The Benefits and Limitations of Floating Slab Track for Controlling Groundborne Noise and Vibration

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Groundborne Noise and Vibration Transmission Paths

- **Vibration at Source**
  - Vehicle (wheel irregularities)
  - Rails (smoothness)
- **Vibration Path**
  - Subsurface Strata
- **Vibration at Receiver**
  - Foundation attenuation
  - Attenuation from floor to floor
  - Floor and wall amplification
- **Ground-borne Noise**
  - Acoustic absorption
- **Empirical Model Elements**
  - Input Force
  - Vibration Path
  - Building Response
Groundborne Noise and Vibration
Predicting Rail Transit Impacts

Example of Predicted Train Passby Vibration Compared to Vibration Limit
Single Degree of Freedom Model

\[ f_n = \frac{1}{2\pi} \sqrt{\frac{k}{m}} \]

\( f_n \) = natural frequency (Hz)

K = stiffness
M = mass
C = damping

increase isolation by decreasing \( f_n \)
Groundborne Noise and Vibration
Types of Mitigation

- **Resilient Fasteners**
  - Static Stiffness < 75,000 lb/in (≈ 13 kN/mm)
  - Low Dynamic to Static Ratio < 1.4

- **Rail Suspension Fasteners**
  - Suspend rail from web and underside of head with elastomeric blocks held in place with steel or iron plates

- **Resiliently Supported Double Block Tie**
  - Resilience of Boot and Mass of Block

- **Ballast Mat and Resilient Mats**
  - Mass of ballast on resilient underlayment
  - Isolated slab track on continuous resilient underlayment

- **Tire Derived Aggregate**
  - Recycled tire underlayment for ballasted track

- **Floating Slab Trackbed**
  - Discrete Spring Elements under a Concrete Slab Mass
Comparison of Insertion Gain for Resilient Fasteners and an 8 Hz FST

Audible freq. range from 20 Hz....
Groundborne Noise and Vibration
Predicting Rail Transit Impacts

No mitigation....

Example - A: Substantial reduction needed

Example - B: Modest reduction needed
Groundborne Noise and Vibration
Predicting Rail Transit Impacts

....with resilient fasteners

Example - A:
Substantial reduction needed

Example - B:
Modest reduction needed
Groundborne Noise and Vibration
Predicting Rail Transit Impacts

....with Floating Slab Track

Example - A:
Substantial reduction needed

Example - B:
Modest reduction needed
Groundborne Noise and Vibration
Selection of Mitigation

Level 1: Moderate Reduction
Frequency Range: >30 Hz
Performance: 4 to 8 dB

Example: ATP Egg resilient fastener

Example: Low Vibration Track (LVT)
Groundborne Noise and Vibration
Selection of Mitigation

Level 2: Intermediate Reduction
Frequency Range: >20 Hz
Performance: 6 to 12 dB

Example: Isolated Slab Trackbed with Continuous Elastomer Layer
Groundborne Noise and Vibration
Selection of Mitigation

Level 3: Substantial Reduction
Frequency Range: >8 Hz
Performance: 15 to 18 dB
Example: Floating Slab Track
Floating Slab Track
Overview

- In use for over 40 years on rail transit systems around the world
- Provides mitigation performance that other (less costly) measures cannot
- Several design types have been developed
- Recent and historic examples
- Performance has been demonstrated though theoretical models may over-predict
FST Designs
Discontinuous Pre-Cast Double-Tie
Some designs such as the GERB system use steel springs instead of rubber pads.
Existing FST Installations are numerous in North America

- WMATA, Washington DC
- TTC, Toronto
- MARTA, Atlanta
- BART, SF Bay Area
- LACMTA, Los Angeles
- NFTA, Buffalo
- SF Muni, San Francisco
- NERL, Newark New Jersey
- JFK Airtrain, New York
- and more!
TTC – Subway Application
Hong Kong – Viaduct Application
Newark, NJ – LRT Application
FST is a candidate mitigation for many current transit projects

- Sound Transit North Link Extension
- Gold Line Foothill Extension in Southern California
- BART extension to San Jose
- Central Corridor Light Rail Project in Minneapolis/St. Paul
- Exposition Corridor LRT in Los Angeles
FST Issues & Limitations

- Cost
- Entrapped air in sealed systems
- Practical lower limit of design resonance
- Implications of mixed traffic such as buses
- Effects of extreme cold temperature
FST Benefits

• Highly effective: may be only option
• Design resonance designed to suit mitigation needs of project
• Lightweight and relatively low profile designs feasible
• Do not need to be heavily damped as once thought
• Long service life
Thank You!

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