Field Implementation of the Vertical In situ Permeameter (VIP) BDV31-977-88

FDOT GRIP Meeting

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Topics Covered

- Introduction
- Background
- Objectives
- Tasks
- Project Benefits

Introduction

- Measuring hydraulic conductivity in soil can be challenging
- Grain size, grain orientation, density, degree of saturation, and soil type all effect hydraulic conductivity
- Soil disturbance can lead to skewed results
- Several methods have been developed to measure hydraulic conductivity
  - Includes laboratory and field methods

Introduction

- Laboratory methods are often questionable
  - Inherent sample disturbance induced during extraction and transport
- Field methods induce less disturbance
  - Provides better insight for in situ conditions
- Field testing is often preferred
  - e.g., cased and uncased methods
- Field testing is more expensive and time consuming
  - Makes the approach less ideal

Background

- Recently UF and FDOT developed a new permeability probe
  - The Vertical In situ Permeameter (VIP)
- VIP measurements were in good agreement with results obtained from various conventional methods
  - Includes both cased and uncased methods
- VIP requires far less test time
  - Greatly improves efficiency
  - More data can be collected with less effort

Background

- During the previous investigation, 104 VIP tests were performed
  - 4 different sites
  - 72 depths ranging from 4 to 15 feet
  - Hydraulic conductivities ranging from $1x10^{-5}$ to $1x10^{-2}$ cm/s
- Based on the success, a new Florida Method of Test was developed for the probe
  - FM 5-614
- Additional testing is recommended to validate the success of the preliminary trials

Objectives

- The primary objective of this research is to implement VIP testing throughout Florida
  - Validation testing
  - Introduce the new test method to each FDOT district
- 8 locations will be tested
  - 7 FDOT districts and along the turnpike
  - 2 sites per location
- Variable soil and field conditions will be encountered
  - Provide a better understanding of the probes capabilities and constraints

Secondary Objectives

- Further investigating and updating the shop drawings provided in FM 5-614
  - More robust internal design for percussive driving
- Fabricating 8 probes and falling head vessels
  - Distribute amongst the districts
- Developing and instructional video
  - VIP training purposes
  - Promote the newly developed test method

Supporting Tasks and Deliverables

- Task (1a) – VIP Probe and Falling Head Vessel Fabrication
- Task (1b) – Updating CAD Drawings for FM 5-614
- Task (2) – VIP Calibration
- Task (3) – VIP Field Testing
- Task (4) – Creating and Instructional Video
- Task (5) – Draft Final and Closeout Teleconference
- Task (6) – Final Report

Task (1a) – VIP Probe and Falling Head Vessel Fabrication

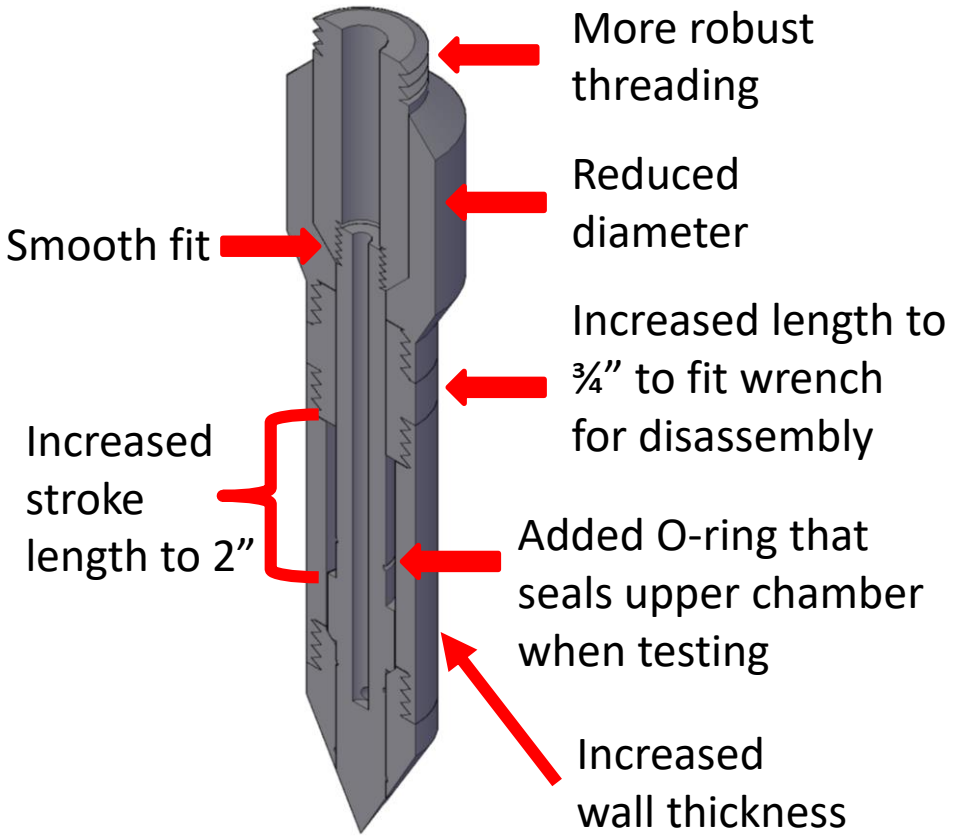
- 8 VIP probes will be fabricated
  - Design will be investigated in Task 1b
- 8 Falling head vessels will also be fabricated
  - Needed to perform VIP testing
- Provide each district with the needed testing equipment to implement VIP testing when desired
  - In-house testing (FDOT)
  - Consultant testing within the district

Task (1b) – Updating CAD Drawings for FM 5-614

- Current probe drawings provided in FM 5-614 were investigated and currently being updated
  - Working alongside machine shop to ensure accuracy
- More robust design was developed
  - FDOT indicated a more robust design would be ideal for percussive advancement into denser soils
  - Allow the probe to be advanced without predrilling which requires more time and may cause soil disturbance
- More in-depth CAD drawings are being completed
  - Three dimensional CAD renderings are being developed
  - Better visualization of probe mechanics and guidance for future fabrication

New Design – 3D CAD Rendering

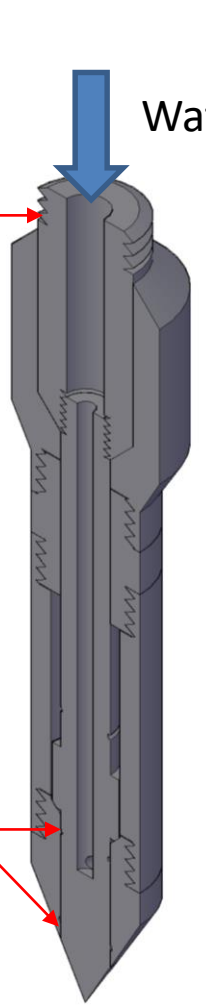
- More robust design
  - Percussive advancement
- More robust threading
- Increased wall thickness
- Increase stroke length to 2”
  - Easier to track the required lift to open the probe tip
- Reduced diameter for the friction reducer
  - Less resistance during advancement
- Increased length of the connector to ¾”
  - fit wrench for easier disassembly
- Added O-ring to seal upper chamber when testing
  - Water only exits through the tip



Probe Mechanics

Closed Position - No Flow

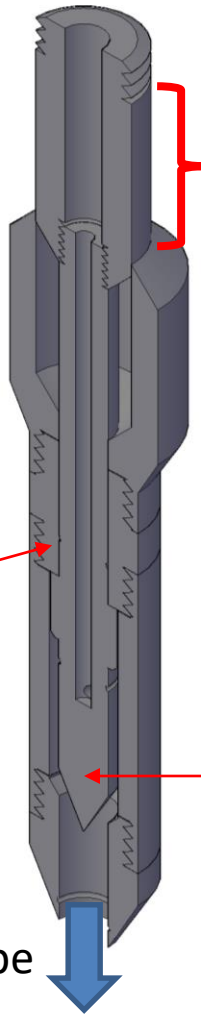
Open Position - Flow



Water enters probe

AWJ Rod Attachment

2 O-rings seal the bottom chamber so no water exits the probe tip in closed position



Lift 2 inches

O-ring seals upper chamber so water only exits through the probe tip in open position

Probe tip retracted

Water exits probe

Probe Comparison

Task (2) – VIP Calibration

- After each probe is constructed, calibration will need to take place to ensure the probes and accompanying equipment function properly before distribution
- Requires a standard calibration procedure to be developed
  - Check O-ring compression
    - Closed off during advancement
    - Properly opens for testing at shallow depths and in less dense soil
  - Determine permeability limits of the probe
- The previously developed shape factor (F) will also be investigated
  - Currently, F = 3D
  - Could range from 2.5D to 3.1D based on the literature

Task (3) – VIP Field Testing

- Field testing will be conducted at 16 different sites throughout Florida
  - 7 FDOT districts and along the turnpike (2 sites/location)
- Each site will be identified by the Project Manager
- Ideal sites will provide ease of access for testing and have prior hydraulic conductivity data available for comparison
- Data will be reduced and analyzed after each site is completed
- Upon completion of all sites, a final analysis will be conducted and conclusions will be drawn
  - Cost comparisons to conventional methods
  - Commentary on any regional/geological variability effects

Task (4) – Creating an Instructional Video

- An instructional video will be developed and made readily available on the internet
  - e.g., YouTube
- Will be developed after calibration standards have been established and some field testing has taken place
  - Allow researchers to identify/resolve any issues before the video is made public
- The video will serve as a companion to the instructions provided in FM 5-614

Project Benefits

- VIP testing will provide a significant increase in the amount of data obtained during a standard site investigation
  - VIP allows more data to collected at multiple depths with reduced test times
  - More data is collected with less effort
- Lead to a reduction in future costs for obtaining accurate hydraulic conductivity data
- This research will validate and promote the use of FDOT's newly developed Florida Method of Test FM 5-614
  - Each district will be provided with the needed equipment and training to implement VIP testing

Questions?