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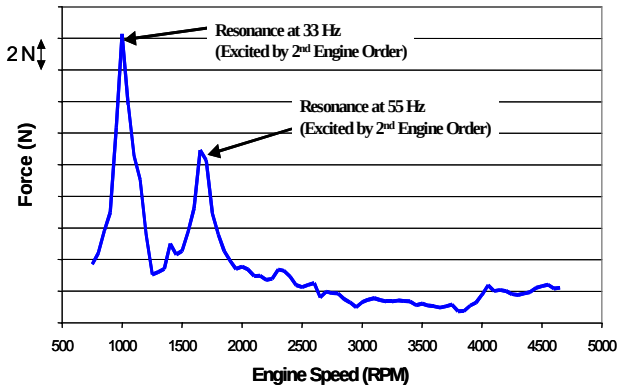
# Vehicle NVH Development

## Exhaust System: Testing Capabilities

*FEV supports all areas of vehicle and powertrain NVH development. Specifically, this sheet summarizes some of FEV's experimental and testing capabilities in support of exhaust system NVH.*

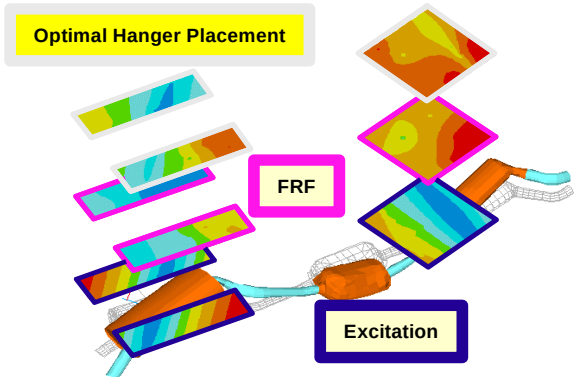
As part of full vehicle evaluations, FEV routinely measures **exhaust hanger vibrations** on both sides of each exhaust mount under various engine speeds and loads. Such measurements are useful to quantify the vibration isolation across the exhaust mounts. The exhaust mount vibrations, in conjunction with the mount properties can be used to estimate force inputs at each exhaust hanger location. Also, mobility measurements can be used to quantify the dynamic stiffness of the vehicle body at each hanger attachment point.




In order to understand the various global resonances associated with exhaust systems, FEV conducts **modal analysis** including the powertrain and the entire exhaust system. Also, acceleration measurements during vehicle operation are used to conduct a running modes analysis. Such analyses are used to obtain correlated analytical models.

An understanding of the dynamics of the exhaust system is critical to optimal **exhaust hanger placement**. Modal analysis and running modes analysis help understand the points of high displacement and the frequencies associated with them. FEV's methodologies for exhaust hanger placement take into account the energy inputs from the exhaust system, dynamic stiffness of the body attachment locations, and vibroacoustic transfer function (exhaust hanger force to interior sound pressure) measurements. Based on the aforementioned measurements, potential hanger locations are mapped and the most optimal ones chosen.

- **Exhaust hanger vibration**
  - Vibration isolation
  - Body mounting point stiffness characterization
  - Force inputs to body
- **Exhaust system modal analysis**
  - Normal modes analysis
  - Running modes analysis
- **Exhaust hanger placement**
  - Force inputs to body
  - Vibroacoustic transfer functions
- **Tailpipe orifice noise**
  - Optimization for improved sound quality




**Tailpipe orifice noise** accounts for approximately 50% of exhaust noise in a vehicle. FEV uses a combination of CAE and experimental techniques to optimize the exhaust tailpipe noise levels and sound quality. Measurements such as tailpipe noise, temperatures and static/dynamic pressures at various points in the exhaust system are conducted to support FEV's CAE model development.

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