Steering Performance Evaluation of Off Highway Vehicle Using Matlab Tools

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Overview of Presentation

• Introduction
• Different Steering Types
• Orbital Steering Mechanism
• Modeling in Simscape
• Performing Analysis
• Results & Discussion
• Summary
Orbital Steering System

- The Orbital SCU is a rotary servo valve connected to a gerotor.
- The steering is fully fluid linked, therefore there is no mechanical connection between the steering wheel and the steered wheels or articulation joint.

Fig1: Orbital Steering
Analysis Objective

• To evaluate the steering performance of the vehicle at the conceptual design stage.

Analysis scope:

To virtually simulate the primary functions and observe the response of machine for performance parameters like:

✓ Steering Cycle times
✓ Metering Performance
✓ Multifunction Analysis
✓ Flow Priority to steering
Assumptions

- The analysis is performed assuming the vehicle is stationary.
- The friction factor for tire road interaction is assumed for this analysis.
- Inertia values between the spool and sleeve and other components are assumed for this analysis.
- Centering spring stiffness values are assumed for this analysis.
Orbital Steering Mechanism

- Orbital steering mechanism has complex components like Spool, Sleeve, centering springs & gerotor assembly.
- The deflection angle between the spool and sleeve causes the orifices to open.
- Spool and sleeve are held at Neutral position by Centering Springs.
- Flow amplification is provided for faster steering requirement, which by-passes the flow to the actuator.
- When steering input ceases, the centering springs bring spool to neutral position.

Fig 2: Orbital Steering valve overview
Steering Model in Simscape

- Steering control unit components like spool sleeve and gerotor are modeled.
- It is challenge to model interaction between the spool sleeve and gerotor to be modeled in simscape.
- Operator input is converted to spool/sleeve rotation.
- Mathematical model of steering control unit and the steering cylinders are developed in simscape.
- Analysis is performed by integrating Steering unit subsystem is integrated with full vehicle level model.

Fig 3: Subsystem View of Simscape Model
Steering Model in Simscape

- Steering Mechanism of the articulated machine is modeled using Sim-Mechanics.
- The front and rear part of the vehicle is modeled as lumped mass. Inertia, Mass and CG Properties are assigned to it.
- Front and Rear end are connected together through hydraulic cylinders which exerts force to articulate the machine.
- Tire models have been developed and used in this model to load the steering linkage mechanism.

Fig 4: Articulation of vehicle
Steering Unit Integrated to Vehicle Level Model
Results & Summary

- Steering cycle times are evaluated for different steering inputs and correlated with the physical test results.
- Steering performance of the machine is virtually evaluated for different engine speeds.
- Pressure and flow to the steering cylinders can be determined for various operator commands.
- The model once developed can be used for evaluating effect in change of various parameters.
Conclusions

• With such kind of advanced virtual simulation, lot of early design stage activities can be eliminated.
• The results obtained provides not only basis for evaluation of steering system performance but also for enhancement of design.
• Virtual simulation of the model reduces the cost and time associated with the design and physical testing significantly.
• Field Issues can resolved at early stage.
• Virtual verification reduces the risk for introduction of new products.
References


2. Steering and Turning Vehicles – 4, Steadystate turning and stability by Prof. R.G.Longoria, University of Texas, Austin, Spring, 2013.