

Management of Vibration Monitoring on Construction Projects



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Presentation Outline

- Background
- Introduction
- Research Goals
- Approach
- Implementation Plan
- Conclusion and Recommendations



Background

- NHDOT Construction moved toward reconstruction and rehabilitation. Projects are located in highly developed areas where structures can be adversely impacted by ground vibrations
 - Increased level of concern and claims
 - Need was identified to standardize the approach to assess potential for impact and needs on a given project



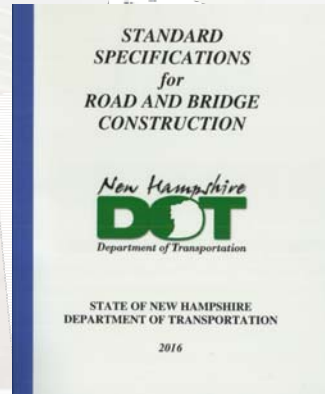
Introduction

- Non-blasting induced ground vibrations are generated by a number of construction activities:
 - Pile driving
 - Vibratory compaction
 - Pavement breaking
 - Movement of heavy equipment
 - Hoe ramming
 - Dynamic compaction



Introduction Cont.

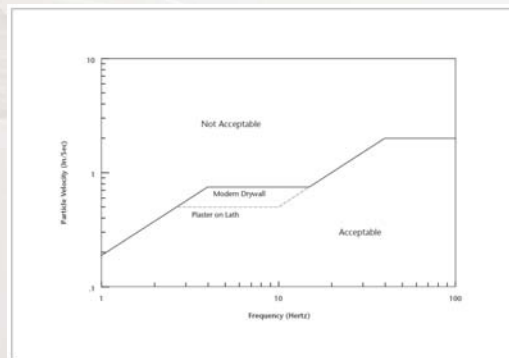
- Significant effort to monitor vibrations from construction activities for a given project
 - NHDOT Item 211.11
 - Tracks the non-blasting vibration monitoring separate



Introduction Cont.

Vibration Criteria

- U.S. Bureau of Mines 1980
- Adopted by most gov. agencies although they are known to be conservative and est. for blasting induced vibrations



Research Goals

1. Develop a method to assess the potential for impacts from construction vibrations
2. Develop a database of historical information that can be used as a decision making tool
3. Develop a guideline to estimate hours and cost of services for proposed projects
4. Identify the types of equipment and activities that cause damaging vibrations

Approach

- Data collected on a variety of projects across the state
 - For NHDOT complaints are most common with *vibratory compaction* and *impact pile driving*
 - Highest vibrations were recorded at start up and shut down of pile driving equipment
 - Variations from site to site and subsurface conditions

Approach

- Most non-blasting vibrations fall in low frequency range 5-30 Hz
- Subsurface conditions can significantly effect levels
- Most homeowners feel vibrations...then it **MUST** have caused damage
 - People can feel vibrations down to 0.02 in/sec



Approach

Published Levels

Table 12-2 Vibration Source Levels for Construction Equipment
(From measured data. ⁽⁸⁾⁽⁹⁾⁽¹⁰⁾⁽¹¹⁾)

Equipment	PPV at 25 ft (in/sec)	Approximate L _v ¹ at 25 ft
Pile Driver (impact)	upper range	112
	typical	104
Pile Driver (sonic)	upper range	105
	typical	93
Clam shovel drop (slurry wall)	0.202	94
Hydromill (slurry wall)	in soil	66
	in rock	75
Large bulldozer	0.089	87
Caisson drilling	0.089	87
Loaded trucks	0.076	86
Jackhammer	0.035	79
Small bulldozer	0.003	58

¹ RMS velocity in decibels (VdB) re 1 μinch/second

From FTA



Approach

Database

- Project information
 - Connected to the DOT data warehouse
- Event information
 - Activity (equipment type), structures, type of vibrations (continuous, single event, high-rate repeated impact)
- Seismograph information
- Subsurface conditions
 - Soil information from gINT
- Readings

Vibration Readings Form

State/Project: _____ Project/Project: _____ Trip/Date: _____
 City/Town: _____ Road/Place: _____ Trip Name: _____

Event Information:
 Event Date: _____ Soil Type: _____ Soil Density: _____
 Project Activity: _____ Soil Type: _____ Soil Density: _____
 Frequency: _____ Soil Type: _____ Soil Density: _____
 Equipment: _____ Soil Type: _____ Soil Density: _____
 Structure: _____
 Structure Description: _____
 Foundation Description: _____

Sub Information:
 Station Location: _____ Station Depth: _____
 Station Elevation: _____ Station Depth: _____

Readings:

Reading No.	Reading Date	Reading Time	Reading Velocity	Reading Freq (Hz)	Reading Date	Reading Time



Approach

Database

Vibration Soil Report - Vibratory Roller
 Sorted by: Project, Vibratory Event

Event Activity: Vibratory Roller

Project	Soil Type	Soil Density	Soil Thickness	Reading Velocity	Reading Freq (Hz)	Reading Date	Reading Time
STEVE 777	Topsoil	Loose	5	23	47	10/16/2008	7:53:00 AM
STEVE 777	Fill	Medium Dense	3	23	47	10/16/2008	7:53:00 AM
STEVE 777	Glacial Marine	Dense	17	23	47	10/16/2008	7:53:00 AM

Event Activity: Vibratory Roller

Project	Soil Type	Soil Density	Soil Thickness	Reading Velocity	Reading Freq (Hz)	Reading Date	Reading Time
111432				0.33	39	8/2/2008	
111432				0.195	43	7/9/2008	

Event Activity: Vibratory Roller

Project	Soil Type	Soil Density	Soil Thickness	Reading Velocity	Reading Freq (Hz)	Reading Date	Reading Time
11530							



Approach

Development of an Assessment Table

- Routinely used by designers to determine if concerns exist
- Ultimately aids in establishing a preliminary cost estimate and hours for monitoring
- Matrix modified based on the FHWA Rock slope rating system
 - Points score of 10 categories determine the potential level of impact from a given activity



Approach

Development of an assessment table

	Points 1	Points 3	Points 5	Points 7	Points 9
Type of Construction Activity/Equipment Crane/ Input from Activity	Hand tool, small plan equipment, temporary power hammer	1 operator with moderate duty, extended construction activities	Secondary roller, tracked equipment, rig, shovel, pile driver, low running rig	High driving, pile driver, impact	Dynamic compaction, pile cap
Attenuation (decay) of peak particle velocity	Coliseum Scale only use in site (0-10 blawft) low vibration risk Very close (0-1 blawft)	Coliseum Scale maximum rate (0-10 blawft) low vibration risk Medium close (5-10 blawft)	Coliseum Scale only use (0-10 blawft) low vibration risk Medium close (11-14 blawft)	Coliseum Scale only use (10-20 blawft) low vibration risk Very close (0-10 blawft)	Coliseum Scale only use (20-30 blawft) low vibration risk Very close (0-10 blawft)
Development, Demolition & Settlement	Any corner cut or backfill	Driveway wall	Masonry corner wall	Umbrella wall	W.C. hole below, covered if not continuous, curb
Distance from Vibration Source	Greater than 400 ft	350-400 ft	300-350 ft	250-300 ft	50 ft or less
Type of Vibration	Single vertical event - continuous or once	Intermittent and vertical event - longer than 10 minutes for 1 hour	Single strike, continuous, intermittent	Intermittent multiple impact	Continuous impact
Location or Construction Activity	Construction activity	Construction activity	Construction activity	Construction activity	Construction activity
Type of Structure	Reinforced concrete structure (1 or 2 stories) structure w/ deep foundation	Concrete w/ shallow foundation	Timber structure or commercial structure w/ deep foundation	Timber, masonry or commercial structure w/ deep foundation	Timber or masonry structure
Condition of Structure	Excellent condition, less than 10 years old, no visible cracks	Good condition, minor minor cracks, 10 to 20 Year Old	Fair condition, many minor cracks, visible cracks, 20-30 Year Old	Fair condition, many minor cracks, visible cracks, 20-30 Year Old	Poor condition, over 100 years old
Vibration Sensitive Equipment/Structure Sensitive Manufacturing Process	No vibration sensitive equipment or processes, general hardware	Minor or low	Small sensitive, well or more w/ vibration	Large sensitive, well or more w/ vibration	Medium sensitive, well or more w/ vibration
Sensitivity of Population	Hand unexcited family residence	Urban area w/ multiple family residence	Urban area w/ apartment, townhome	Urban area w/ apartment, townhome	Residential, nursing home

Construction Vibration Impact	Point Total
Very High Impact	400 or greater
High Impact	300 to <400
Moderate Impact	200 to <300
Low Impact	100 to <200
Very Low Impact	Less than 100



PRE-POST CONSTRUCTION AND CONSTRUCTION ACTIVITY MONITORING ITEM 211.11 - "VIBRATION MONITORING SERVICES"

PROJECT: Tamarack 16239
 DATE: 12/29/16
 BY: ALS

LOCATION: #150108

Seq	Code	Description	STRUCTURE/POPULATION INFORMATION		CONSTRUCTION ACTIVITY			DECISION MATRIX			EVALUATION CLASS			TIME QUANTITY ESTIMATE														
			General of Hazard	Structure	Structure Occupancy	Structure Use	Structure Type	Structure Age	Structure Height	Structure Depth	Structure Width	Structure Length	Structure Area	Structure Volume	Structure Density	Structure Value	Structure Condition	Structure Age	Structure Type	Structure Age	Structure Type	Structure Age	Structure Type					
1	001	CONSTRUCTION SITE																										
2	002	CONSTRUCTION SITE																										
...
25	005	CONSTRUCTION SITE																										
26	006	CONSTRUCTION SITE																										
27	007	CONSTRUCTION SITE																										

Legend:
 001 = CONSTRUCTION SITE
 002 = CONSTRUCTION SITE
 003 = CONSTRUCTION SITE
 004 = CONSTRUCTION SITE
 005 = CONSTRUCTION SITE
 006 = CONSTRUCTION SITE
 007 = CONSTRUCTION SITE

Source: New Hampshire DOT

Implementation

- Publish a guidance manual outlining the method
- Historical data will become an asset to assess the need and estimate hours
 - Save money!
- Developed a separate form required to be submitted
 - Better database reporting
- Share the institutional knowledge to prepare for the future!



Conclusions

- Value of the database will increase as more data is entered with variable site conditions and activities
- Establishing good public relations, through education, communication, and coordination with landowners and business owners is key
- Projects can require special considerations and may require adjustment to limits or monitoring distances
- Special requirements such as sensitive operations/manufacturing processes historic/fragile structures need to be identified early and called out in the contract documents



Questions?

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