

# EVALUATION OF VIBRATION LIMITS AND MITIGATION TECHNIQUES FOR URBAN CONSTRUCTION

2013 GEOTECHNICAL RESEARCH IN PROGRESS  
GAINESVILLE, FL



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# PRESENTATION OUTLINE

Background and Problem Description

Research Objectives and Methodology

Phase-I: Data Collection (Dr. Bayraktar)

Phase-II: Analysis and Recommendations (Dr. Svinkin)

Questions & Answers

# BACKGROUND

- ❑ Construction-induced ground vibrations
  - ❑ Blasting
  - ❑ Pile driving
  - ❑ Dynamic compaction
  - ❑ Operation of heavy construction equipment
- ❑ Level of ground vibrations
  - ❑ Source energy
  - ❑ Distance from the source of vibration
  - ❑ Soil characteristics
  - ❑ Characteristics of wave propagation
- ❑ Concern to engineers
  - ❑ Annoyance to people in urban environment
  - ❑ Interference with sensitive devices
  - ❑ Architectural and structural damage
  - ❑ Soil settlement

## FDOT Research Need Statement

- ❑ Work needed on:
  - ❑ Anticipated vibration levels generated by construction operations
    - ❑ Prediction of peak particle velocity (PPV)
    - ❑ Vibratory rollers, tandem rollers, sheet pile installation of particular interest in addition to pile driving
  - ❑ Evaluation of vibration limits
    - ❑ Currently, 0.5 in/sec is the general PPV limit in FDOT projects
  - ❑ Evaluation of vibration mitigation techniques
  - ❑ Standardized procedures for pre-construction surveys
- ❑ Recommendations for addressing vibration issues in the “Standard Specifications for Road and Bridge Construction” and/or “Soils and Foundations Handbook”
  - ❑ 455-1.1 “Structures Foundations” >> Protection of Existing Structures
  - ❑ 7.1.6 Vibration Monitoring; 9.2.4 Existing Structures Survey and Evaluation

# OBJECTIVES OF THE PROJECT

1. Analysis of the **current practice** in assessment and control of the vibration effects of construction operations in Florida;
2. Development of **appropriate equations for the calculation of expected ground vibrations** prior to the beginning of construction activities;
3. Evaluation of **condition surveys** of structures as an important step in mitigating vibration effects from construction operations;
4. Evaluation of diverse **vibration limits** of ground and structural vibrations for application to roadway and bridge construction in Florida;
5. Evaluation of **mitigation strategies** to control ground and structural vibrations from construction sources;
6. Development of **recommendations** for addressing vibration issues in FDOT Specifications;” and
7. Preparation of a **final research report** for the Florida DOT.

# RESEARCH APPROACH

## PHASE-I: DATA COLLECTION

**Task-1:** Conduct a literature review (*Reported at GRIP 2012*)

**Task-2:** Conduct a survey on practice and policies for vibrations (*Reported at GRIP 2012*)

**Task-3:** Collect and sort available field-measured data from construction operations (*GRIP 2013*)

**Task-4:** Prepare an interim report

## PHASE-II: ANALYSIS AND RECOMMENDATIONS

*GRIP 2013*

**Task-5:** Develop simple equations to calculate PPV of ground vibrations

**Task-6:** Develop criteria and standardized procedures for pre-construction surveys

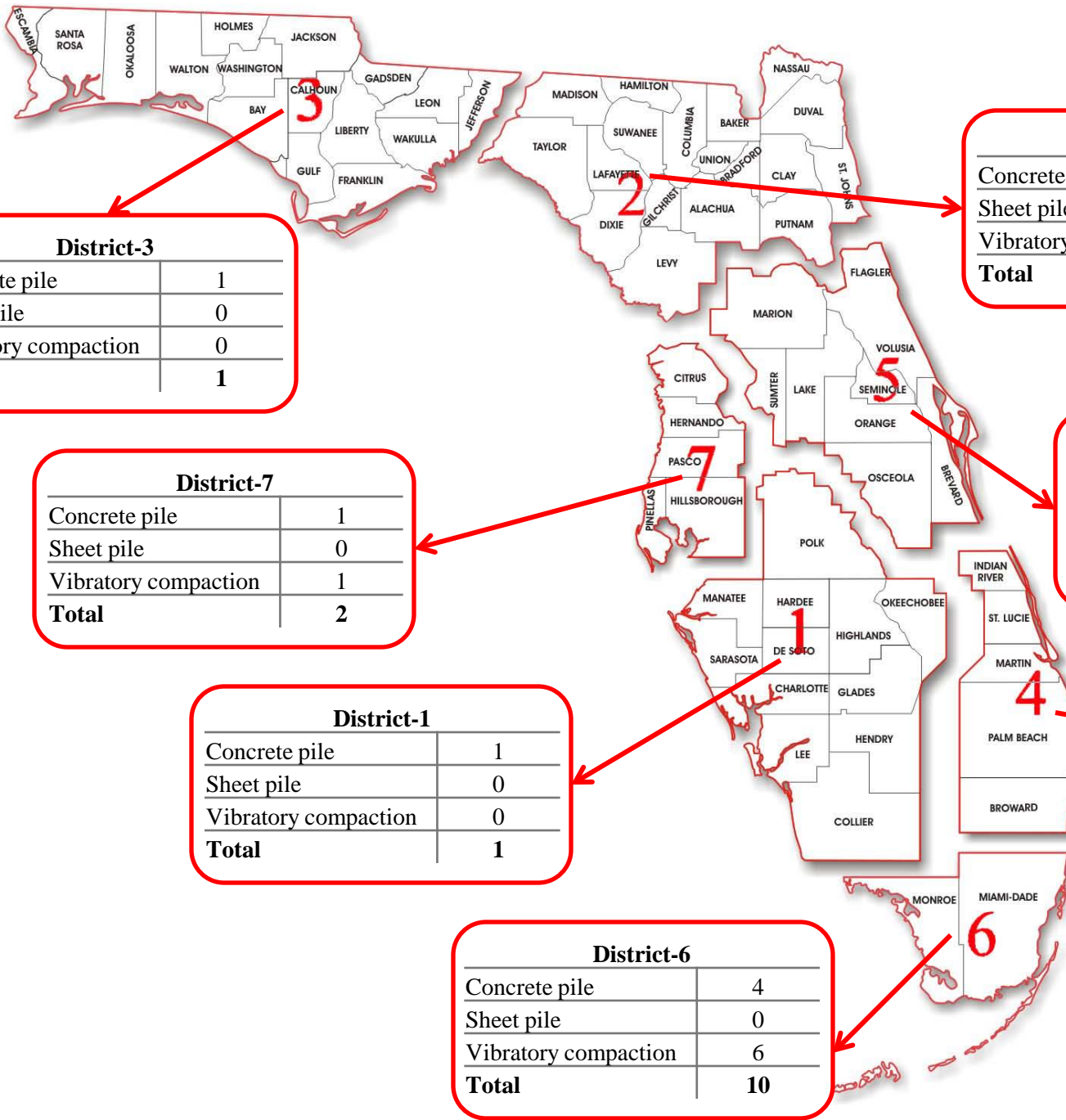
**Task-7:** Evaluate existing vibration limits and develop flexible limits for FDOT projects

**Task-8:** Evaluate mitigation techniques

**Task-9:** Develop recommendations

## Project Data Collection

- ❑ Data collected
  - ❑ hammer/equipment characteristics: (manufacturer, model, maximum energy, maximum stroke, etc.)
  - ❑ pile information: material, length, cross-section
  - ❑ pile driving logs
  - ❑ soil conditions
  - ❑ results of measurements of ground vibrations
  - ❑ results of static and dynamic pile testing



**District-2**

Concrete pile	6
Sheet pile	1
Vibratory compaction	2
<b>Total</b>	<b>9</b>

**District-3**

Concrete pile	1
Sheet pile	0
Vibratory compaction	0
<b>Total</b>	<b>1</b>

**District-7**

Concrete pile	1
Sheet pile	0
Vibratory compaction	1
<b>Total</b>	<b>2</b>

**District-1**

Concrete pile	1
Sheet pile	0
Vibratory compaction	0
<b>Total</b>	<b>1</b>

**District-6**

Concrete pile	4
Sheet pile	0
Vibratory compaction	6
<b>Total</b>	<b>10</b>

**District-5**

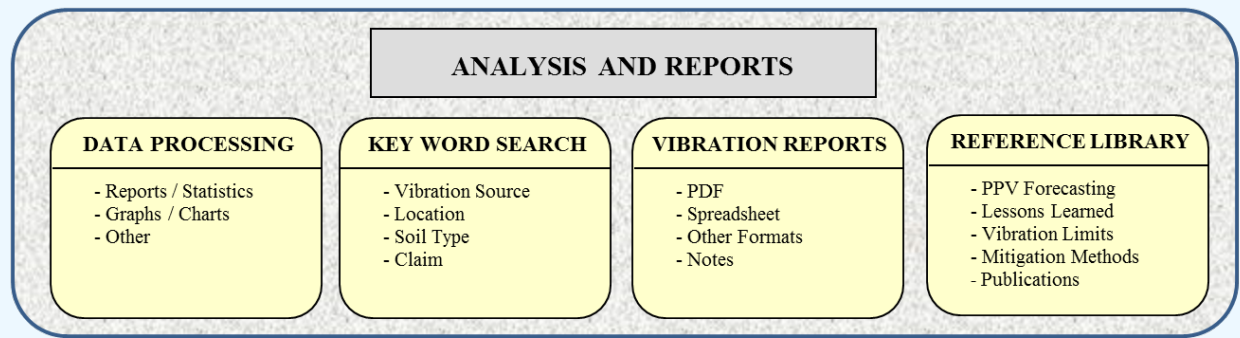
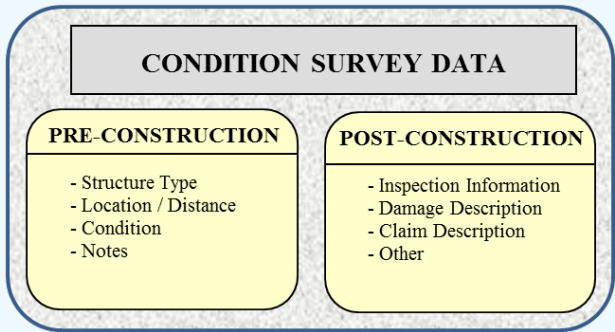
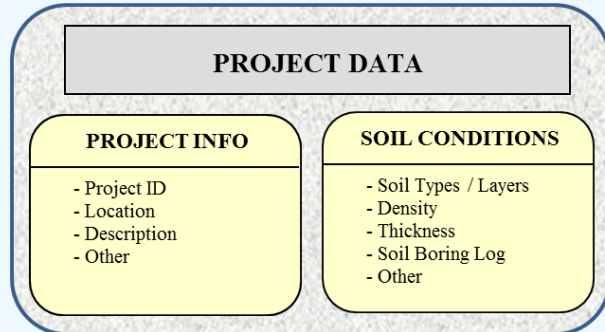
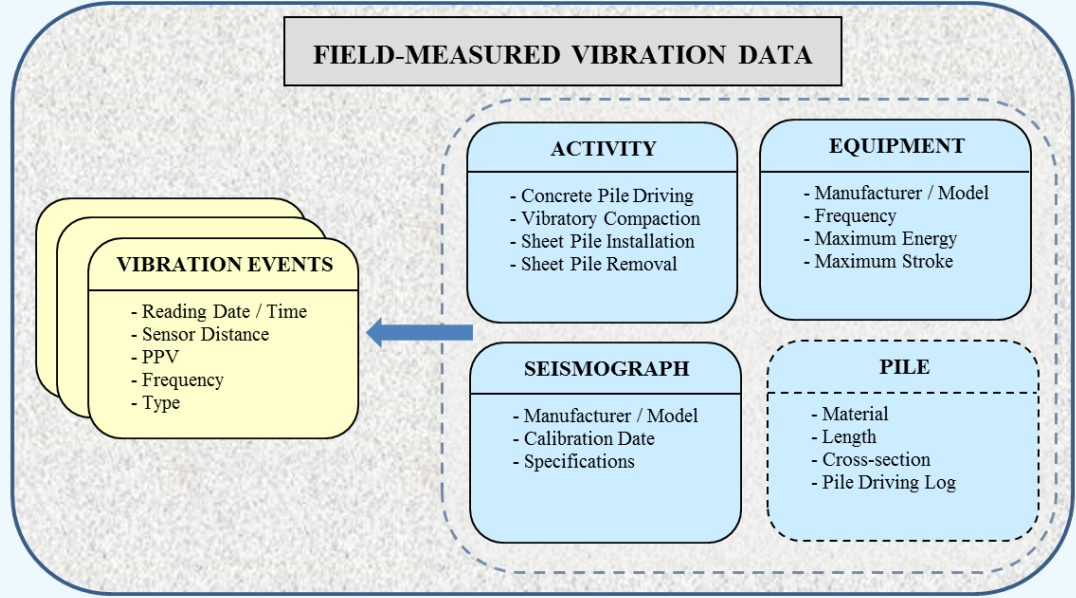
Concrete pile	12
Sheet pile	2
Vibratory compaction	9
<b>Total</b>	<b>23</b>

**District-4**

Concrete pile	23
Sheet pile	11
Vibratory compaction	29
<b>Total</b>	<b>63</b>

## Project Data Collection

- ❑ Challenges
  - ❑ required data scattered among different stakeholders
  - ❑ long lead times; lost information
  - ❑ vibration measurement reports with minimal information
  
- ❑ Recommendation: FDOT Construction Vibration Database
  - ❑ collect, store and track construction vibration data in a database to:
    - ❑ facilitate standardized data collection from Districts, contractors and vibration consultants
    - ❑ provide decision support during design and construction phases
    - ❑ refine and modify specifications/methods over time by analyzing collected data



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**NEXT:**

- PHASE-II: ANALYSIS AND RECOMMENDATIONS

**THANK YOU!**