



Engineered Measurement Systems, Inc.
Professional Experts in Strain Gages and Torque / Horsepower Measurement

2008 North American Test Expo Open Forum

Automotive Fuel Economy Improvement

By Reduction of Vehicle

Parasitic Horsepower Losses

Using EMS Coastdown Wheel Torque-Meters

with

F.T.Buckley Data-Acquisition & Analysis Software

Definitions of Terminology

“Road Load”

- *Generic:* Forces that Impede Vehicle Motion.
- *Common Thought:*
Force Needed to Propel a Vehicle Forward.

Horsepower Losses

SAE Automotive Classifications:

- *Aerodynamic Drag*
- *Tire Rolling Resistance*
- *Chassis Friction*

MEASUREMENT SYSTEM GOALS

Accurate Measurement of the *Actual* “**Road Load**” Forces Acting on the Vehicle and on each Wheel at the Test Track & on a Chassis Roll Dynamometer.

Analysis & Separation of the *Horsepower Losses* into:

- *Aerodynamic Drag*
- *Tire Rolling Resistance*
- *Lump Sum Chassis Friction*
- *Certain Components of Chassis Friction*

Measurement System for Improving Fuel Economy

**REDUCE THE
HORSEPOWER LOSSES**

&

IMPROVE FUEL ECONOMY

Identify the “Biggest Bang for the Buck”!

OVERVIEW OF MEASUREMENT SYSTEM

Accurate Measurement of Horsepower Losses

- EMS Coastdown Wheel Torque-Meters
 - ABCD Data Acquisition Hardware
 - F. T. Buckley ABCD Modules “D” & “E”
- Data Acquisition & Analysis Software

Typical Tests with Wheel Torque-Meters

- SAE J2263 Test Track
- SAE J2264 Chassis Rolls Dynamometer
- Series of Coastdowns
- EPA Type, Highway Drives
- ABCD Steady-State Drive Tests

Basic Coastdown Test

- Vehicle is Accelerated to ~75 mi/hr (120 km/hr).
- Transmission is Disengaged to a “Neutral” Position.
- Vehicles Coasts to a Stop.
- Individual Wheel Torque-Speed-Time Data is Recorded.

Model of a Basic Coastdown Test

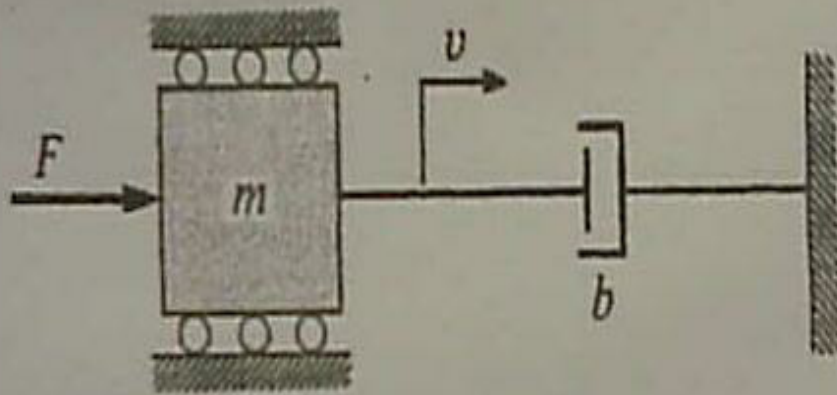


Fig.1 Mechanical Model of a Coastdown Test

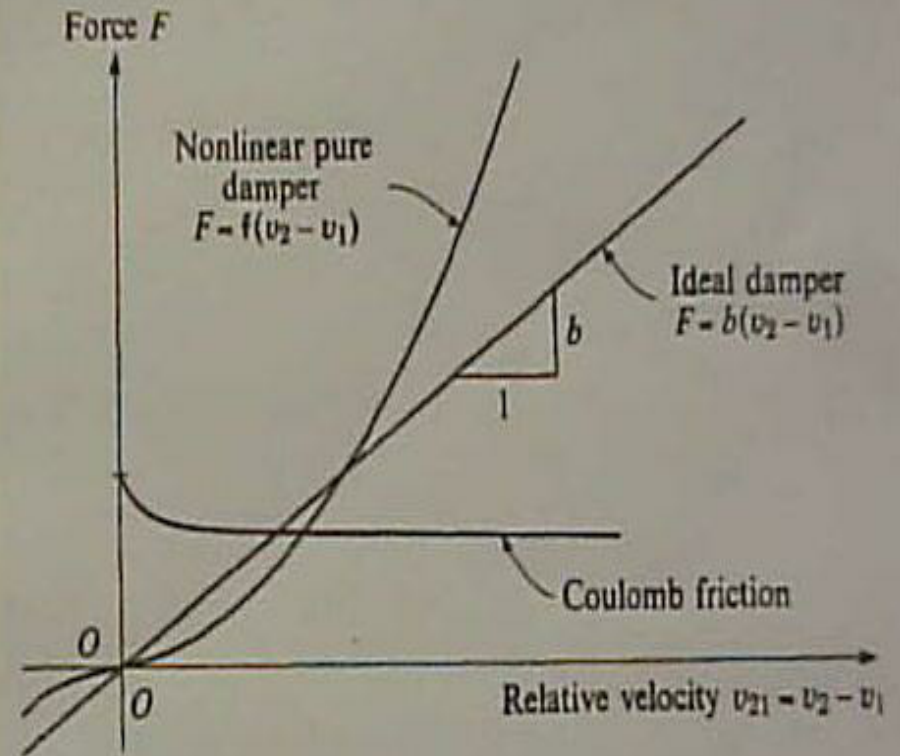


Fig. 2 "D"-Type Energy Dissipation

Forces Acting on a Coasting Vehicle

Aerodynamic Forces:

- Lift
- Side Forces
- Drag

Tire Rolling Resistance:

- Tire Rolling Deformation
- Traction Forces from Tire Tread Geometry
- Suspension Down-Forces

Chassis Drag:

- Transmission & Drive Train Components
- Brakes, Seals & Lubricants

OVERVIEW of MEASUREMENT SYSTEM

- Special Wheel Torque-Meters, ABCD Hardware & Software on an Automotive Chassis that has been “Broken-In” (i.e. vehicle’s friction losses have been stabilized).
- Test Track Runs are Accompanied with a Wind Anemometer and a Vehicle Velocity Sensor.
- Roll Dynamometer Runs are Accompanied with Wheel Speed Sensors.
- Temperature Measurements are made of Ambient Conditions and Vehicle Components, at the Test Track & on the Dyno.

OVERVIEW OF MEASUREMENT SYSTEM

- “Road Load” can be separated into Aerodynamic Drag + Tire Rolling Resistance on one side of the Wheel Torque-Meter.
- Lump Sum Chassis Friction on the other side of the Wheel Torque-Meter.
- Component Chassis Friction is Identified through Default Tests by Component Removal

Special Torque-Meter Requirements

- Very High Torsional Overload is Required.
- Minimum Errors Due to Temperature and Temperature Gradient Conditions.
- Negligible Errors from Radial Loads.
- Negligible Errors from Bending Moments.
- Excellent Low Range Repeatability.
- Allows Coastdown Compatibility Analysis for Roll Dynos & Test Tracks.

EMS Wheel Torque-Meter Features

- State-of-the-Art/Science of a Strain Gage Based Measurement System.
- Good Fatigue Life.
- Rotary Transformer Power & Signal Electromagnetic Coupling System.
- Contains **NO** Rotating Electronics.
- $\pm 250,000$ Counts of Stable Resolution.
(i.e. $\pm 25,000$ in-lbs with 0.1 in-lb Resolution)

*****Future Application for the EMS Wheel Torque-Meter*****

- The Ability to Model the Dynamometer to Simulate Forces Acting on Various Road Grades.
- Investigations into *Actual* Vehicle Passing Push/Pull & Underbody Turbulences.
- Investigations into *Actual* Tire Rolling Resistance Various Tire Geometry on Different Road Surfaces.
- Verification of *Actual* Roll Dynamometer “Road Load”

*****Future Application for the EMS Wheel Torque-Meter*****

Investigation into AWD/4WD Dyno Restraint Systems:

- Comparison and Insight into the Differences of Road Load Coefficients on each Wheel.
- Measurement of Vehicle Coastdown Target Load Error for each Speed Interval.
- Ability to Investigate the Frictional Force Coefficients of the Dyno/Vehicle Combination.

*****Future Application for the EMS Wheel Torque-Meter*****

Alternative Drive Test for Determining “Road Load”:

- Solves the Problems with Coasting CVT Transmissions.
- Removes the Repeatability Problems Related to the Variability of “Spin Loss” Associated with Coasting Some Automatic Transmissions.
- Possible Use for the Hybrid Electrics.
- Allows a Shorter Test Track to be Used to Determine “Road Load” for Vehicle Emissions Certification.

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&

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- Document the Vehicle Parasitics.
- Identify the “Biggest Bang for the Buck”!

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