TEC INFO

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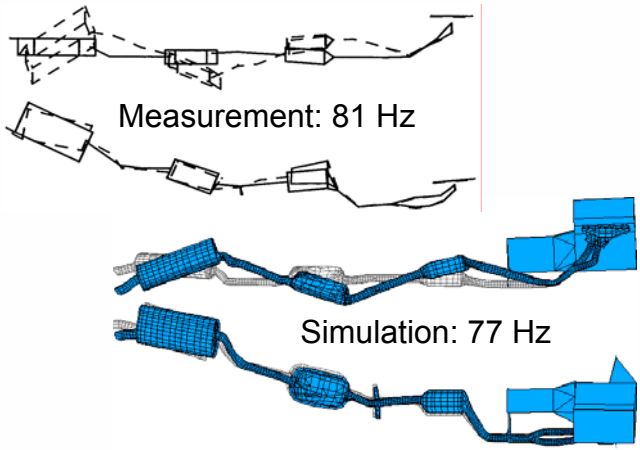
Powertrain NVH Development
Exhaust System CAE

Modern exhaust systems and manifolds carry high dynamic and thermal loads. FEV has developed CAE methodologies to help ensure that the exhaust systems function satisfactorily under operating dynamic and thermal loads.

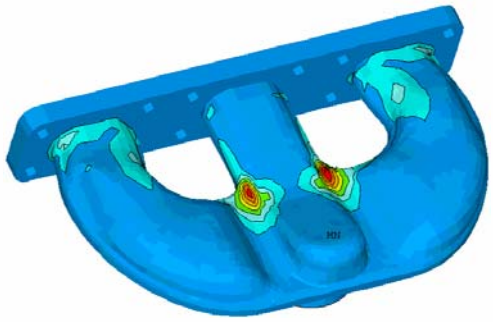
Vibrations of the exhaust system can cause durability problems at the muffler inlet and outlet locations. Also, exhaust system vibration can propagate through the exhaust hanger mounts and manifest as perceived noise and/or vibrations in the passenger compartment. FEV has developed a new methodology to perform a reliable dynamic analysis. This methodology is based on a Finite Element Analysis of the complete exhaust system including the powertrain and all mounts. Also, air-gap insulated manifolds and decoupling elements are considered and modeled appropriately. In addition to computing normal modes and mode shapes, FEV's methodology captures realistic boundary conditions and system damping properties. As a result, this technique can perform an accurate prediction of vibrational amplitudes.



The analysis of thermal loads is required to ensure the exhaust manifold durability. FEV has developed accurate CAE tools to perform life expectancy predictions for exhaust manifolds. To make accurate life expectancy predictions, our technique captures the transient response (under thermal shock) taking into account the plastic material properties of the exhaust manifold. Also, the technique uses a new quasi-transient analysis method, that allows for a significant reduction in computational time.

Typically, the exhaust tailpipe orifice noise accounts for 50% of exhaust noise, while the other half is caused by radiated shell noise. FEV uses a one-dimensional CFD model for prediction and optimization of tailpipe orifice noise. Radiated shell noise is caused by engine vibration and gas pulsation excitation. FEV uses a FEA based methodology to optimize the radiated shell noise characteristics.

- **Exhaust system vibration caused by engine and road excitation**
  - Durability issues
  - Cab interior noise and vibration
  - Forces at the hanger positions
- **Thermal stress**
  - Exhaust manifold
  - Brackets
- **Noise**
  - Radiated shell noise induced by engine vibration and gas pulsation excitation (for e.g. manifolds, cross-over pipes …)
  - Orifice noise



Exhaust Manifold Thermal Stress Distribution

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