New Possibilities for Analysis Based on Dynamic K&C Data

Pascal Mast, Manager Dynamic Chassis Simulator (DCS); 2009/06/18

TÜV SÜD Automotive GmbH
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The Challenge of Suspension Analysis

- The suspension affects two key characteristics of a vehicle: ride and handling.
- Today’s consumer expects a maximum of agility and comfort (=ride) and driving pleasure (=handling).
- Modern suspension systems must harmonize the traditional “opposites” of ride & handling as well as ensuring maximum safety.
- Weight and CO₂ reduction requires new chassis and body concepts without disadvantages in vehicle dynamics performance.
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The Challenge

- Transient vehicle dynamics play an important role
- Enormous amount of dynamic phenomena must be controlled
- Parasitic effects have major impact on handling and ride
- Validated dynamic simulation models are required for cost reduction
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Analyses

Objective Benchmark

Subjective Benchmark

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**Dynamic Chassis Simulator and dyn K&C Data**

- Enables to analysis of dynamic kinematics & compliance and frequency response analysis for evaluation & validation
- Various application such as full vehicle as well as system and component testing
- New possibilities of researching dynamic and parasitic influences with respect to comfort, agility and safety
- Unique concept in Europe – Huge range of applications with quick measurements and advanced results
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**DCS**

- Force and displacement controlled, 2 x 16 channel 3D optical Krypton measurement device + further measurement device

- Direct data export to simulations software and data post processing with different software applications possible
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Operation area

50 Kg Operating Range

Displacement (+/- mm)

Frequency (Hz)

30 Hz

50 Kg Operating Range
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Dynamic Chassis Simulator and dyn K&C Data

- The dynamic K&C analysis expands the currently used static evaluation and validation processes.
- It enables the comprehensive analysis of dynamic and transient characteristics.
- Investigations in single and combined directions with frequency response for handling as well as comfort aspects are feasible.
- Nonlinear effects such as hysteresis and friction can now be analyzed in more detail.
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Applications

- **Damping Characteristic:** Comparison between Damper Dynamometer and DCS

  \[ f = 6 \text{Hz} \quad \text{Amplitude} = 2, 4, 8, 12, 22, 32, 42 \text{ mm} \]

- Analyses of Shockabsorber behaviour under real conditions

- Variable damping characteristic in combination with axle models (HIL)

- Body characteristic is considered

- Dynamic effects could be allocated
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Applications

- **Steering characteristic:**
  Frequency response analyses

  ![Diagram showing force vs. frequency with THD factor]

- **Total Harmonic Distortion**

  \[\text{THD}\% = \sqrt{\frac{P_h}{P_1}} \cdot 100\]

- **Complete range of force and frequency possible**

- **All chassis parts are involved**

- **Nonlinear effects, hysteresis and friction can be analyzed in more detail, and the hole steering characteristic could be compared**
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Applications

- **Virtual Vehicle:** Validated simulation models based on K&C / Damping curve / Center of gravity / Inertia axis / Objective data /

- Output: e.g.:
  - Toe and Camber vs. [F]
  - Roll angle [°] vs. track [m]
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Combining the benefits of measurement and simulation

- The generated and validated axle simulation data can now be directly used for virtual driving maneuvers which are not possible on the test rig e.g. sinusoidal steer maneuver.
- The simulation results can be compared with measured track data or characteristic values.
- Objective characteristics and subjective benchmarks can be derived under realistic testing scenarios.
**Outlook and Summary**

- The DCS expands the static K&C testing, rig testing and component analysis
- Based on measured results, the vehicle tuning could be done very precisely, parts could be easily changed and replaced
- The DCS combines the benefits of objective and subjective evaluation and simulation
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