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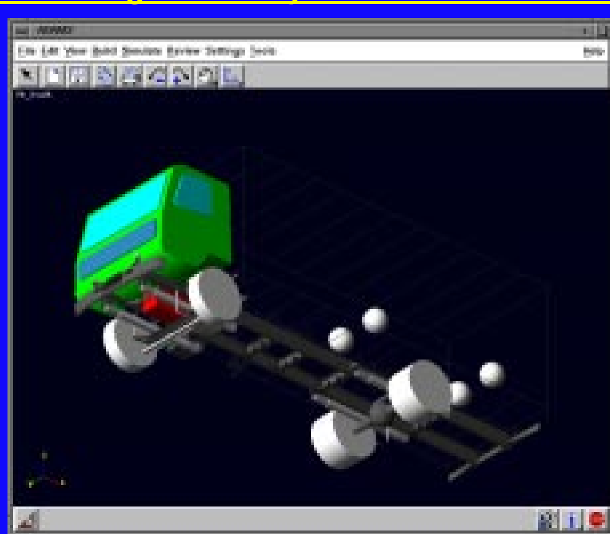
MBS modelling of the Leyland Trucks 55 Series 12Te



Dr. M.A.Pendlebury

19th November 1998

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Background

Two distinct approaches to Truck modelling have developed historically, each with associated limitations:

Multi-body approach

- Rigid body/torsional spring chassis models of limited accuracy
- Spring element suspensions fail to model geometric effects

Finite Element approach

- Beam models used to minimise model size can yield joint stiffness inaccuracies
- standard vehicle components (tires, road profiles, nonlinear dampers) are cumbersome to implement
- simulation times very high
- results interrogation difficult

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MBS modelling of the Leyland Trucks 55 Series 12Te

Modelling Objectives:

To accurately model a production vehicle to allow prediction of ride dynamics up to 20 Hz

using the following data -

- **Nastran finite element frame model**
- **Tested bushing and damping characteristics**
- **Component mass/inertia or material/geometry characteristics**

Further Objectives

To provide a model to evaluate ride, handling and structural NVH (to 50Hz) using ONE model only

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Leafspring modelling

Accurate leafspring models are essential to correctly replicate dynamic and kinematic behaviour -

- *Spring geometry has strong influence on steering behaviour*
- *FE approach is attractive but multiple FE bodies are required for each spring to prevent linearity errors due to range of deflections*

- **Multi - leaf springs simulated using Adams beams and parts**
- **Leaf contact simulated using IMPACT forces at tips**
- **Interleaf friction modelled as function of contact force and relative velocity of leaf tips - computationally intensive and limited accuracy**

For model, springs constructed fron geometries and cheched for:

- **Static rate**
- **First bending mode**

Modelled accuracy better than 5%

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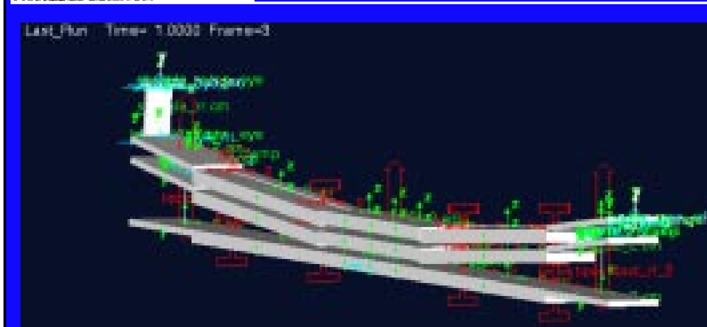

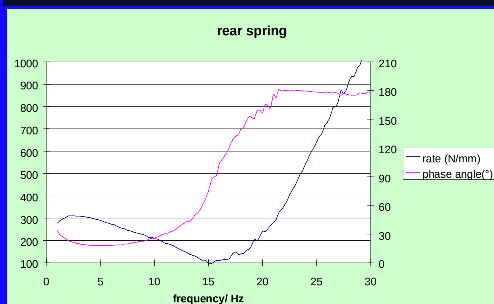

Adams spring model:

Static rate - 300 N/mm

1st bending mode - 16.4 Hz

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Frequency Dependent Bushings

Conventional bushings fail to represent true dynamics

- ***Viscous damping results in excessive dynamic stiffness at higher frequencies***
- ***Phase behaviour of the bush is incorrect***

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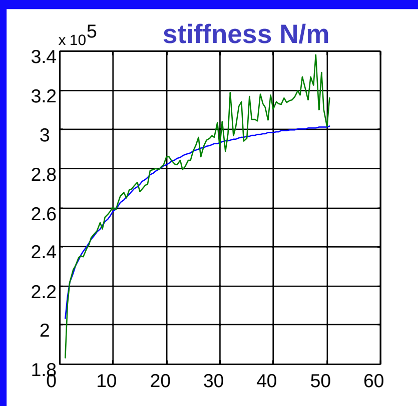
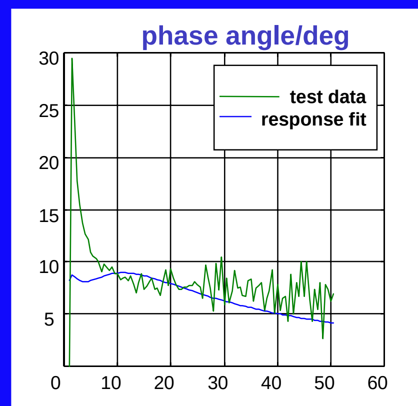
Frequency Dependent Bushings

Rubber mounts are modelled as GFORCE statements using Matlab to fit responses to test data- stiffness and damping remain accurate at high frequencies





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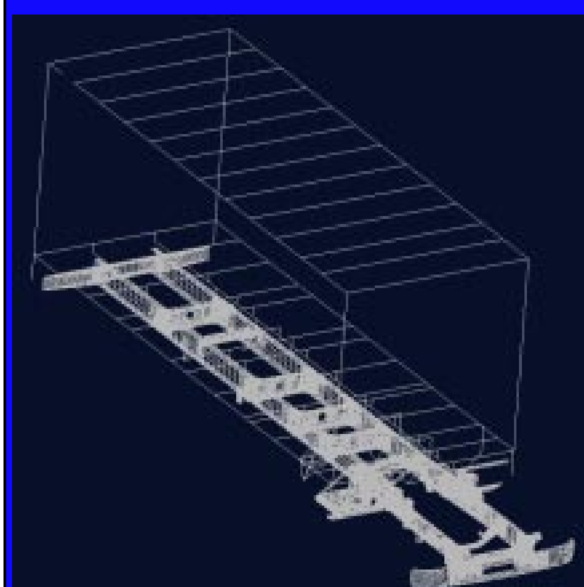

Nastran Frame Model

45,000 Nodes
135,000 DOF’s

Superelement -
31 exterior points
370MB .mnf file

From an initial 200 modes, over 150 can be reduced withuot noticable loss of accuracy

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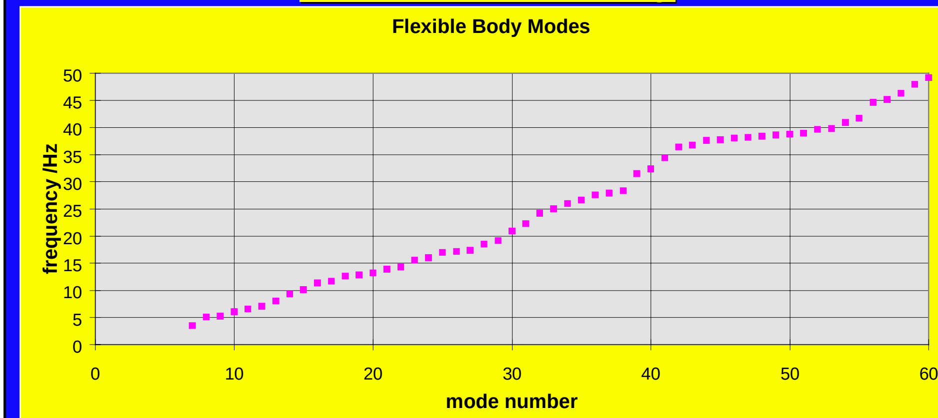
Frame Modal Activity



- LMS Link test correlation - 5% accuracy, predicted frequency against tested frequency
- Lowest frame mode typically falls around 3-5Hz, with consistent modal activity beyond this frequency

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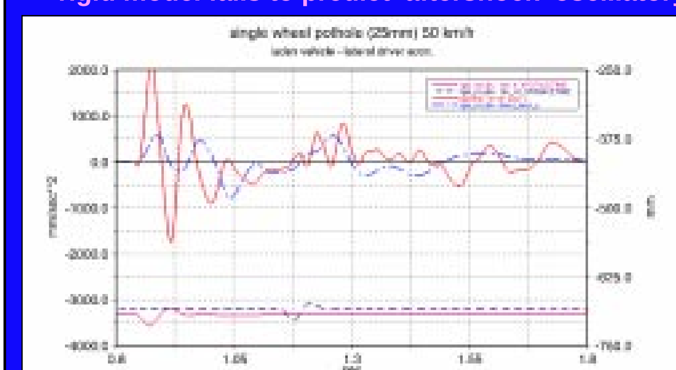
Importance of Flexibility - an example

model simulated over single sided pothole: lateral cab acceleration indicates significance of frame flexibility on response

- x 5 underprediction of peak level
- rigid model fails to predict 'aftershock' oscillatory effects



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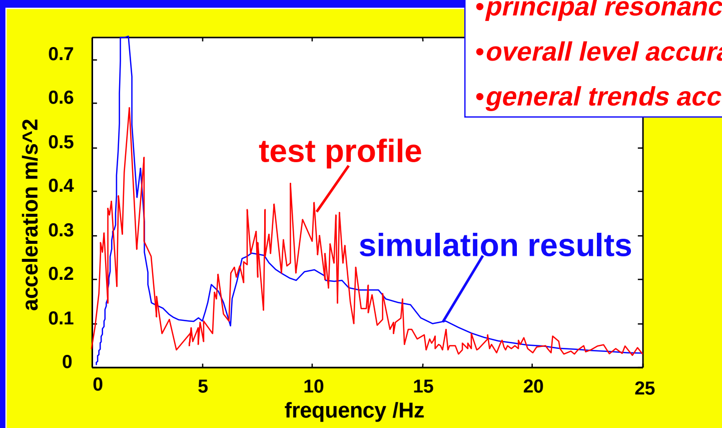
Ride Response: model vs. test vehicle

vehicle tested over a known road surface and compared to simulation over the same stochastic profile

- *principal resonances detected*
- *overall level accurately predicted*
- *general trends accurate*



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Typical Adams Performance Statistics

Model Summary:
86 Parts
417 DOF’s

Platform Summary:
SGI Octane
250 MHz R10000
1GB Ram

Five second ‘B’ road simulation	
all modes enabled	3300 secs
<2% strain energy modes disabled	1312 secs

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Current/Future Developments

- Incorporation of flexible cab models
- Validation of model up to 50 Hz for structural NVH prediction
- Liaison with tyre manufacturers to enhance tyre models
- Feedback of Adams results to FE to develop new loadcases