Transportation Vibration Induced by Roadway Irregularities

Tony Evans
ATS Consulting
ADC40 Summer Meeting
July 22, 2014

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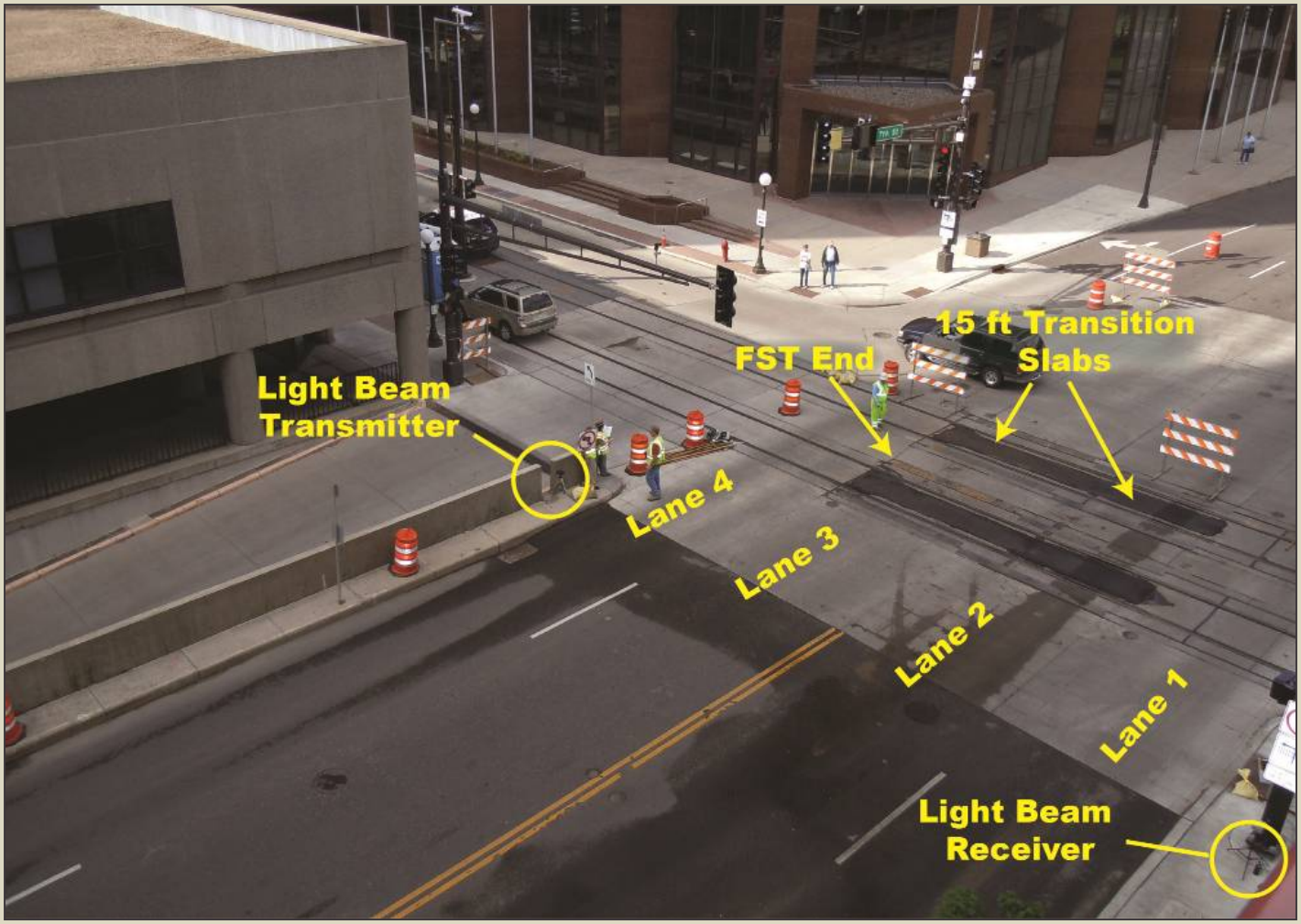
Introduction

- ATS Consulting performed a series of vibration measurements at a radio studio near a recently constructed LRT system

- Purpose of measurements
  - Determine vibration levels in studios due to vehicles crossing over the track system and other road features
  - Determine if the floating slab track (FST) is contributing to the levels in the studios
  - Evaluate the effects of vibration mitigation measures
  - Determine the need for further mitigation

Introduction



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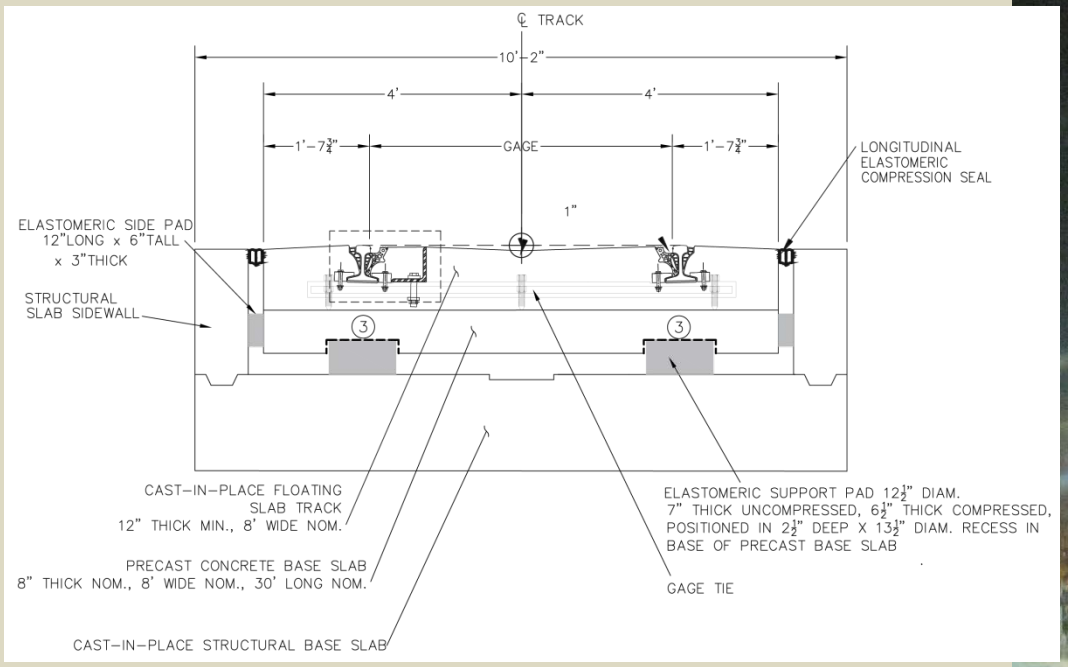
Floating Slab Track



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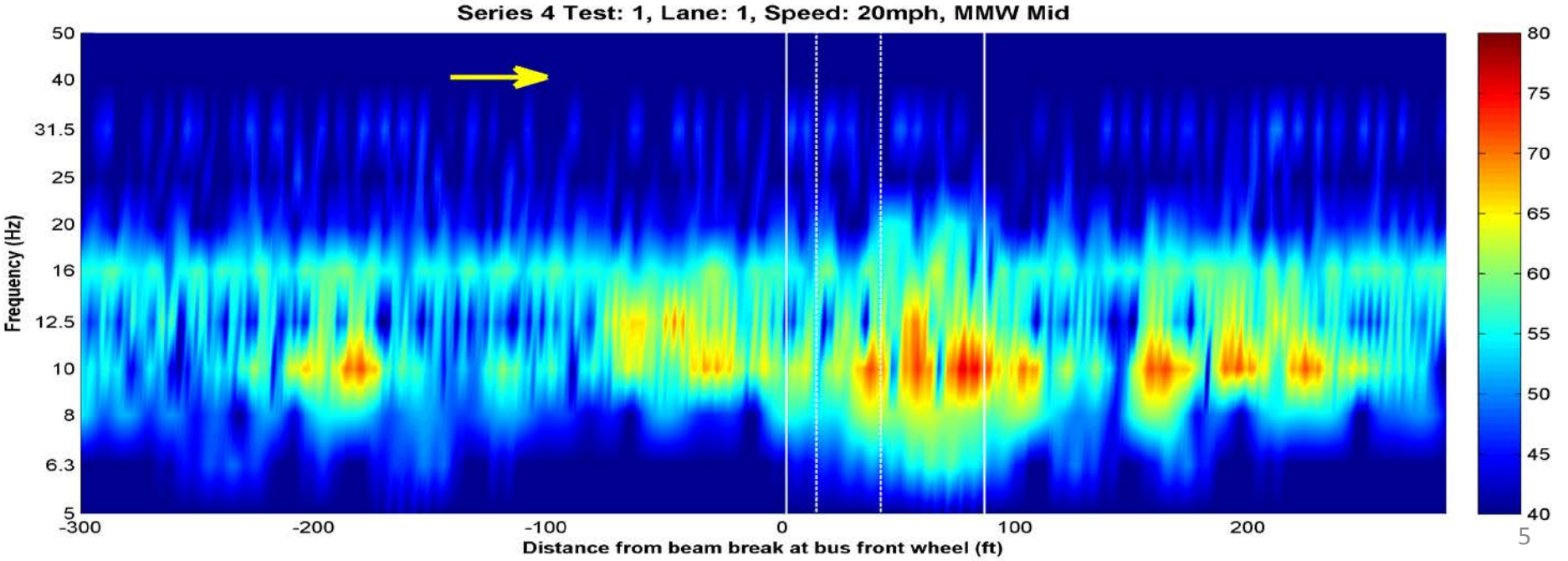
Introduction

- Key conclusions …
  - Vibration levels exceed criteria (65 VdB) in the studios
  - There seems to be a vibration source from the track system, but there are also sources along 1st St
    - No evidence that FST resonances contribute
  - 4-way stop reduces vibration levels compared to normal traffic

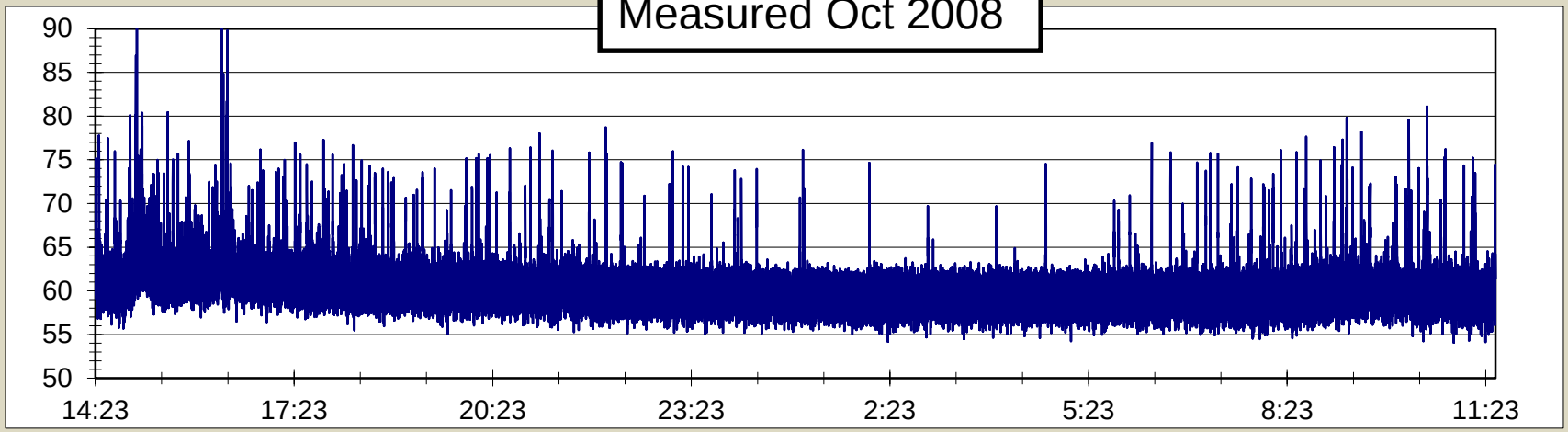
Dashed vertical lines = front wheel on track system

Solid vertical lines = front wheel in intersection

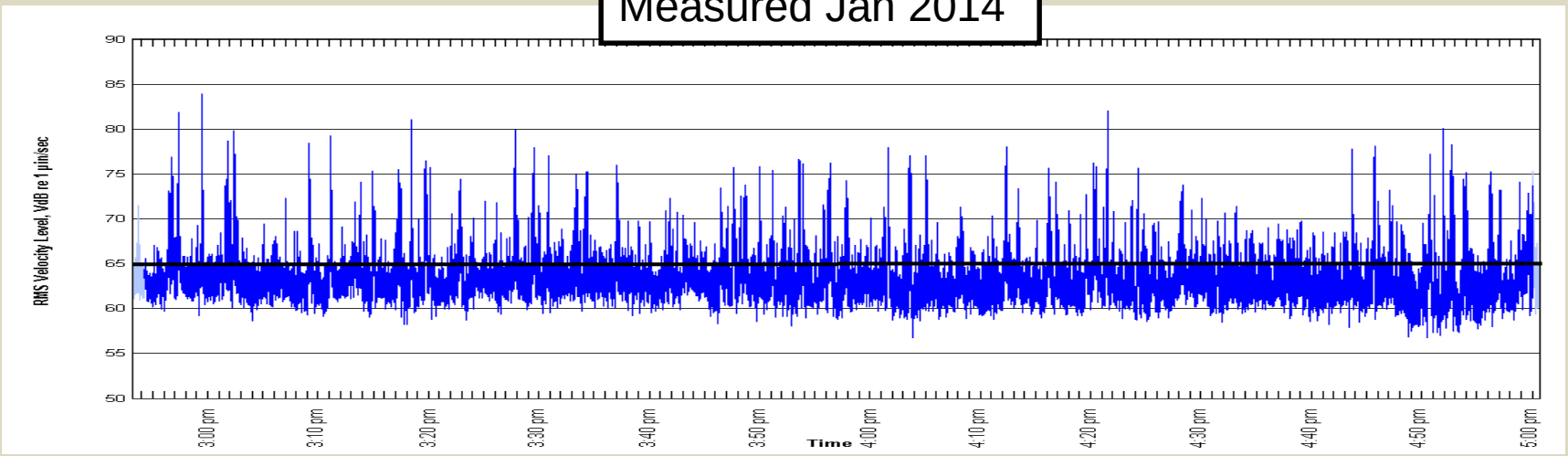


Ambient Vibration

Measured Oct 2008



Measured Jan 2014



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Mitigation

- September
  - Filling drainage swales (with concrete) between tracks
  - Pavement cut (~12 in. deep) along curb line
  - Preparatory cuts for future installation of steel plates
- October
  - Installation of steel plates to smooth path between road and FST (Lanes 1-3)
- January
  - Resilient layer under hand-hole covers in intersection

Mitigation Effects

- Studios MMW and 4H Lmax (avg over regions) deltas

	Sept - Jun	Oct - Sept	Jan - Oct	Jan - Jun
MMW deltas	-5.5	2.0	-10.4	-13.9
4H deltas	-4.5	0.0	-5.9	-10.5
Average deltas	-5.0	1.0	-8.2	-12.2



Note: January had lower vibration levels all along 1st St (weather?); data showed slightly greater decrease in intersection than other regions

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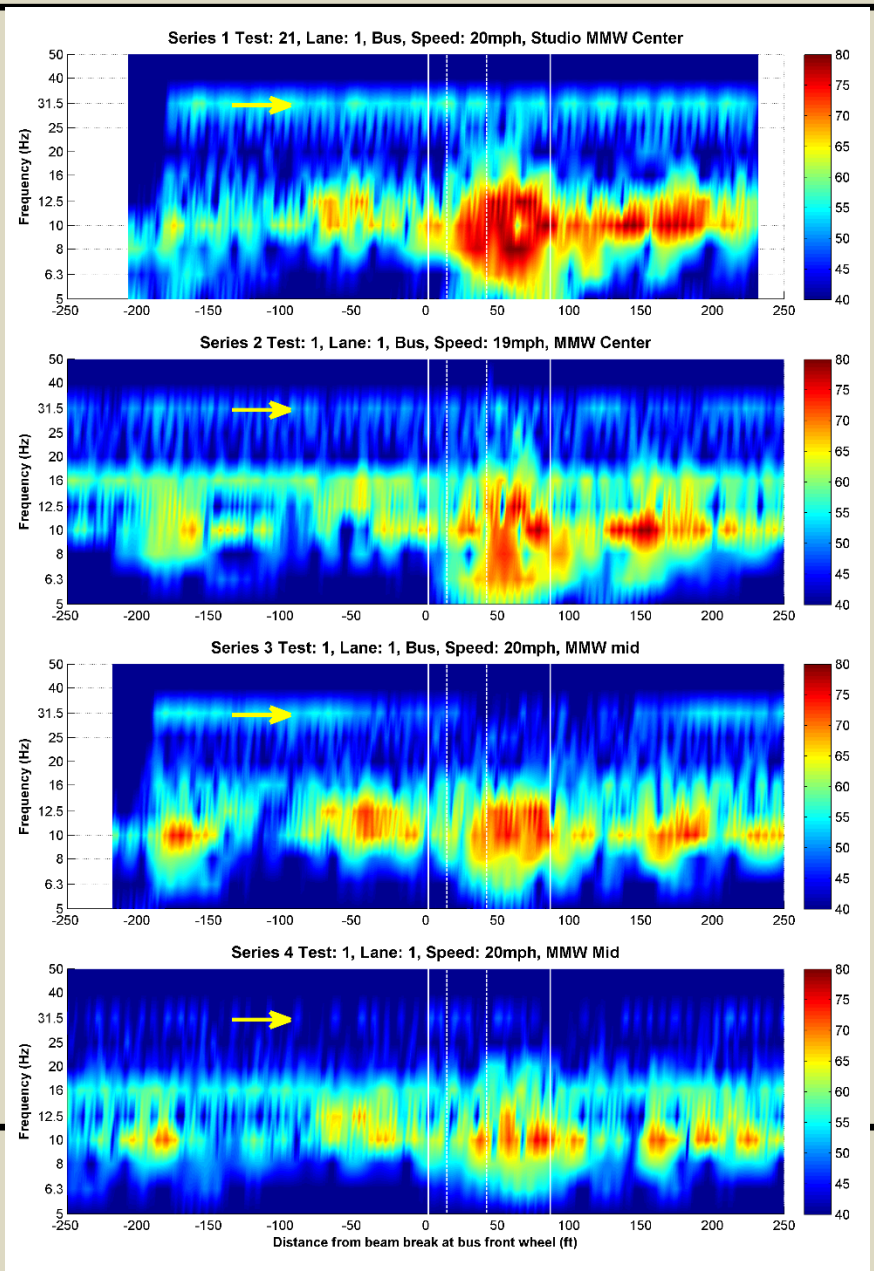
Spectral Vibration Comparison

Jun 2013

Sept 2013

Oct 2013

Jan 2013



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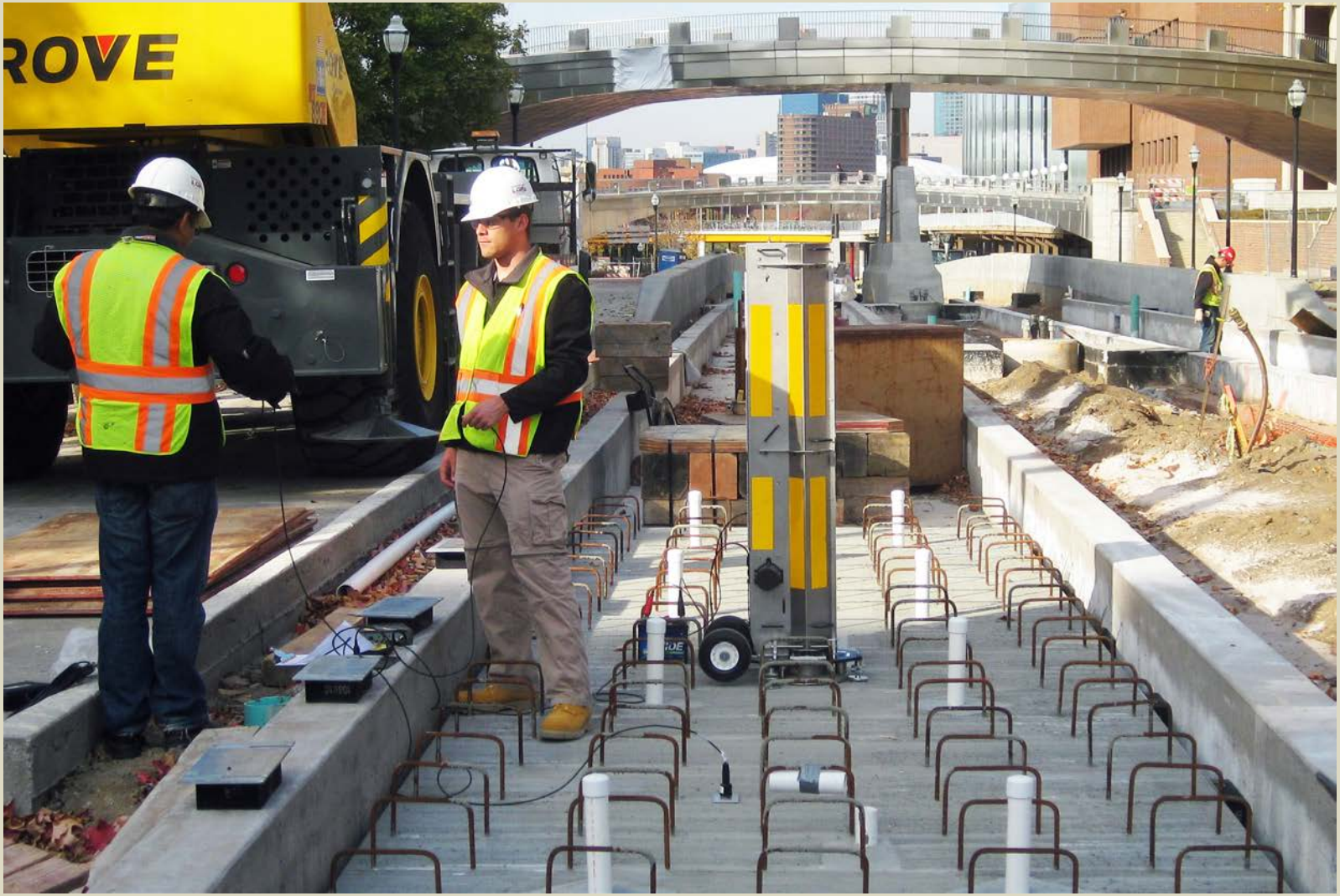
Impact Testing



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Impact Testing

- Observations based on drop-hammer testing
  - There does not appear to be efficient propagation from impacts to basement walls and supports, other than higher (audible) frequencies
  - Efficient propagation
    - To MMW at 10-12.5(16) Hz
    - To 4A at 10-12.5 Hz
    - To 4H at 10-20 Hz
    - To 3C at 16-20 Hz
  - MMW
    - Center and under floor approximately same response
    - Column near window does not appear to efficiently receive vibrations

Final Observations and Conclusions

- Criterion exceedance: maximum vibration levels in studios exceed 65 VdB
- Vibration sources: many along 1st St, all lanes (C St as well)
- Studios responding more to road vibrations than basement and outside ➔ building response contributing to higher levels
- Ambient vibration: appears to be about the same before and after track construction

Final Observations and Conclusions

- Vibration propagation
  - Studios efficiently receive road-source vibrations at key low frequencies
  - No evidence of vibrations entering building via pipes

- Mitigation
  - Previous applications appear to be effective
  - Providing additional mitigation
    - Switch intersection to 4-way stop
    - Smooth Road