EVALUATION OF VIBRATION LIMITS AND MITIGATION TECHNIQUES FOR URBAN CONSTRUCTION

2013 GEOTECHNICAL RESEARCH IN PROGRESS

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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

BACKGROUND

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

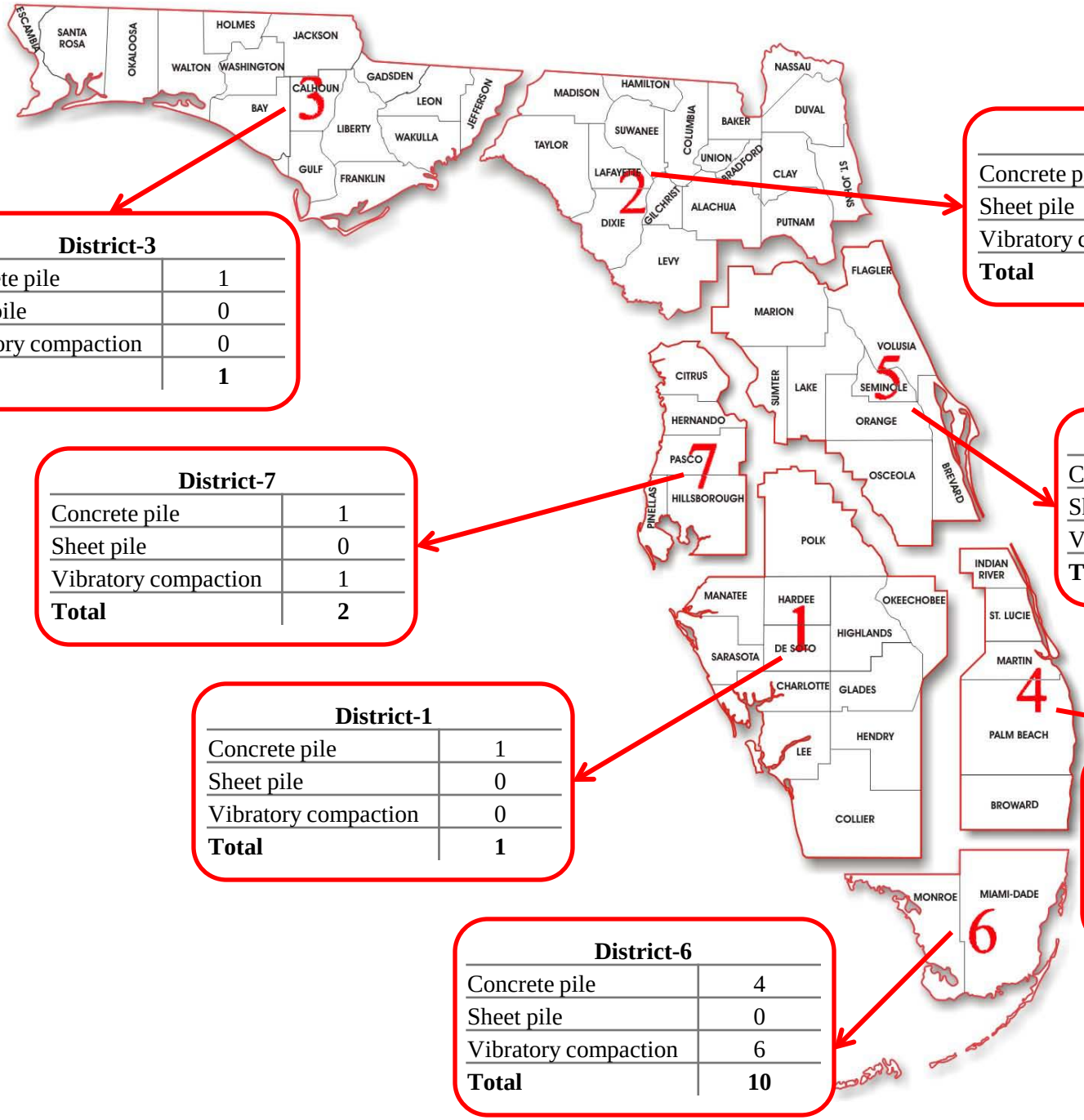
Task-7: Evaluate existing vibration limits and develop flexible limits for FDOT projects

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-3

Concrete pile	1
Sheet pile	0
Vibratory compaction	0
Total	**1**

District-2

Concrete pile	6
Sheet pile	1
Vibratory compaction	2
Total	**9**

District-7

Concrete pile	1
Sheet pile	0
Vibratory compaction	1
Total	**2**

District-5

Concrete pile	12
Sheet pile	2
Vibratory compaction	9
Total	**23**

District-1

Concrete pile	1
Sheet pile	0
Vibratory compaction	0
Total	**1**

District-4

Concrete pile	23
Sheet pile	11
Vibratory compaction	29
Total	**63**

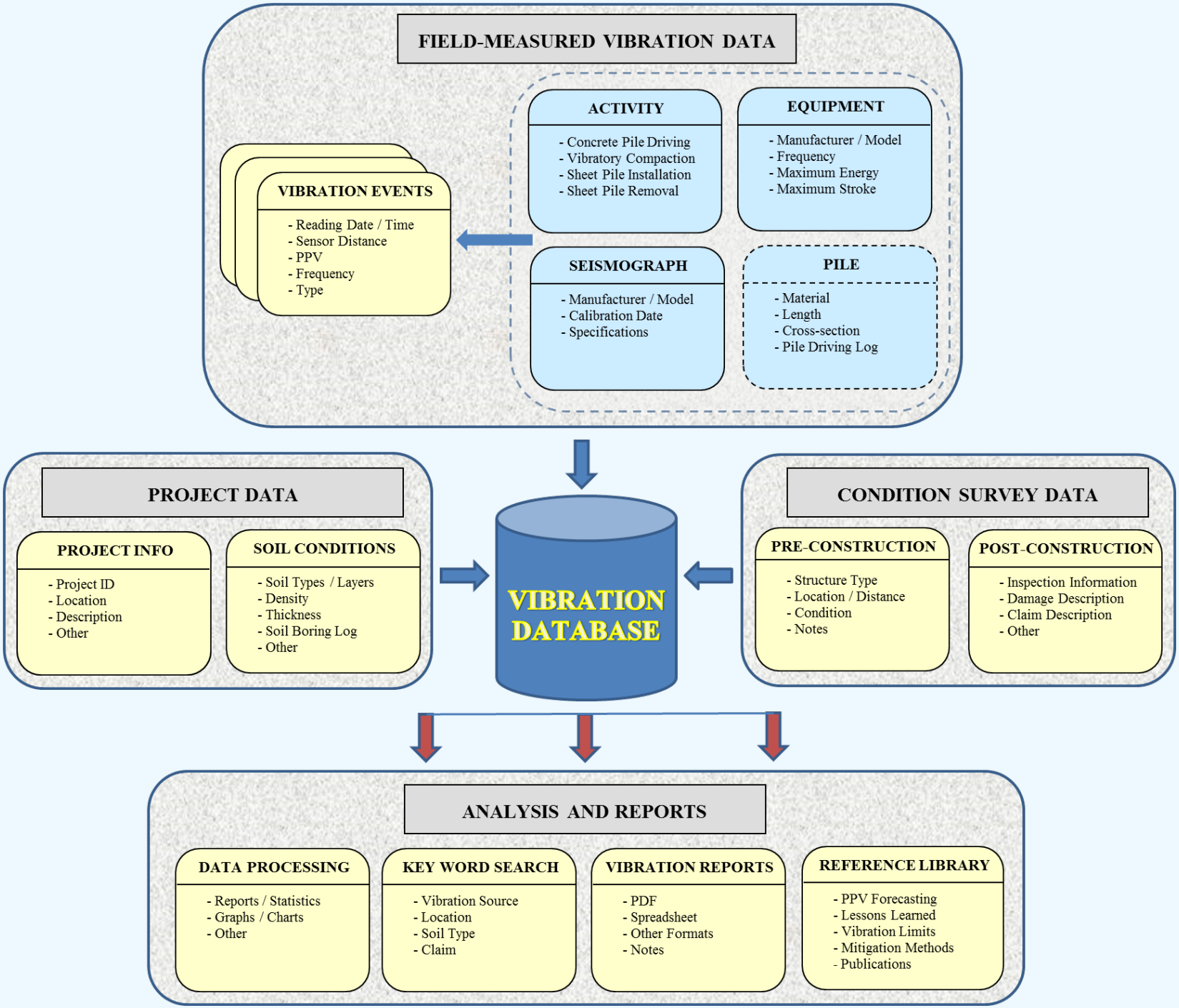
District-6

Concrete pile	4
Sheet pile	0
Vibratory compaction	6
Total	**10**

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


FIELD-MEASURED VIBRATION DATA
VIBRATION EVENTS
- Reading Date / Time
- Sensor Distance
- PPV
- Frequency
- Type
ACTIVITY
- Concrete Pile Driving
- Vibratory Compaction
- Sheet Pile Installation
- Sheet Pile Removal
EQUIPMENT
- Manufacturer / Model
- Frequency
- Maximum Energy
- Maximum Stroke
SEISMOGRAPH
- Manufacturer / Model
- Calibration Date
- Specifications
PILE
- Material
- Length
- Cross-section
- Pile Driving Log
PROJECT DATA
PROJECT INFO
- Project ID
- Location
- Description
- Other
SOIL CONDITIONS
- Soil Types / Layers
- Density
- Thickness
- Soil Boring Log
- Other
VIBRATION DATABASE
CONDITION SURVEY DATA
PRE-CONSTRUCTION
- Structure Type
- Location / Distance
- Condition
- Notes
POST-CONSTRUCTION
- Inspection Information
- Damage Description
- Claim Description
- Other
ANALYSIS AND REPORTS
DATA PROCESSING
- Reports / Statistics
- Graphs / Charts
- Other
KEY WORD SEARCH
- Vibration Source
- Location
- Soil Type
- Claim
VIBRATION REPORTS
- PDF
- Spreadsheet
- Other Formats
- Notes
REFERENCE LIBRARY
- PPV Forecasting
- Lessons Learned
- Vibration Limits
- Mitigation Methods
- Publications

NEXT:

- PHASE-II: ANALYSIS AND RECOMMENDATIONS

THANK YOU!