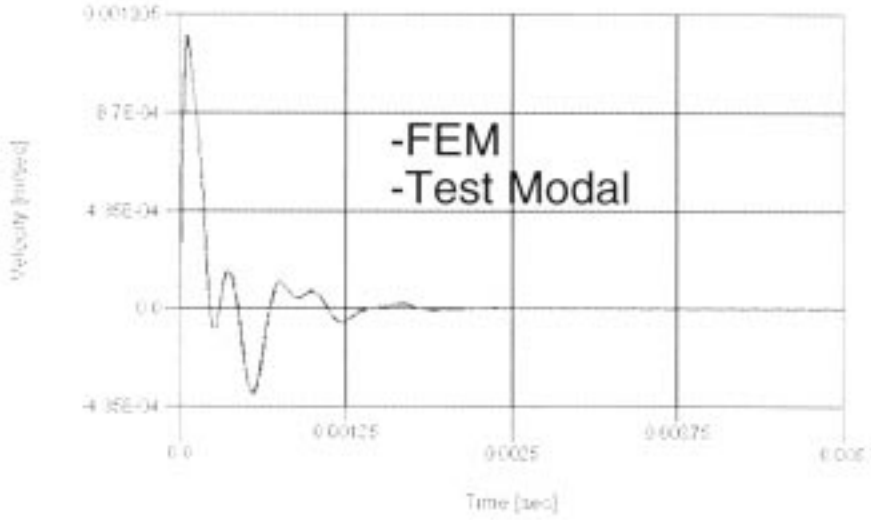
Mode 9



2 of 10 Modes via ADAMS/Linear

Validation (Assembly ADAMS)

Time Response under Step Force



Conclusion

- Method for utilizing test modal model within ADAMS was developed.
- Results were verified via ADAMS and NASTRAN.
- With the translated test modal model, it is possible to obtain more accurate results by accounting for local stiffness at connection points.