

# Task 16: Ride Measurement Experiment

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# Outline

- Smoothness Thresholds
- Measurement Equipment
- “Ride” Data Analysis
- Summary Results
- Further Work

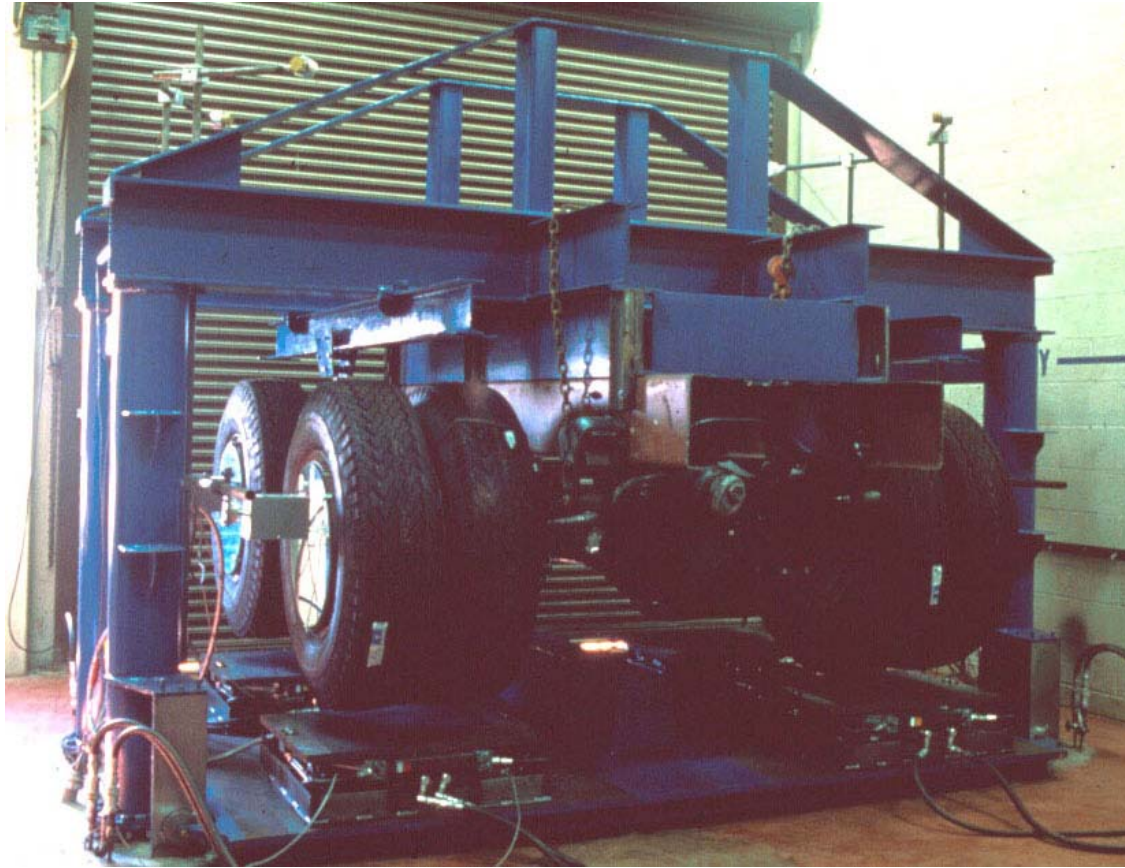
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# Smoothness Thresholds

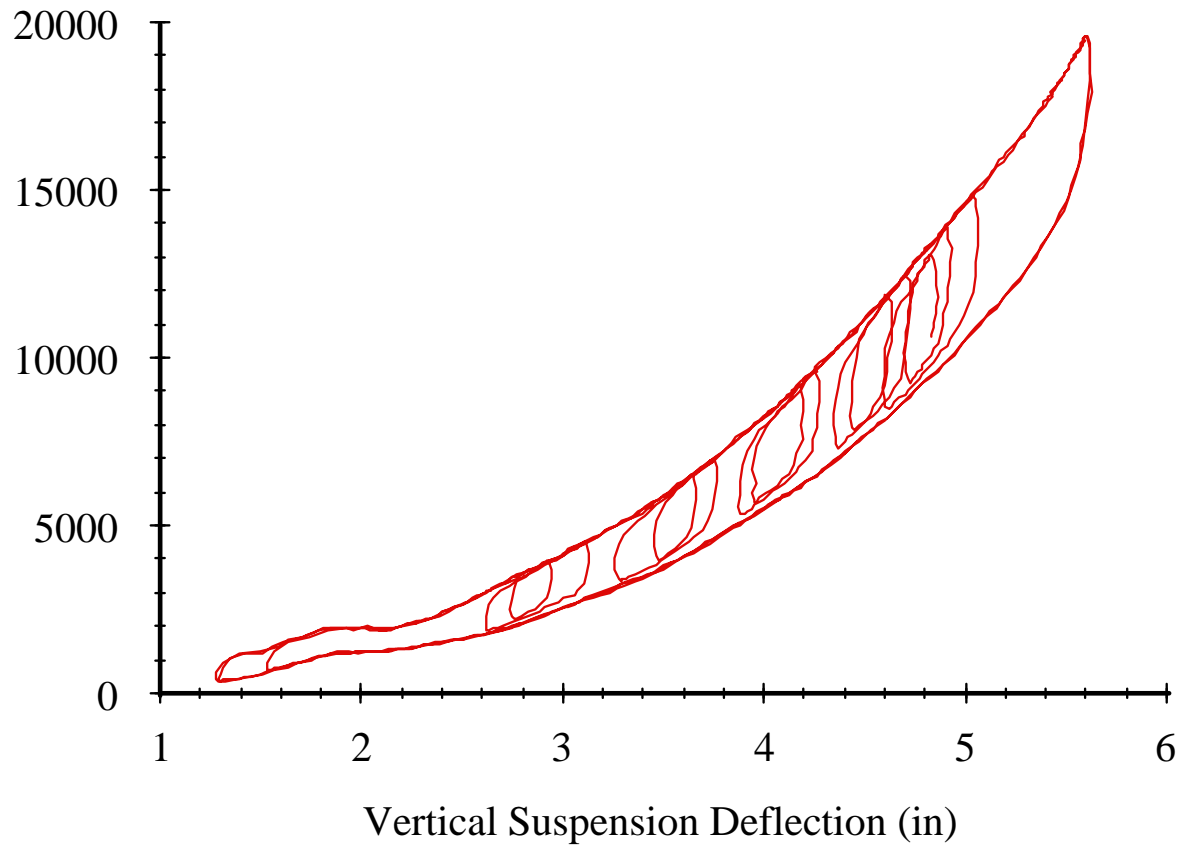
- How smooth is smooth enough?
  - reduction of truck dynamic loading
  - reduction of operating costs
  - user perception of ride quality
- Balance smoothness thresholds against added construction costs.

# Truck Suspension Properties



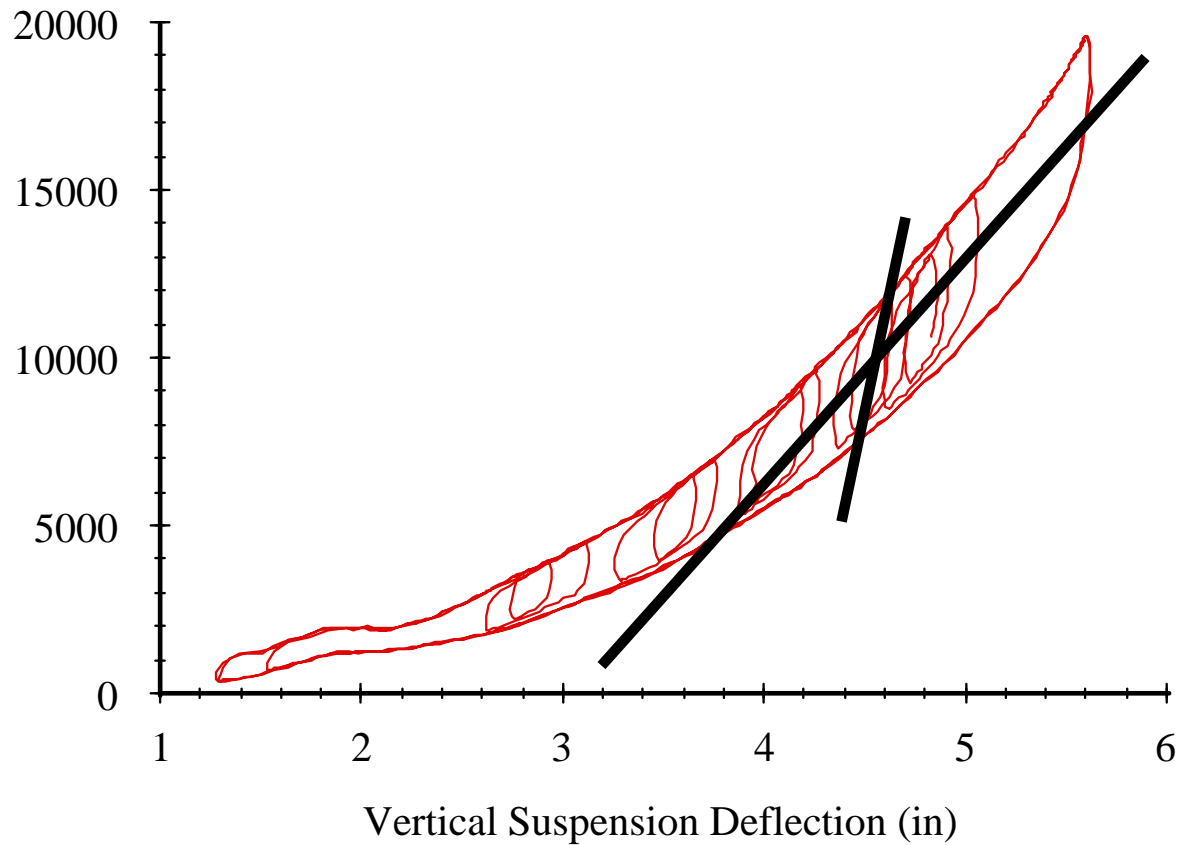
# Suspension “Stiffness”

Vertical Suspension Load (lbs)



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Vertical Suspension Load (lbs)



# User Perception of Ride

- We are looking for the threshold of perception, annoyance:
  - Often expressed as a limit on acceleration
  - Suspension friction may be a factor
  - Internal sources of vibration are important



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# The Experiment

- Measured accelerations at human/vehicle interfaces.
- Simultaneously measured profile.
- Tested 2 vehicles.
- Covered 33 pavements.

# 2005 Infiniti Q56



# 2003 Altima



# Sensor Layout



# Seat/Buttock and Seat/Back



# Floor/Feet



# Steering Wheel/Hands





# Profiler



# Operator “Station”



# Test Sections

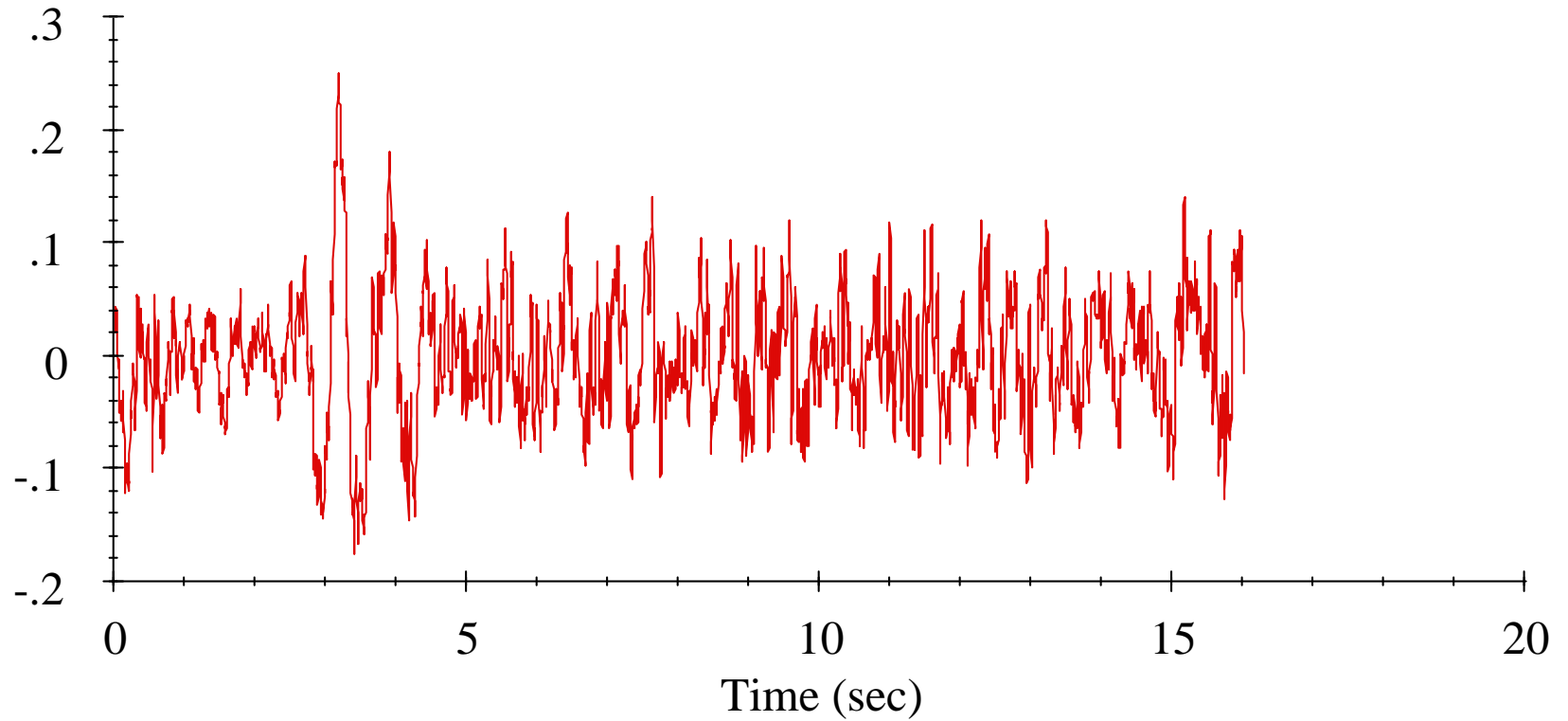


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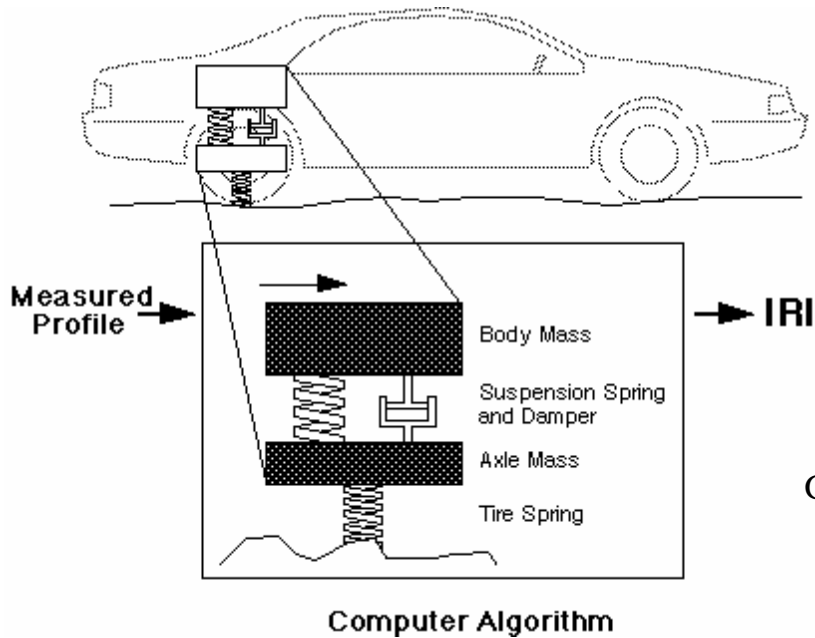
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# Acceleration Trace

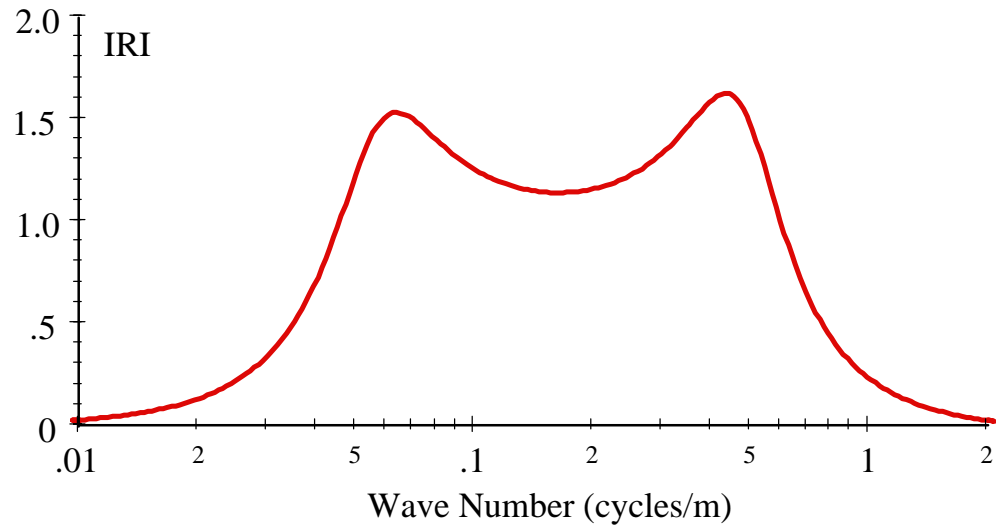
Seat/Buttock Vertical Accel. (g)



# Resonance Frequencies



Gain for Profile Slope

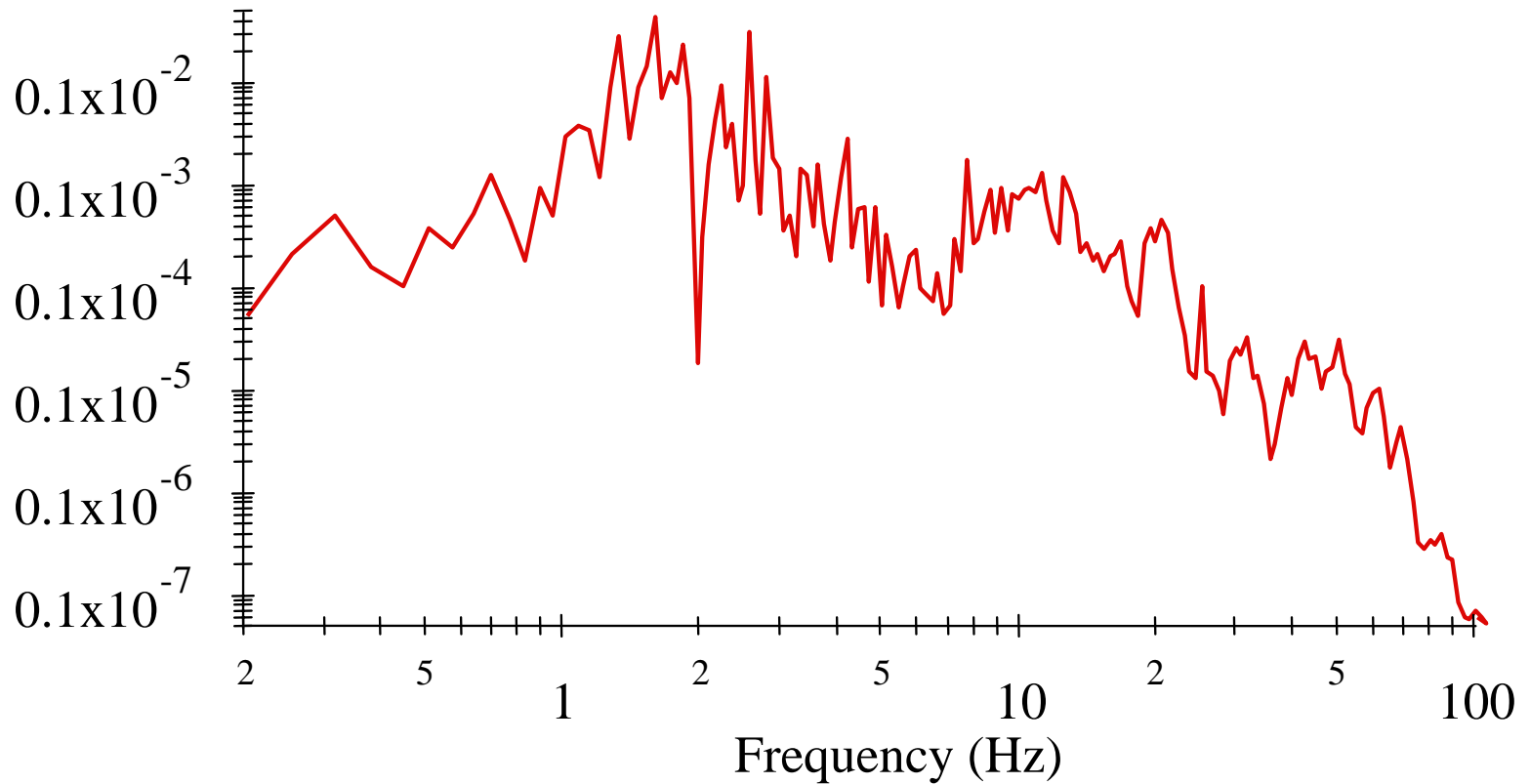


# Resonance Frequencies



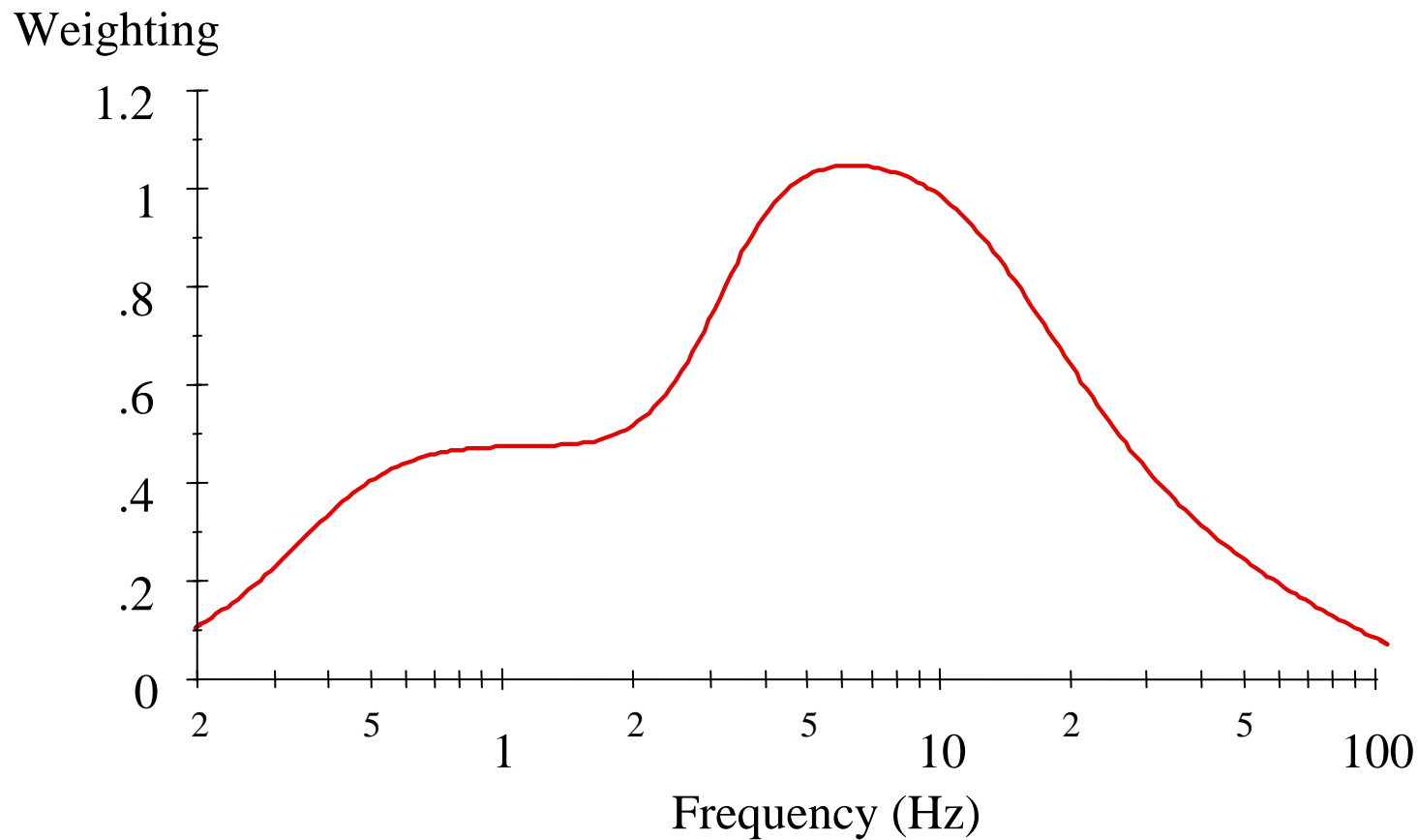
# Power Spectral Density

SeatBTZ Accel. ( $g^2/\text{Hz}$ )



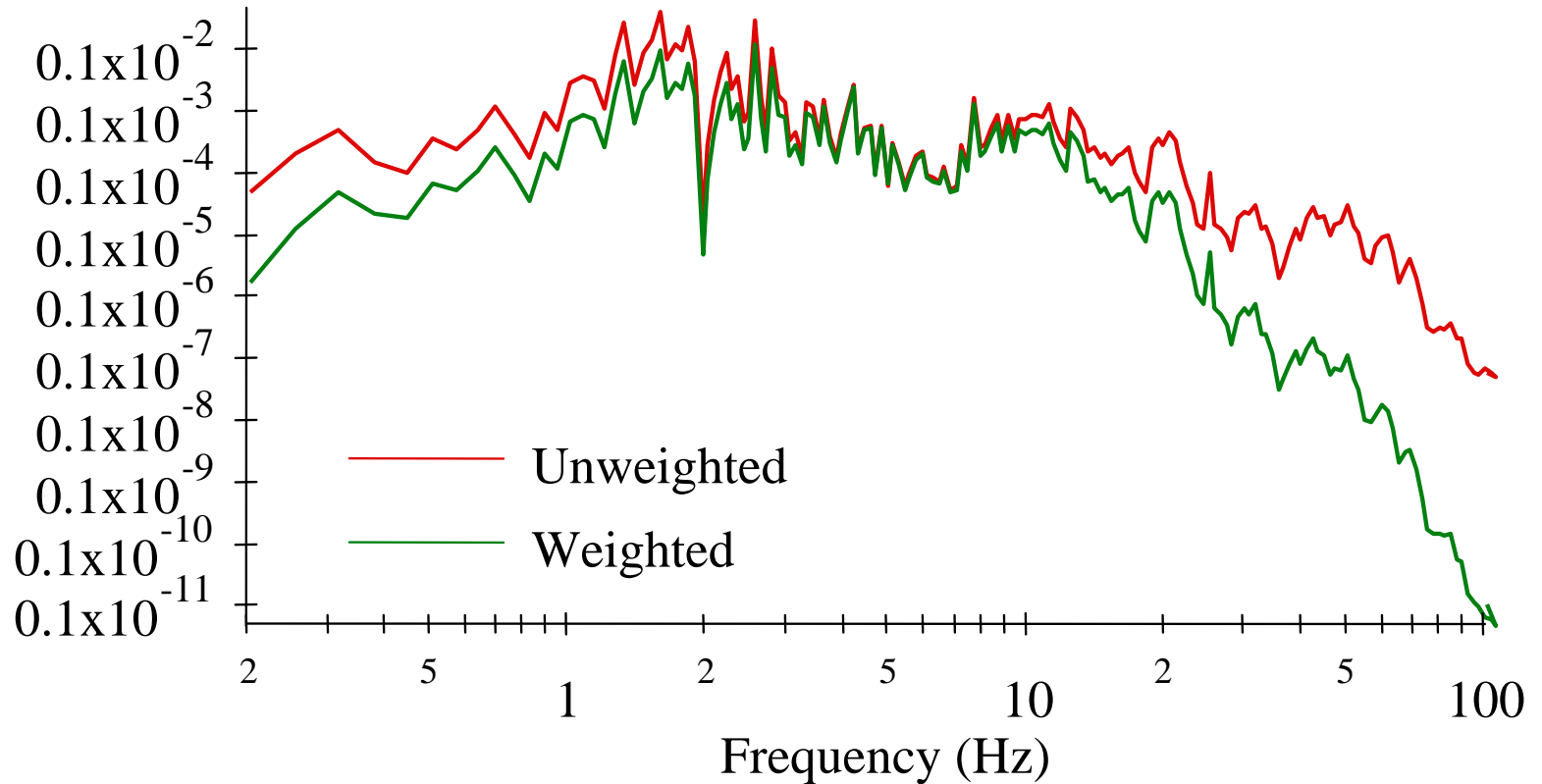


# Frequency Weighting

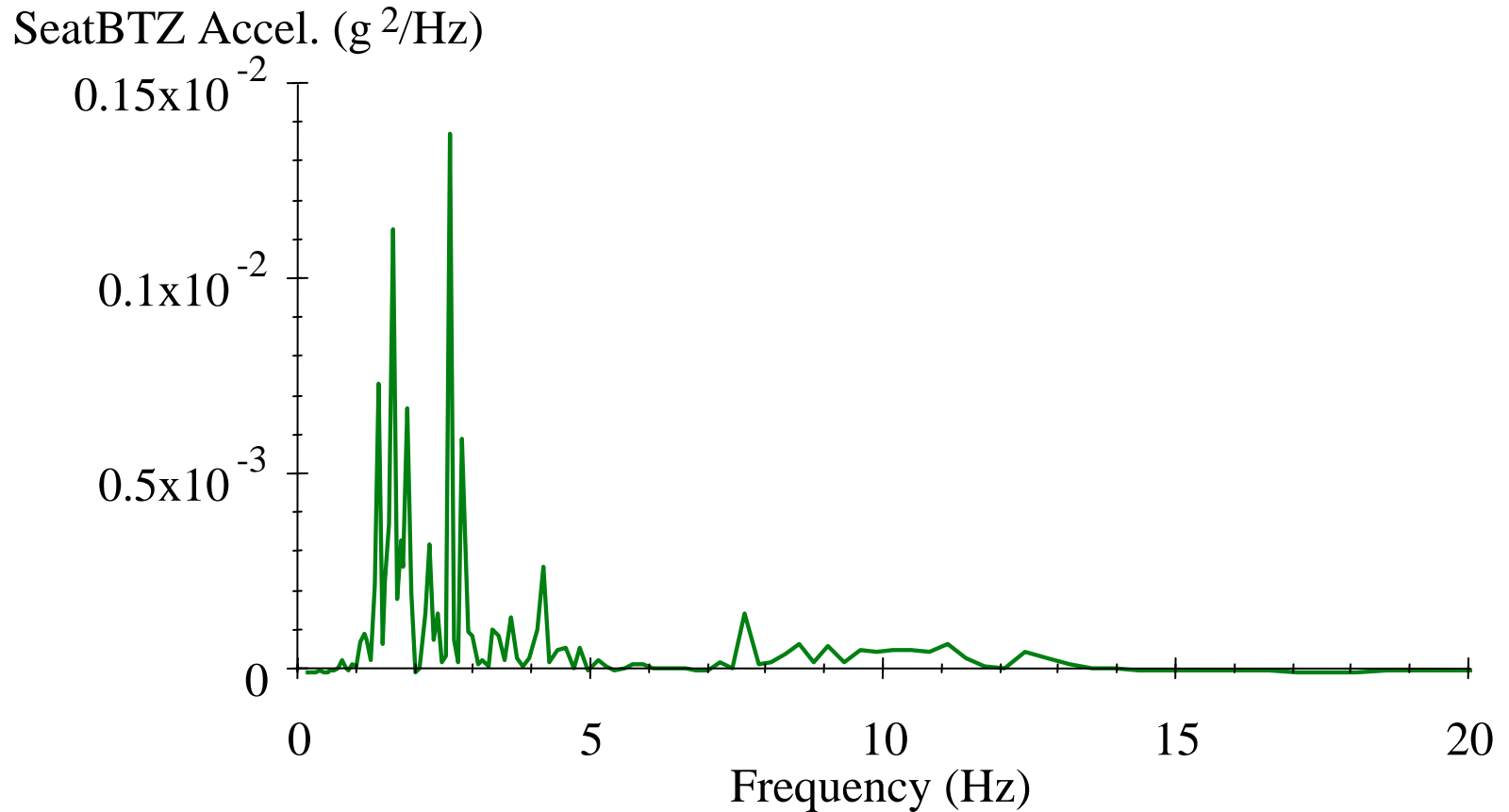


# Frequency Weighting

SeatBTZ Accel. ( $g^2/Hz$ )

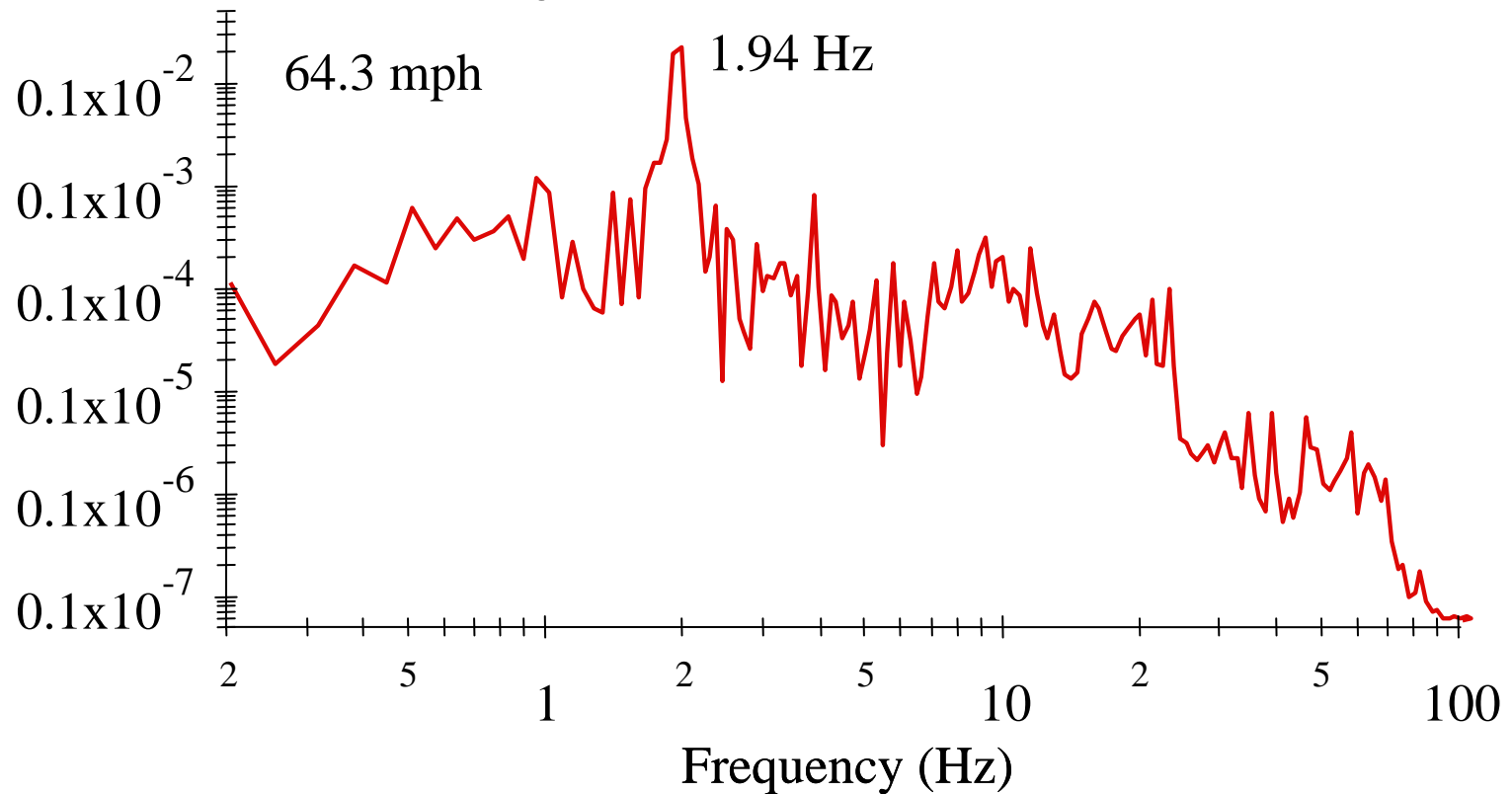


# Frequency Weighting



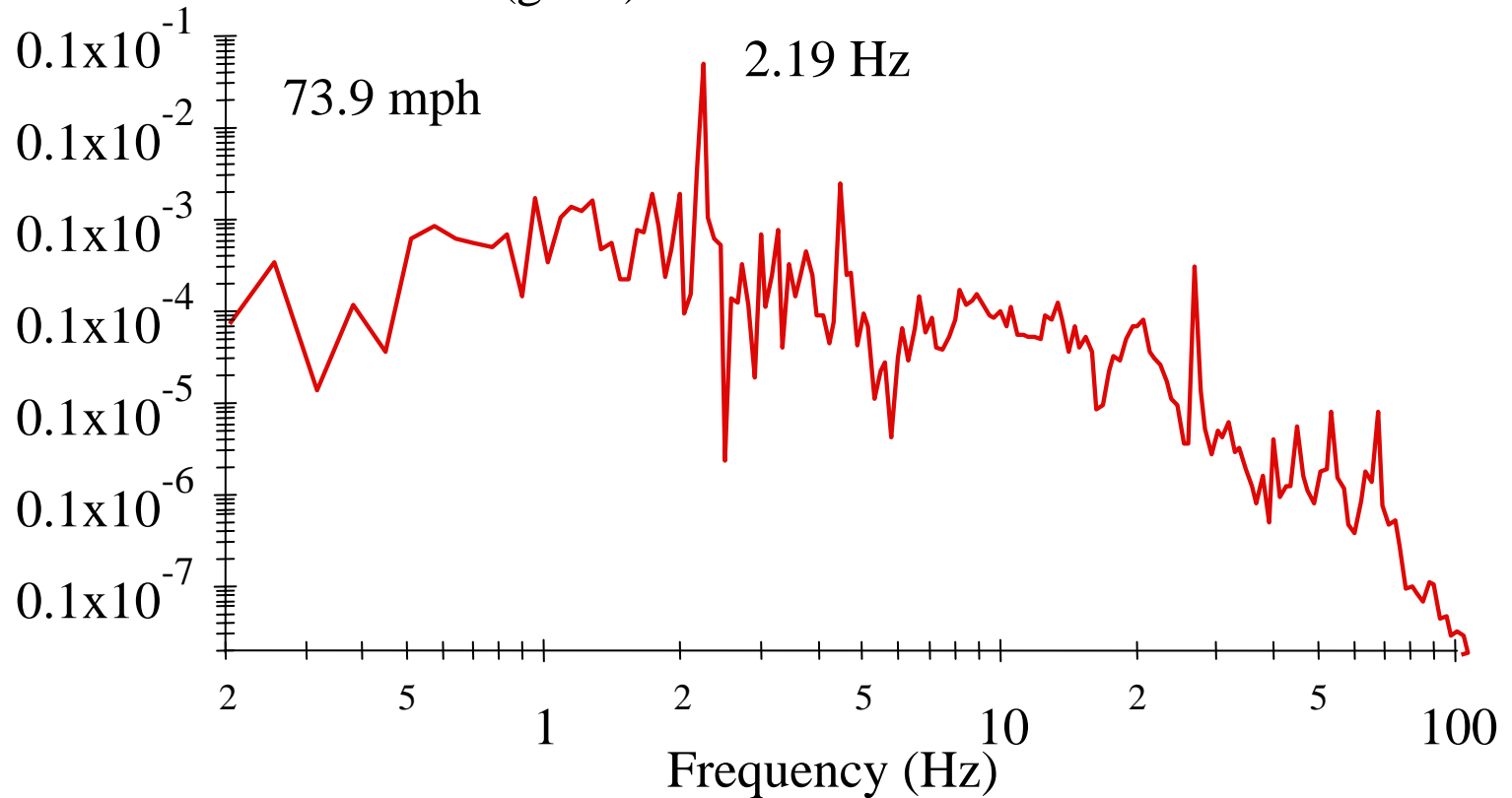
# I-75 Northbound, MP 136

Seat BTZ Vertical Accel. ( $g^2/Hz$ )



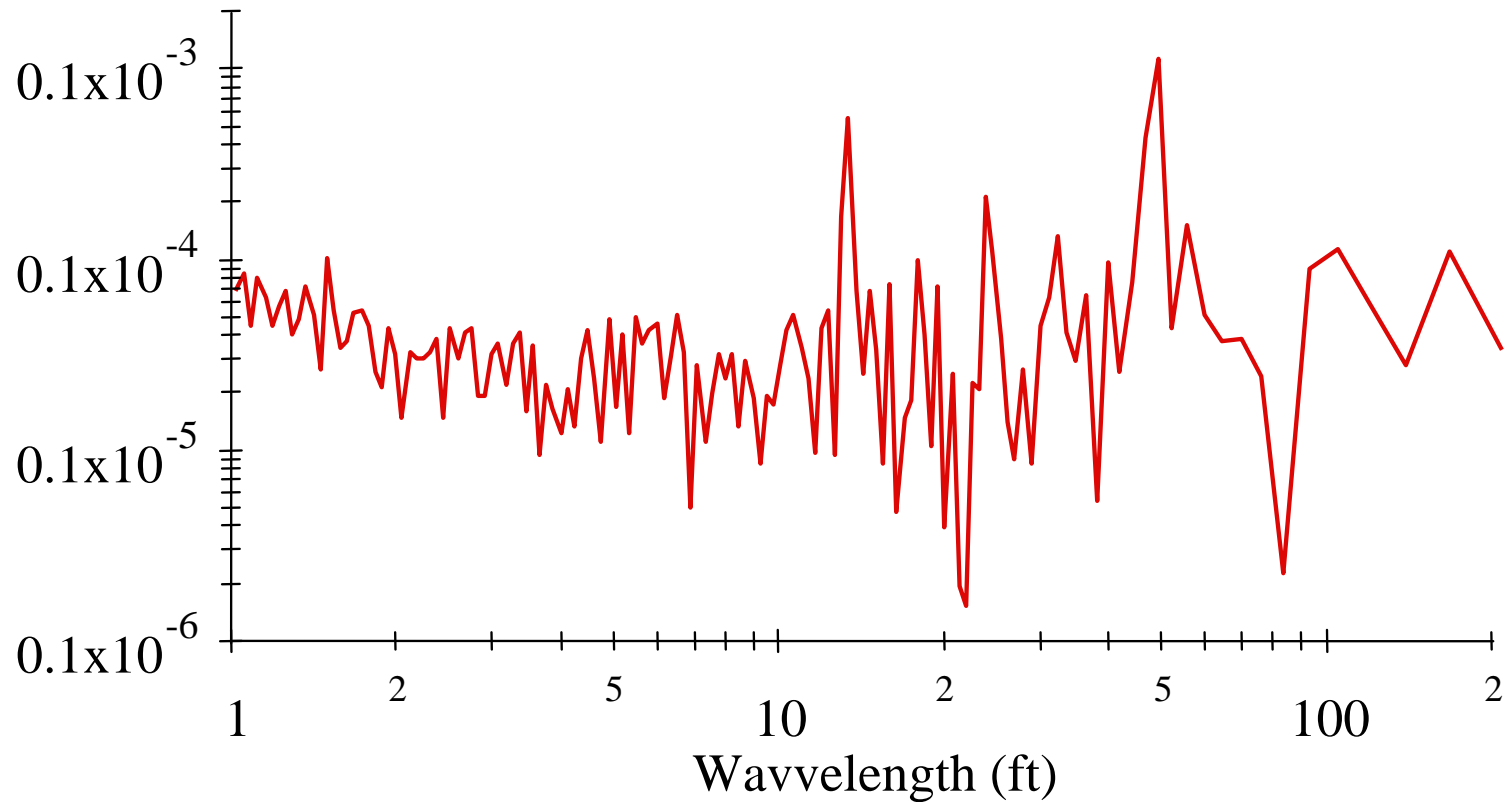
# I-75 Northbound, MP 136

Seat BTZ Vertical Accel. ( $g^2/Hz$ )



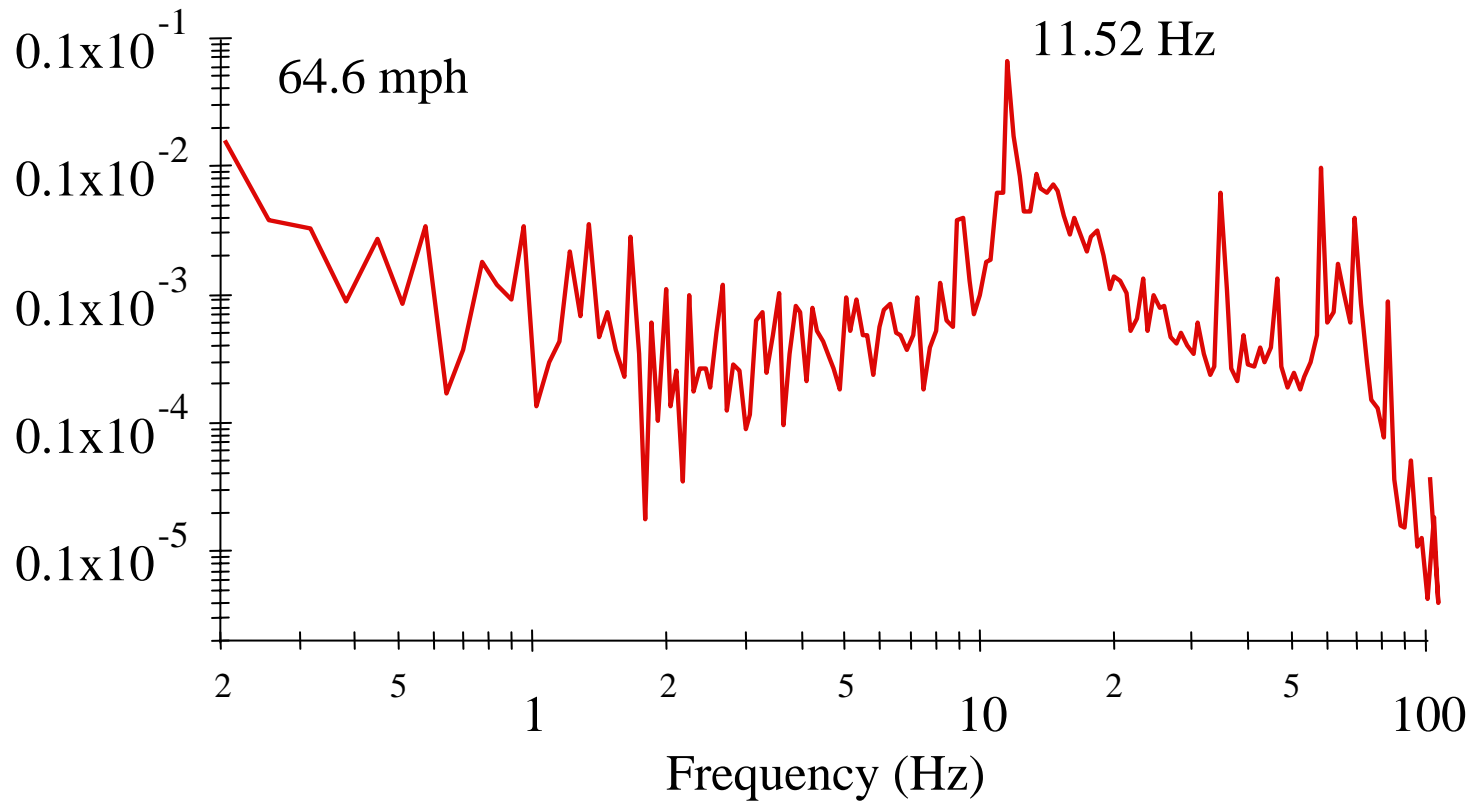
# I-75 Northbound, MP 136

PSD of Left Slope (ft/cycle)



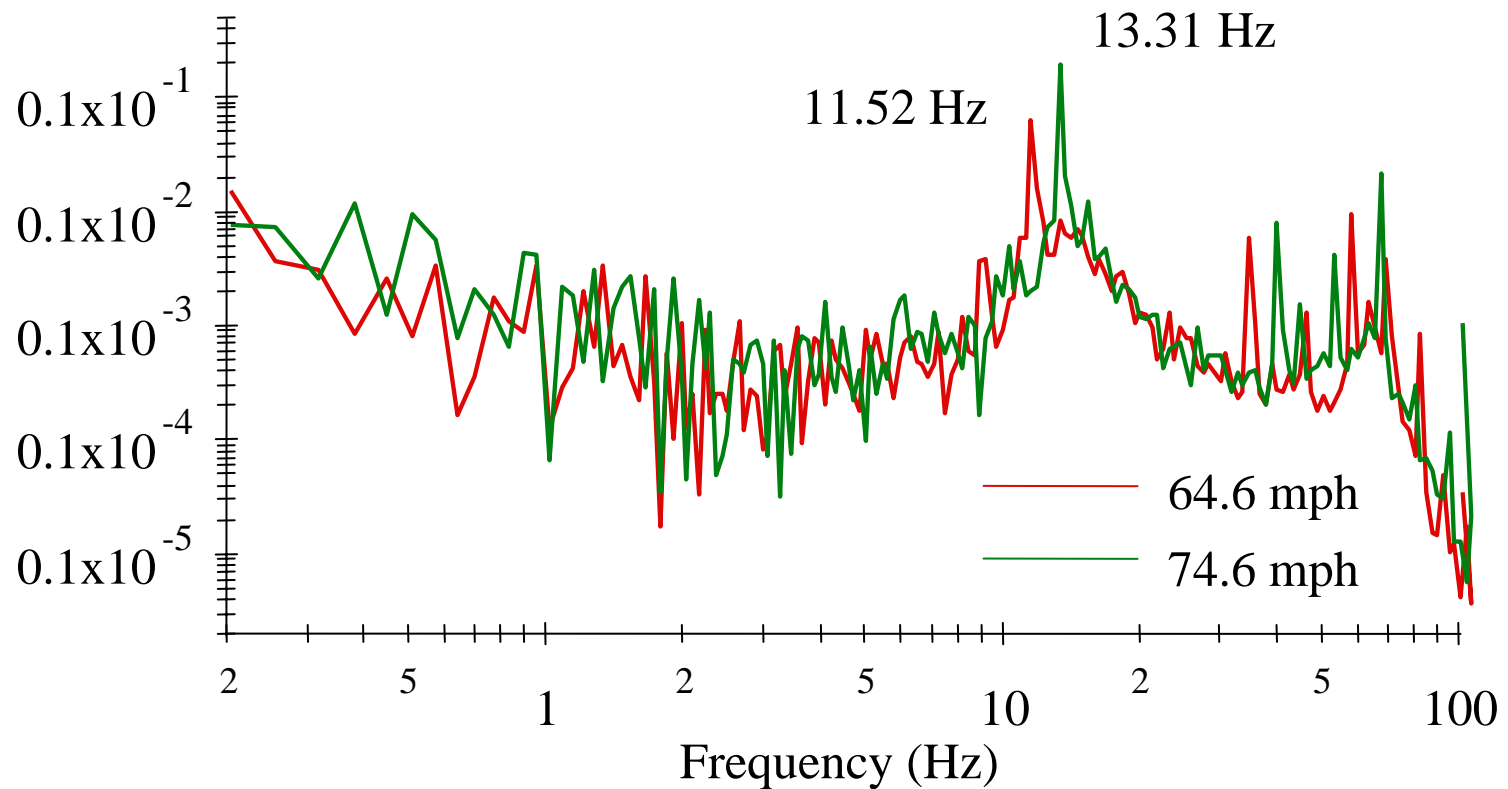
# US-23 Southbound, MP 29

Left Spindle Vertical Accel. ( $g^2/Hz$ )



# US-23 Southbound, MP 29

Left Spindle Vertical Accel. ( $g^2/Hz$ )





# 8.2-ft Cycle Length

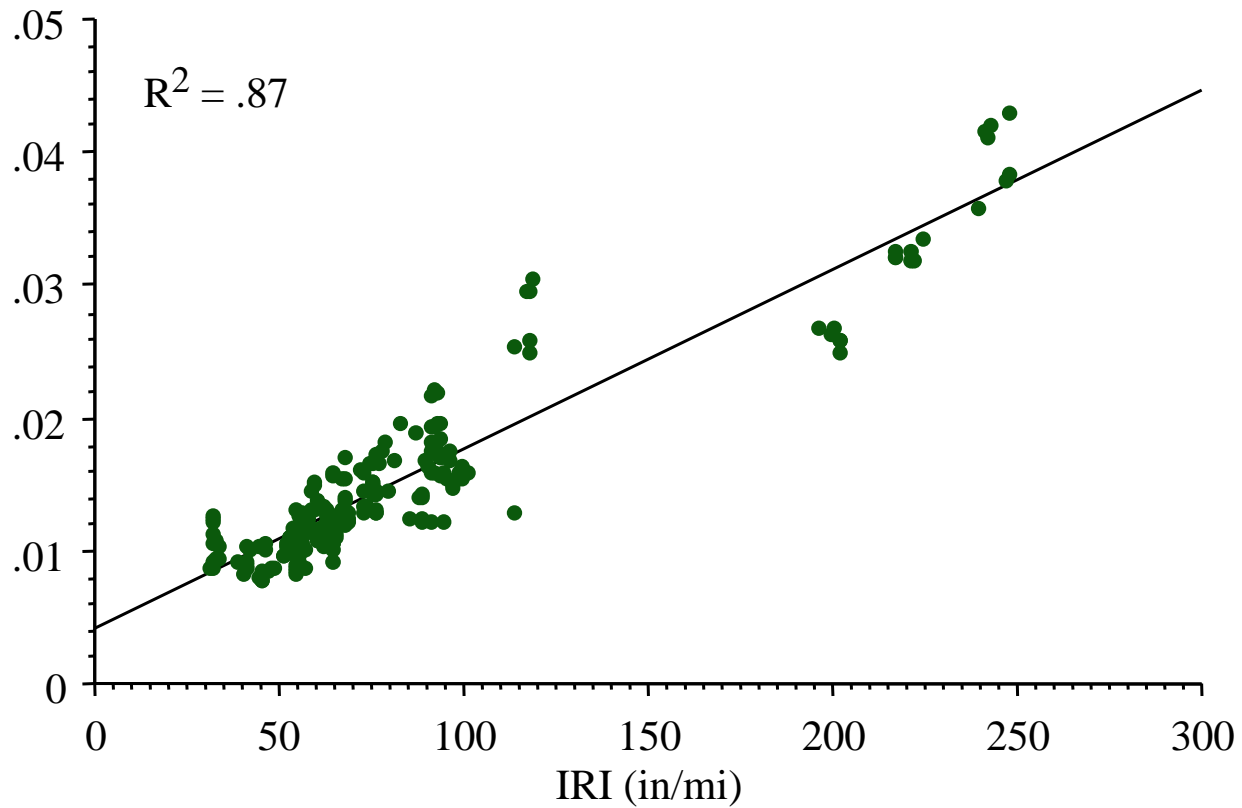


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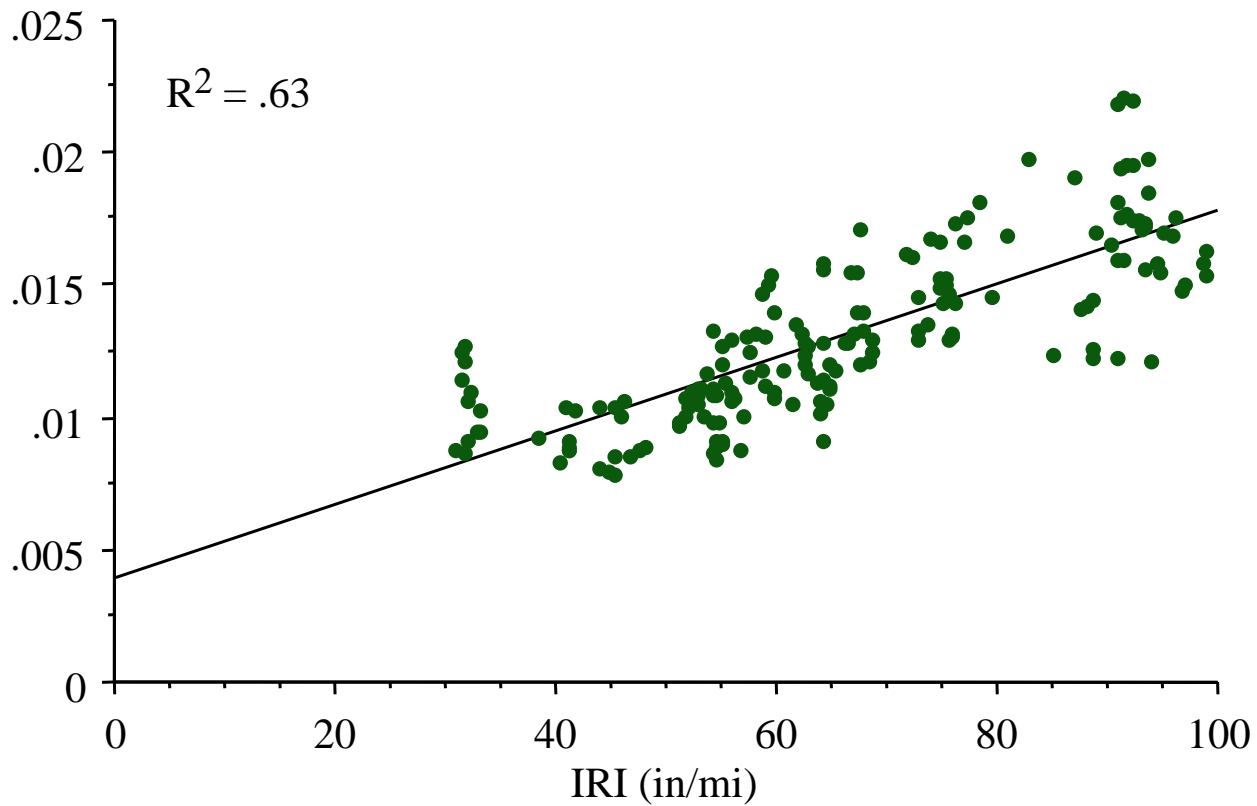
# Relationship to IRI

Weighted RMS Seat/Buttock Accel. (g)



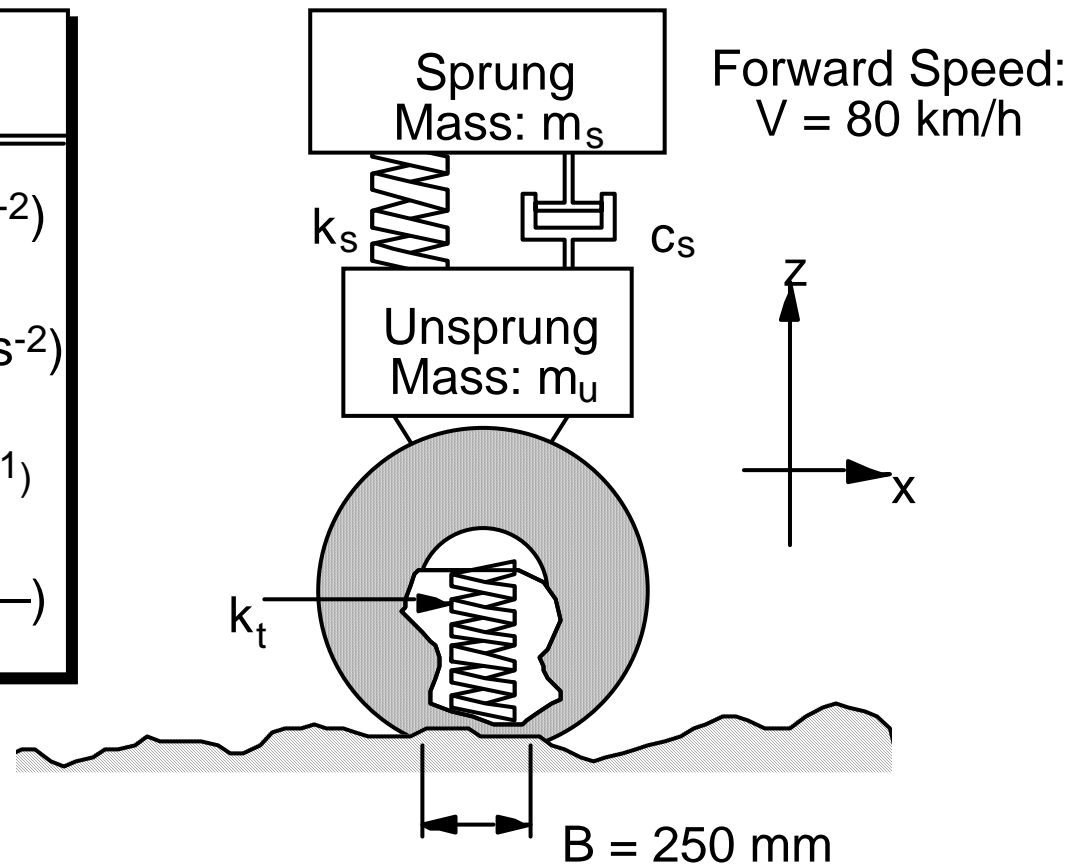
# Relationship to IRI

Weighted RMS Seat/Buttock Accel. (g)

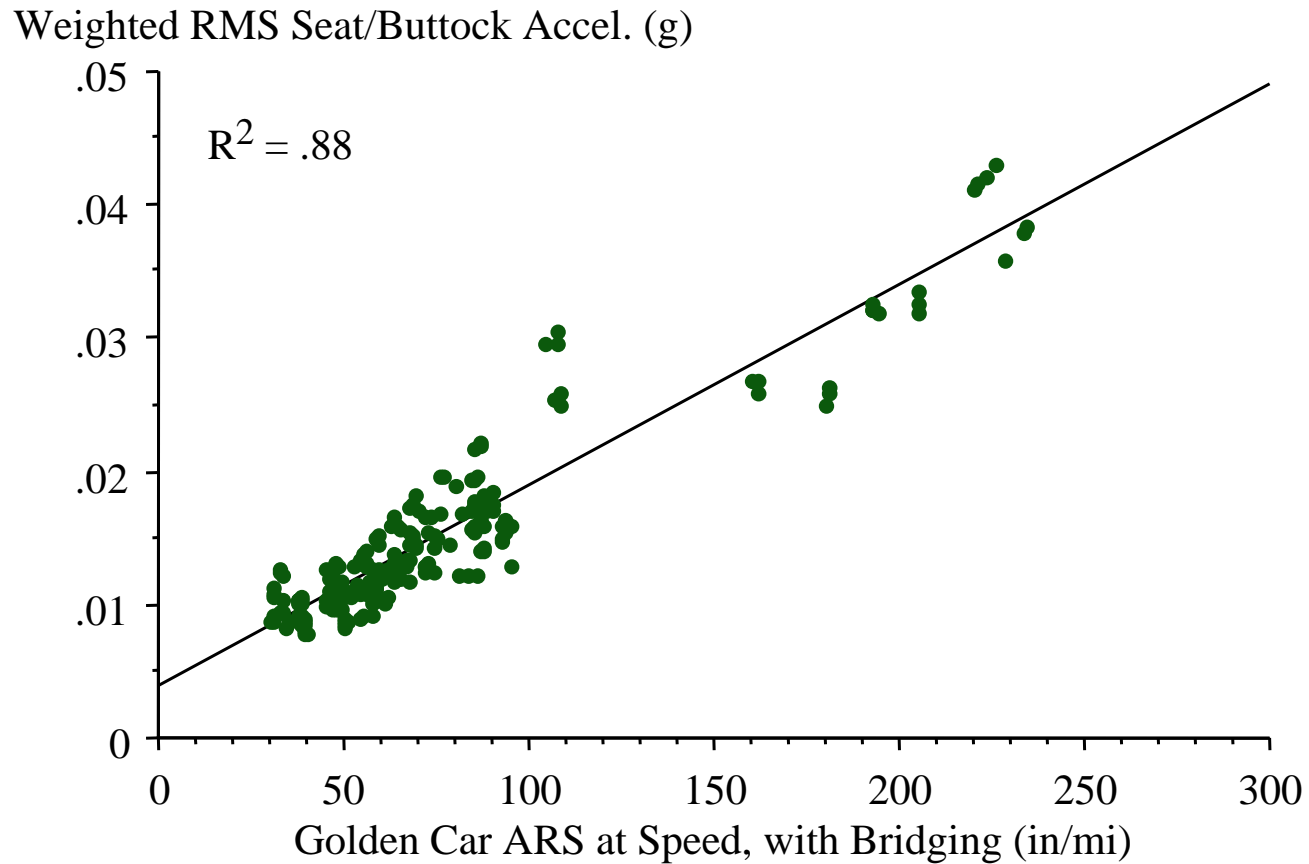


# Quarter-Car Model

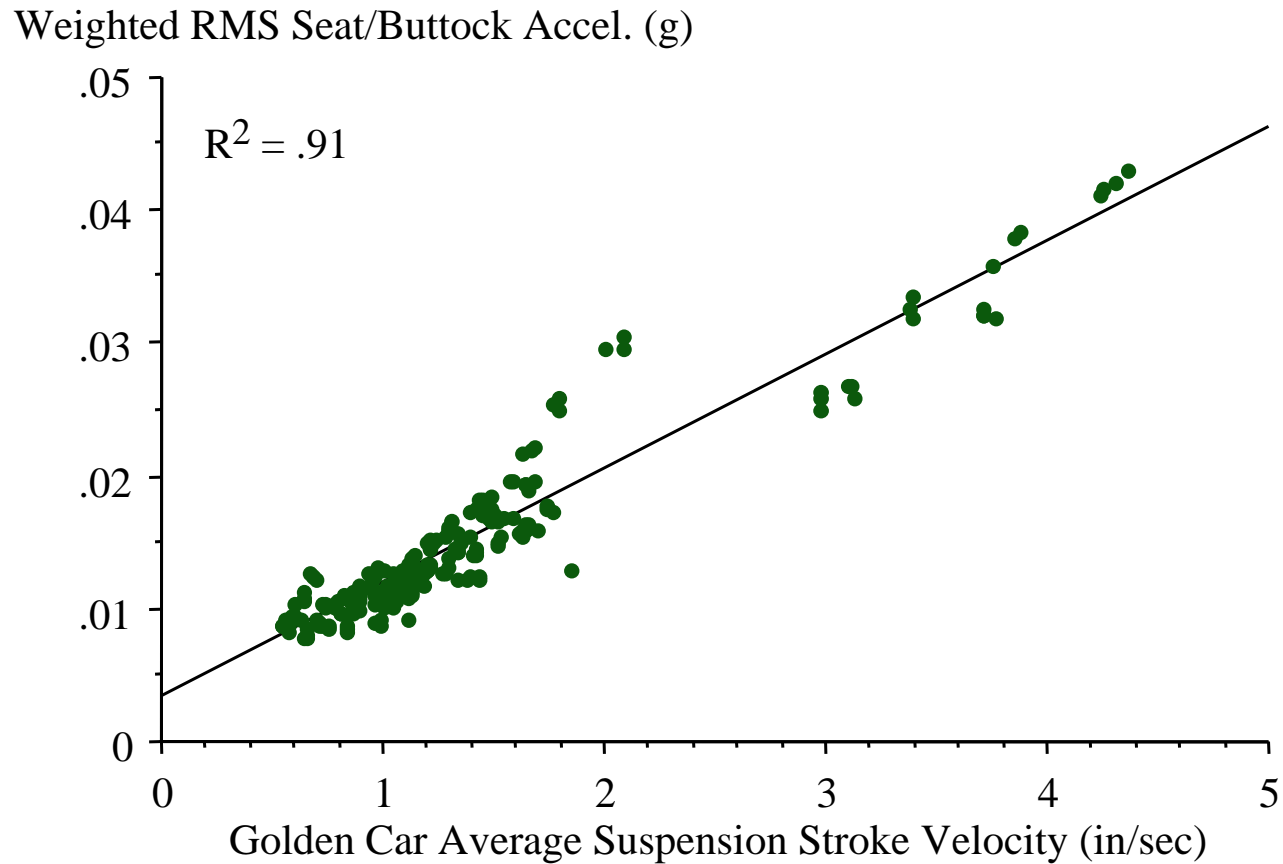
Golden Car Parameters
$\frac{k_t}{m_s} = k_1 = 653 \text{ (s}^{-2}\text{)}$
$\frac{k_s}{m_s} = k_2 = 63.3 \text{ (s}^{-2}\text{)}$
$\frac{c_s}{m_s} = c_2 = 6.0 \text{ (s}^{-1}\text{)}$
$\frac{m_u}{m_s} = \mu = 0.15 \text{ (—)}$



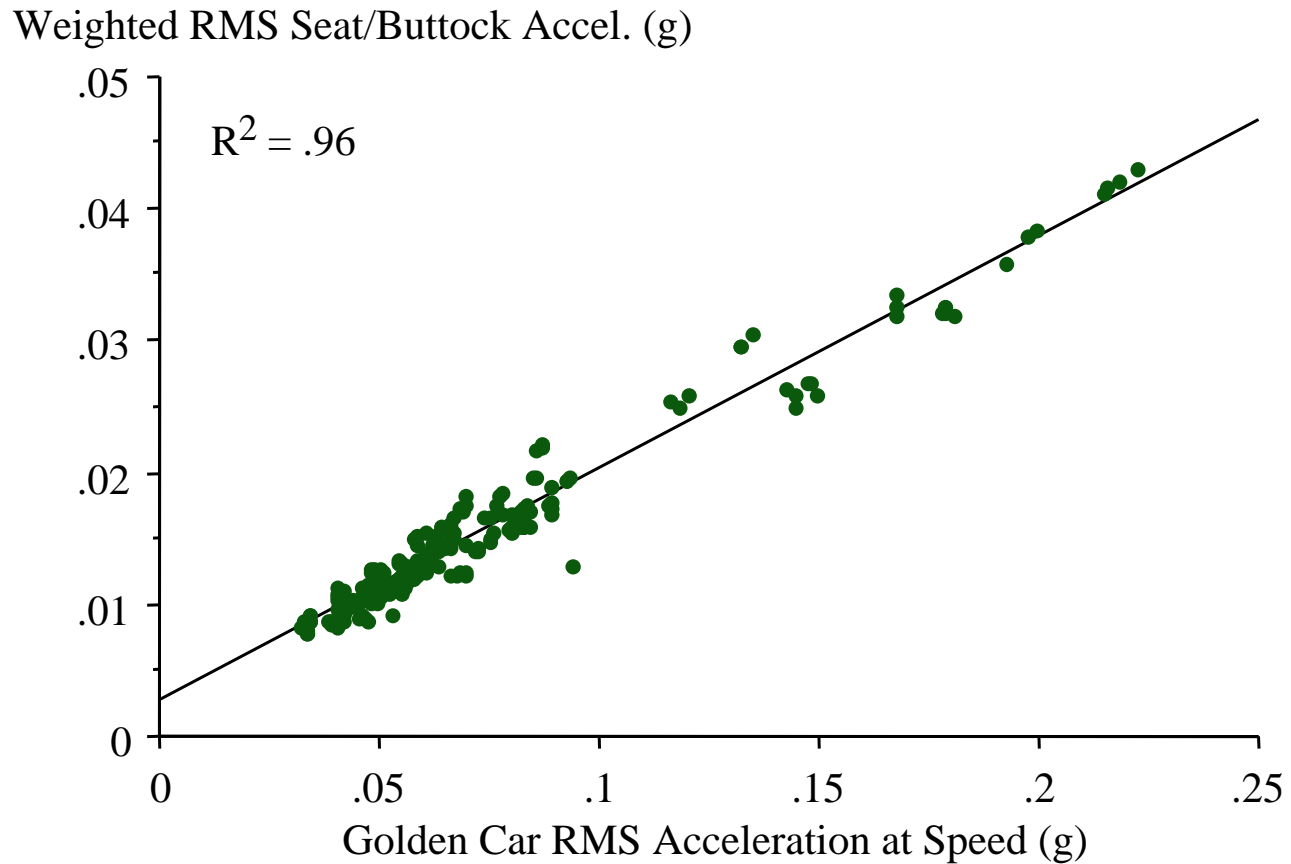
# Relationship to the Golden Car



# Relationship to Temporal Stats



# Relationship to Predicted Accel.





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# Further Work

- Explain outliers (tuning, wheelbase filtering, etc.)
- Study localized roughness
- Compare to the second vehicle
- Predict truck dynamic loads
- Define a simulation study

Thank you.