WHERE INSPIRATION AND INNOVATION COMBINE
NORTH AMERICAN PICK-UP RIDE ANALYSIS

Matthew Taylor - Principal Engineer Vehicle Dynamics
Contribution by Ricardo Prado of Metalsa
INTRODUCTION

• Requirement to understand ride limitation of large US pick-up trucks
• High volume strong selling vehicle – competitive market place
  – domestic product
  – imported vehicles
• Do we understand the cause of the ride deficiencies
• Decision drivers for truck chassis
  - direction from suppliers
  - perception of consumer
  - performance
WHERE ARE THE OPPORTUNITIES?

- Two ways to gain a financial advantage
  - better product for same money (less than competition)
  - same product for less money (less than competition)
WHAT IS OUR DIRECTION?

• Our aim was to match the competition for less money
  – understand the system
  – do not just follow the crowd
BENCHMARK

- Ride and handling comparison of six trucks
  - three domestic market, three imported

- Goal of this report – ride performance
  - target vehicle perceived worse primary ride
  - target vehicle perceived worse secondary ride
• Benchmarks 4 and 5 were thought to have car-like ride when unladen
• Ride centres of most US trucks were not axle aligned
  – significant spread of ride frequencies
  – axle centred strategy improves accuracy of front / rear type ride frequency calculation
- Benchmarks 4 and 5 were thought to have car-like ride when unladen
- Ride centres of most US trucks were not axle aligned
  - significant spread of ride frequencies
  - axle centred strategy improves accuracy of front / rear type ride frequency calculation
  - problems with primary ride strategy of target vehicle apparent
- Potential to improve axle centre strategy limited by vehicle’s mass, inertia and wheelbase ratio (dynamic index)
- Modification of wheelbase outside scope of project
  - modification of spring tune
  - significant recalibration of dampers
• Secondary ride (shake) identified as much more significant problem
  – dominated by axle roll and hop (in- and out-of phase wheel hop)
  – in phase of particular problem
• Strong couple to vehicle chassis – common to all beam axle trucks tested
• Axle bending frequency clearly not contributory
• Repositioning of chassis modal behaviour impractical
  – below 6Hz to separate from axle heave
  – above 13Hz to separate from axle bounce
• One vehicle attempted to lower chassis frequency
  – subjective appraisal notes persistent shake
• Operating shape analysis confirms similarity
  – modal positioning of vehicles very similar
  – amplitude of target vehicle significantly greater than benchmark
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Solution is to understand cause of higher amplitude
• Modal decoupling is not cost effective
  – lower axle mode too low
  – high axle mode too high
• Reduction in target vehicle axle mass will reduce excitation energy
• Nothing in findings to support removal of Hotchkiss system
• Combination of two concepts
  – low cost, low complexity Hotchkiss
  – minimised weight, rigid beam De-Dion
Secondary Ride – Reduced Axle Weight

- Beam no longer carries differential device
- Reduced weight, large section beam pressing
- Improved camber and toe stiffness
- ‘Unsprung’ mass reduced by 25%
- Excitation energy reduced by 3dB
#### RESULT OF MODIFICATION

- Subjective ride rating improved by 1.5 points
- Objective results show significant reduction in axle energy
- As anticipated, modal behaviour unaltered
FURTHER WORK

- Increased acceleration response at seat rail dominated by front axle activity
  - modifications to chassis have altered front axle coupling
  - opportunity to re-tune mass damper
CONCLUSIONS

• Primary ride compromised by poor inertia mass relationship
  – can be improved in limited sense by damping
• Axle activity and modal behaviour of chassis not realistically separable
• Secondary ride subjectively improved by reduced mass axle
• Simple solution represents cost effective fix
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