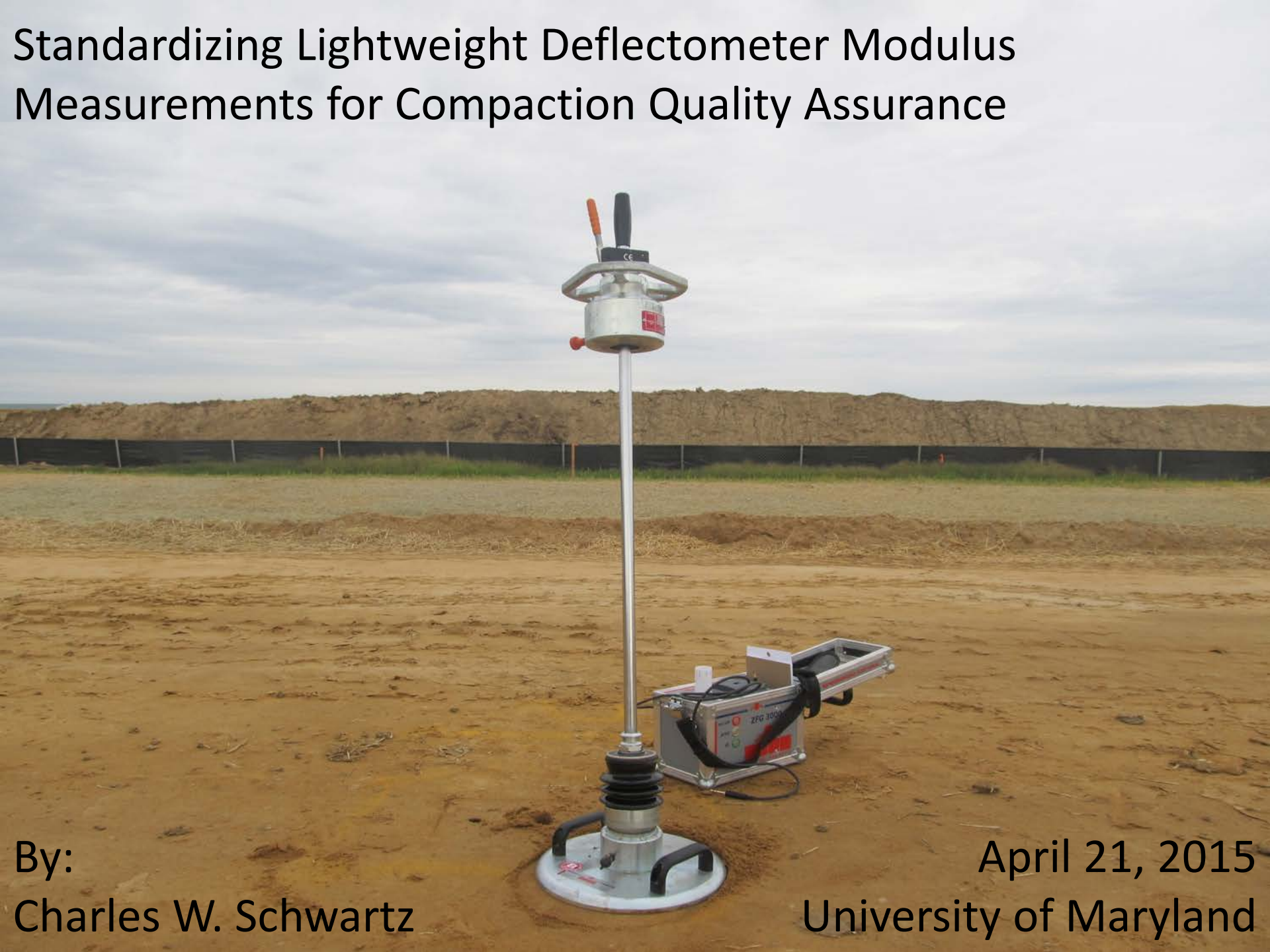
# Standardizing Lightweight Deflectometer Modulus Measurements for Compaction Quality Assurance



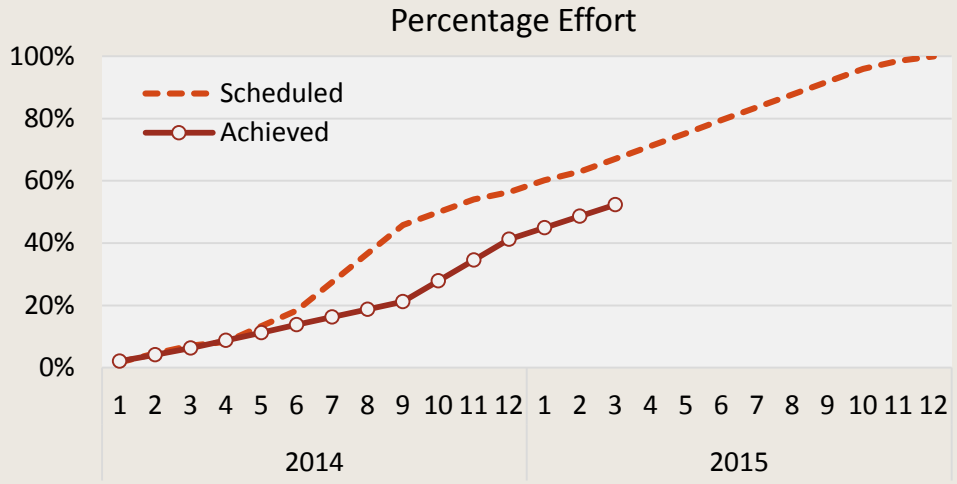
By:
Charles W. Schwartz

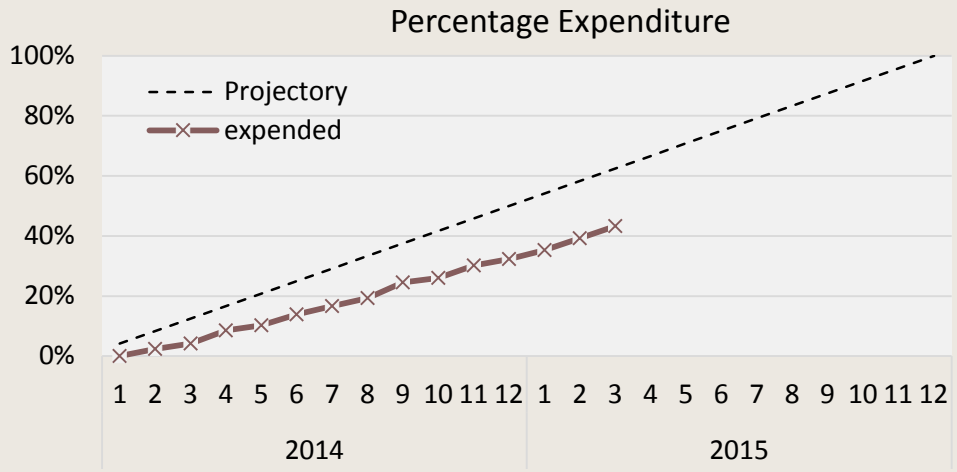
April 21, 2015

University of Maryland

# Schedule

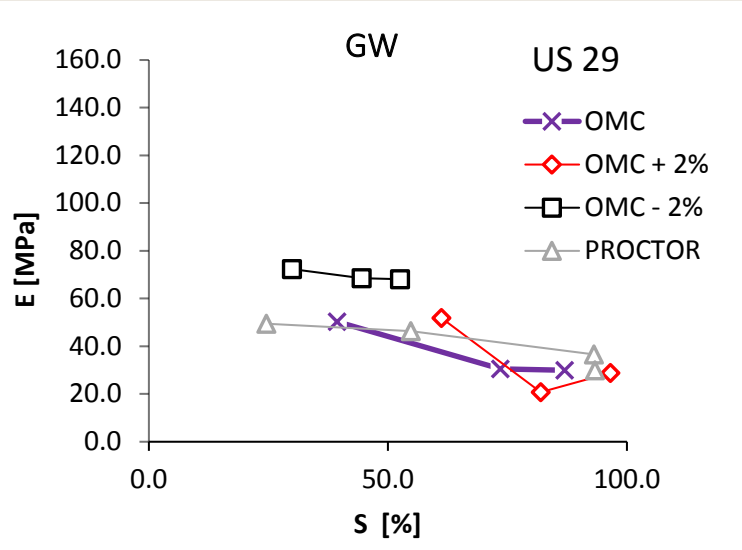
Task 1: Literature Review -100%
Task 2: Equipment Evaluation- 100%
Task 3: Refine/Develop Model- 86%
Task 4: Controlled Trials- 70%
Task 5: Field Validation- 25%
Task 6: Draft Test Specifications- 0%
Task 7: Workshop & Final Report- 2%

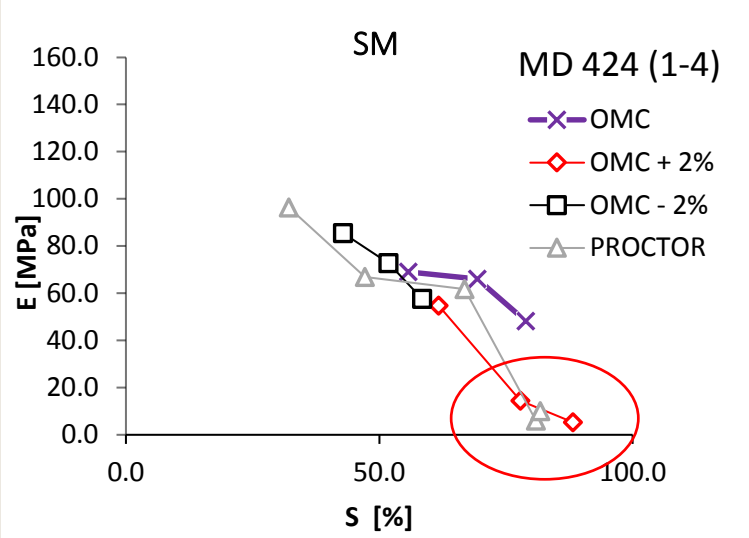


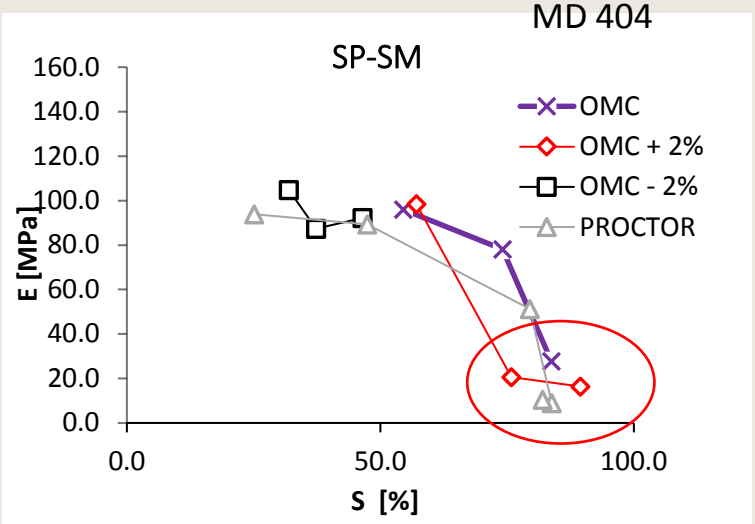



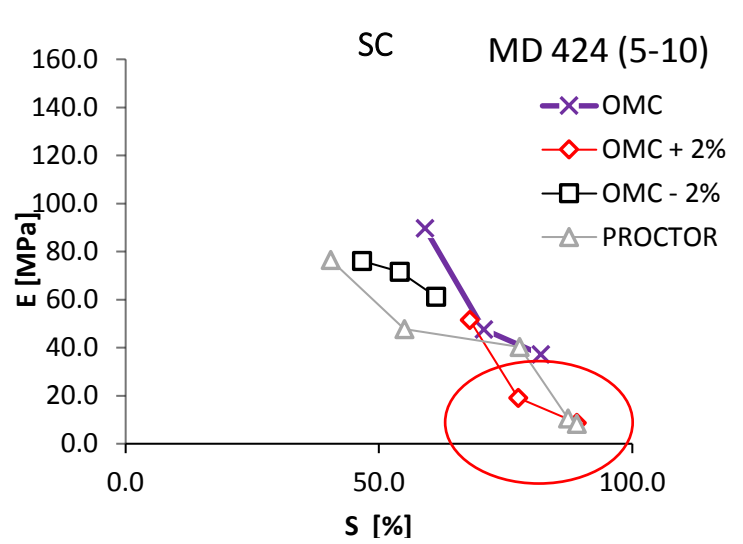
# LWD Tests on Mold

LWD testing on proctor molds



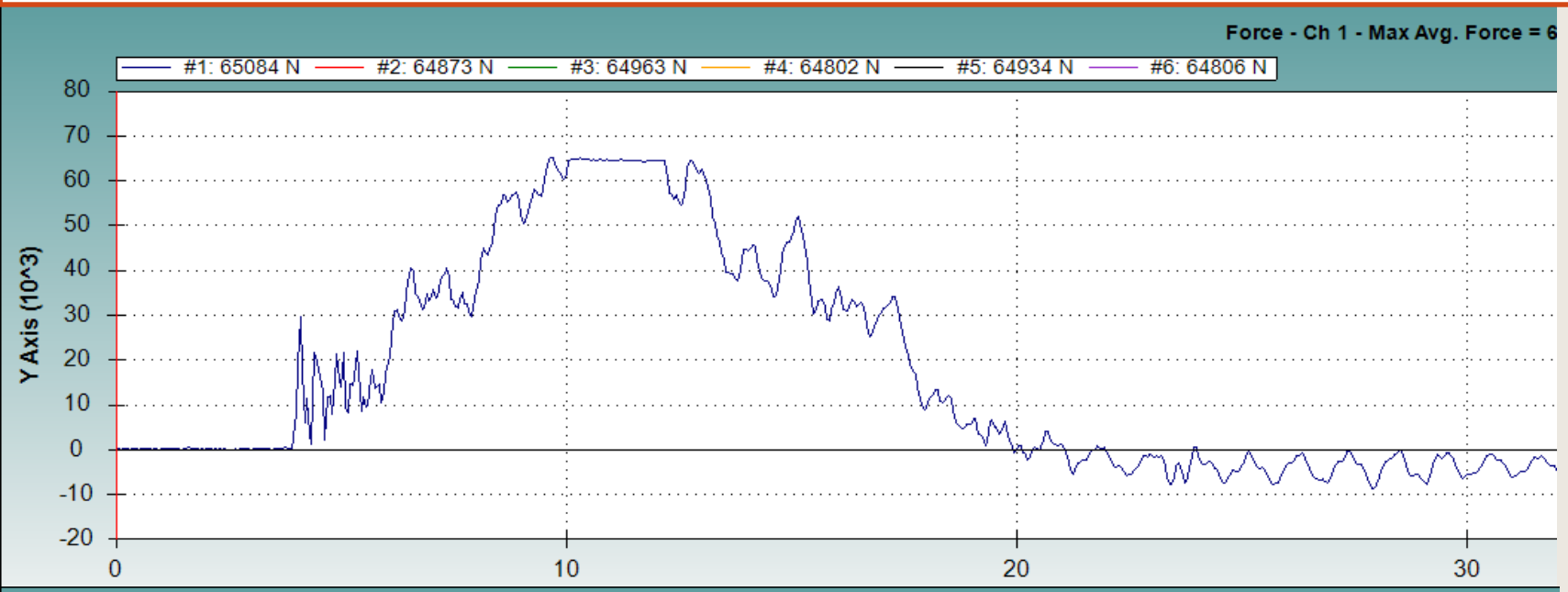



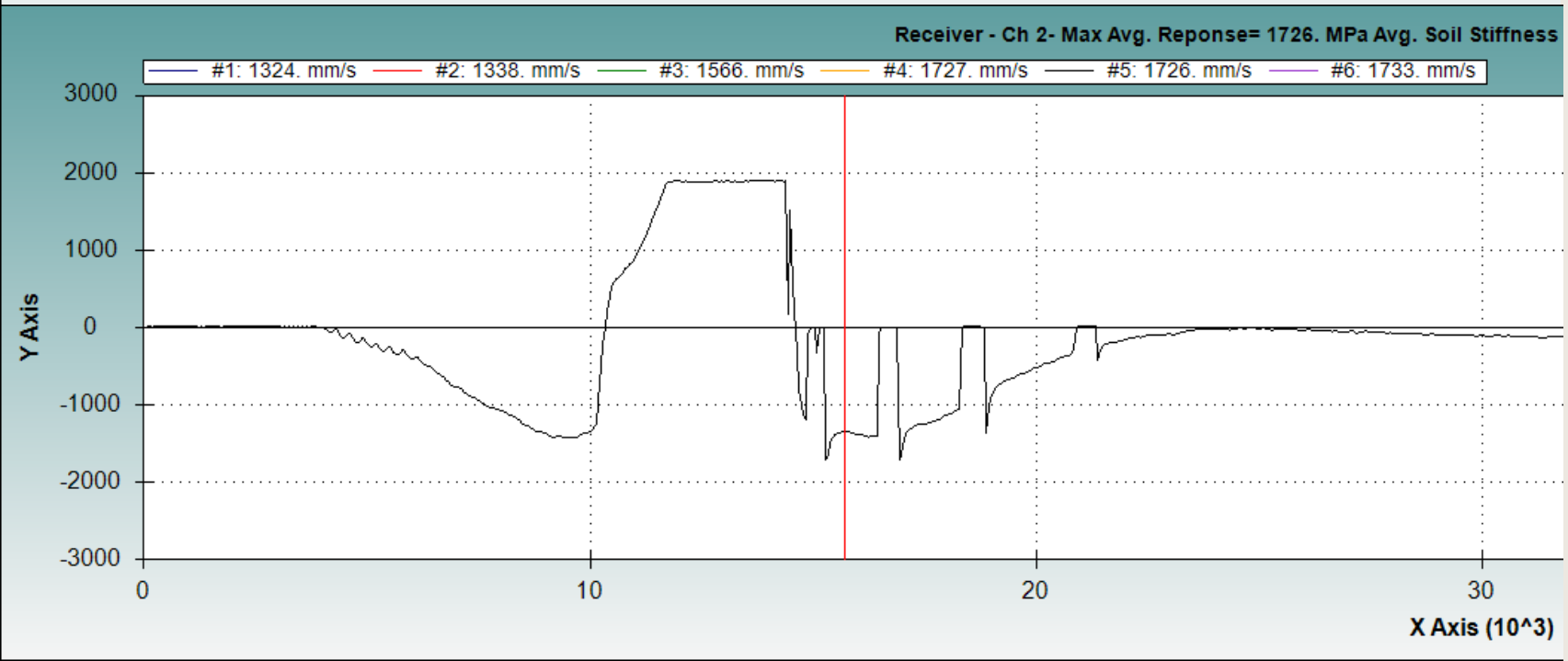



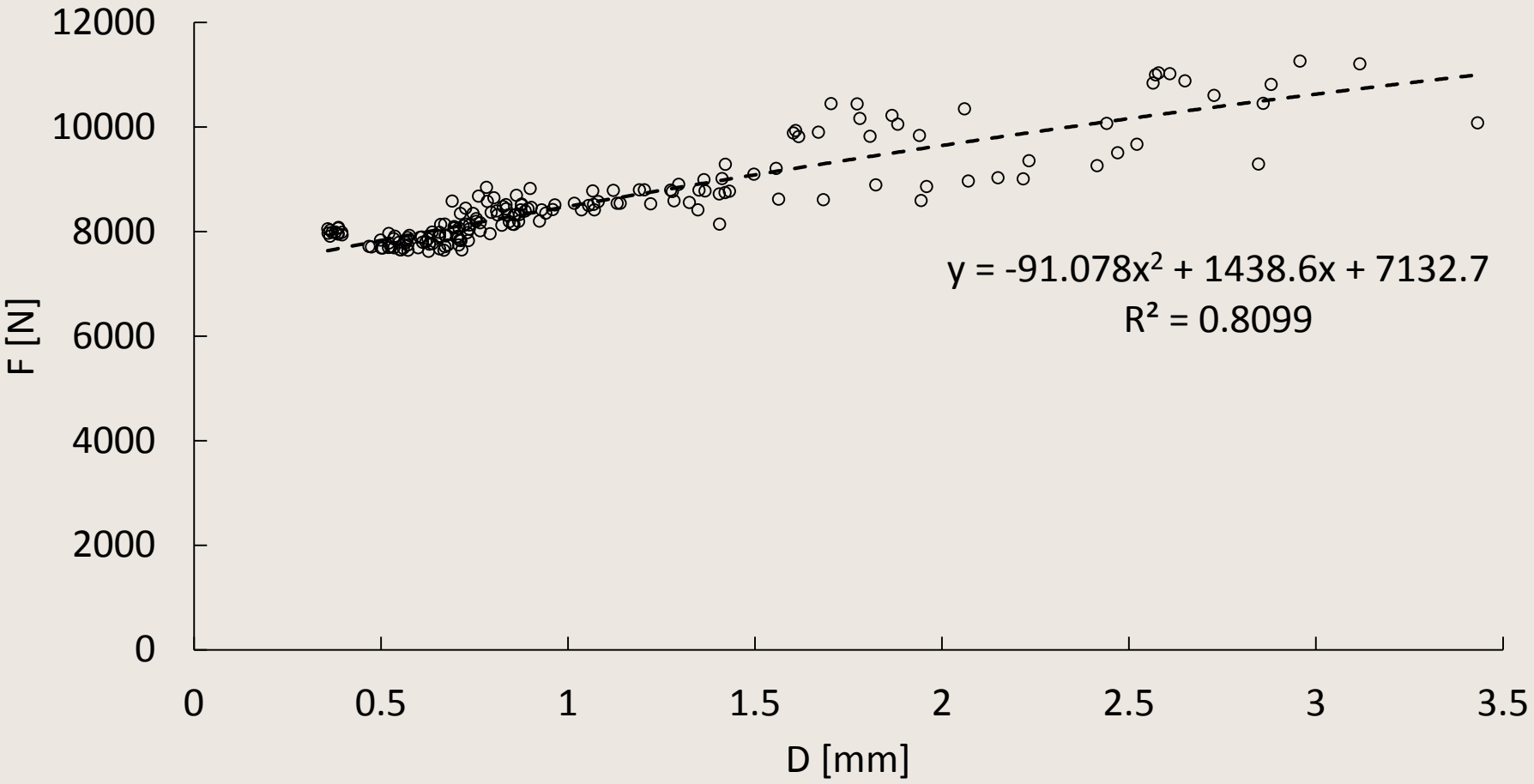

Sensor overload on some of the tests
Rerun the test with lower induced stress

# Olson LWD Tests on Mold

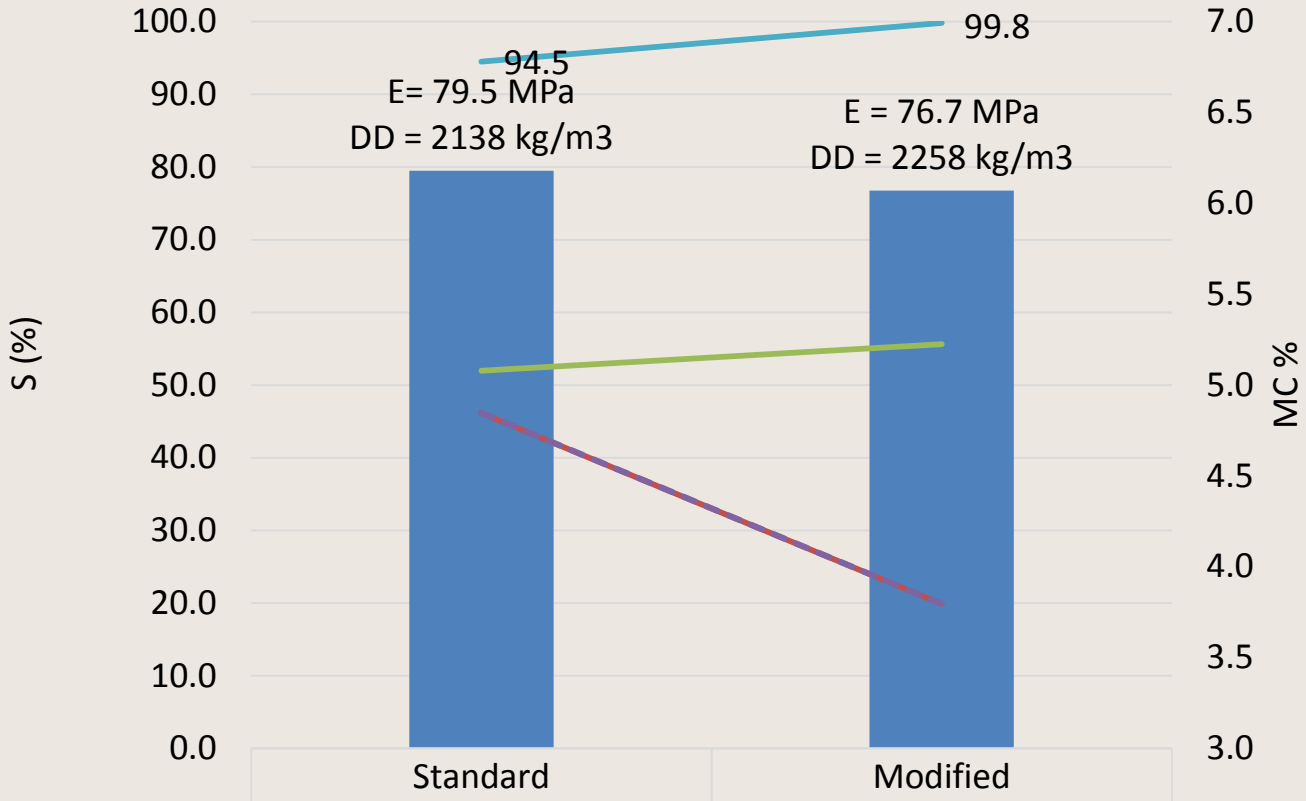


# Olson LWD Tests on Mold

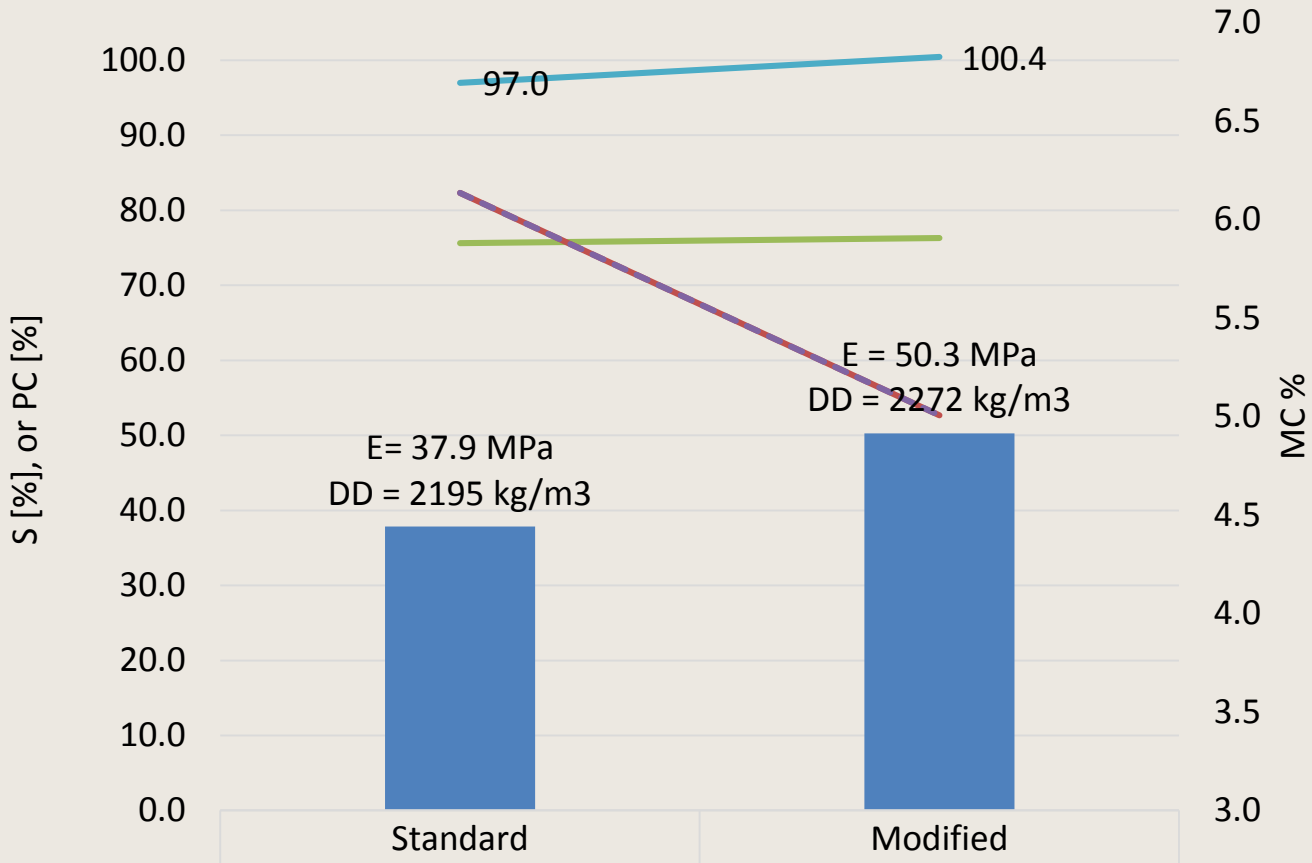


# LWD Tests on Mold




| | Standard | Modified |
|---|---|---|
| E [MPa] | 79.5 | 76.7 |
| S @testing [%] | 52.0 | 55.6 |
| PC [%] | 94.5 | 99.8 |
| MC@Compaction [%] | 4.8 | 3.8 |
| MC@Testing [%] | 4.8 | 3.8 |

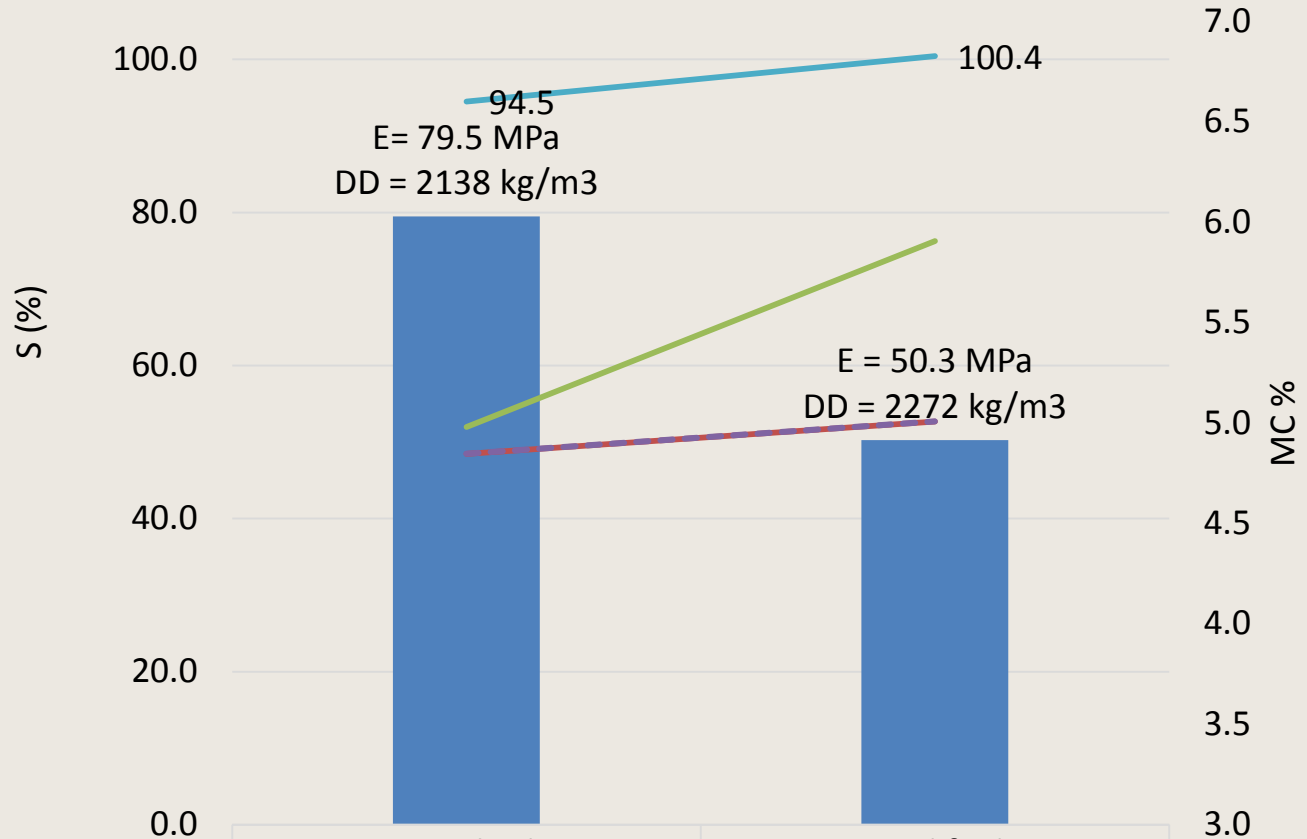
# LWD Tests on Mold




| | Standard | Modified |
|---|---|---|
| E [MPa] | 37.9 | 50.3 |
| S @testing [%] | 75.6 | 76.3 |
| PC [%] | 97.0 | 100.4 |
| MC@Compaction [%] | 6.1 | 5.0 |
| MC@Testing [%] | 6.1 | 5.0 |

# LWD Tests on Mold

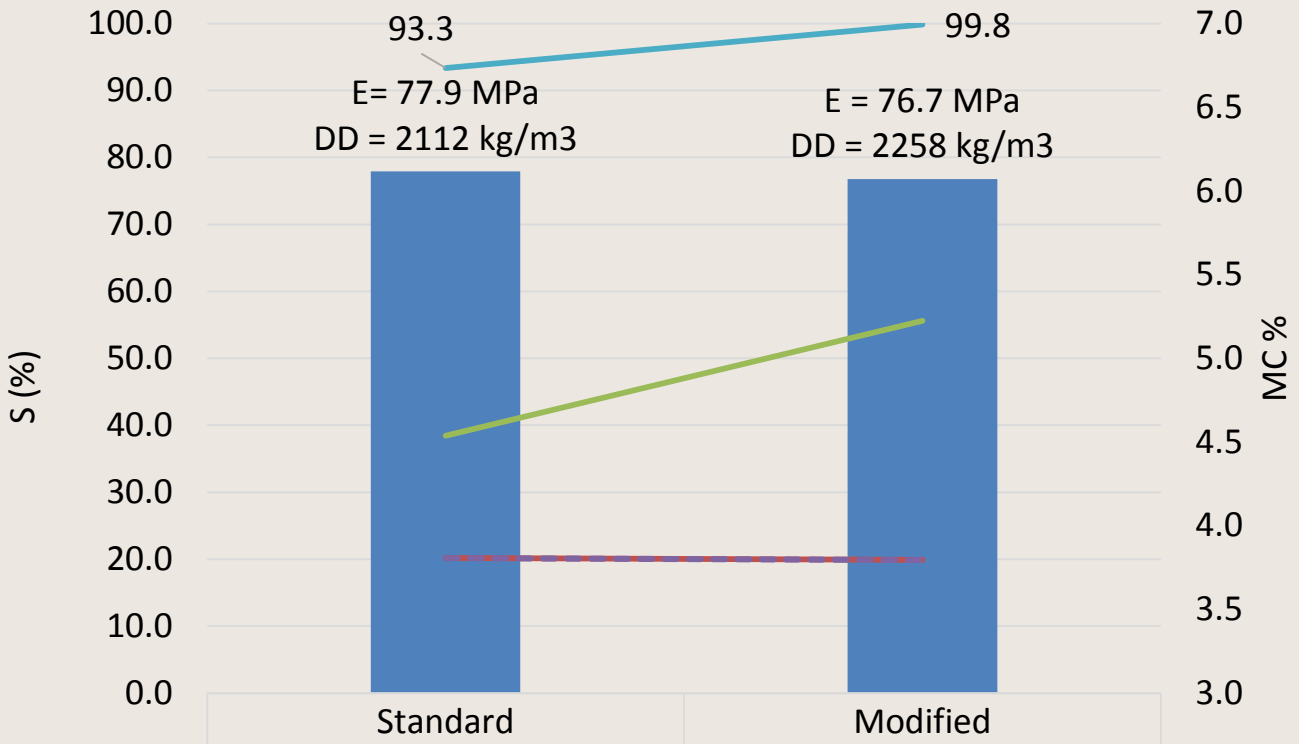
**Lessons learnt from tests performed on LWD molds using Olson LWD-1**




| | Standard | Modified |
|---|---|---|
| E [MPa] | 79.5 | 50.3 |
| S @testing [%] | 52.0 | 76.3 |
| PC [%] | 94.5 | 100.4 |
| MC@Compaction [%] | 4.8 | 5.0 |
| MC@Testing [%] | 4.8 | 5.0 |

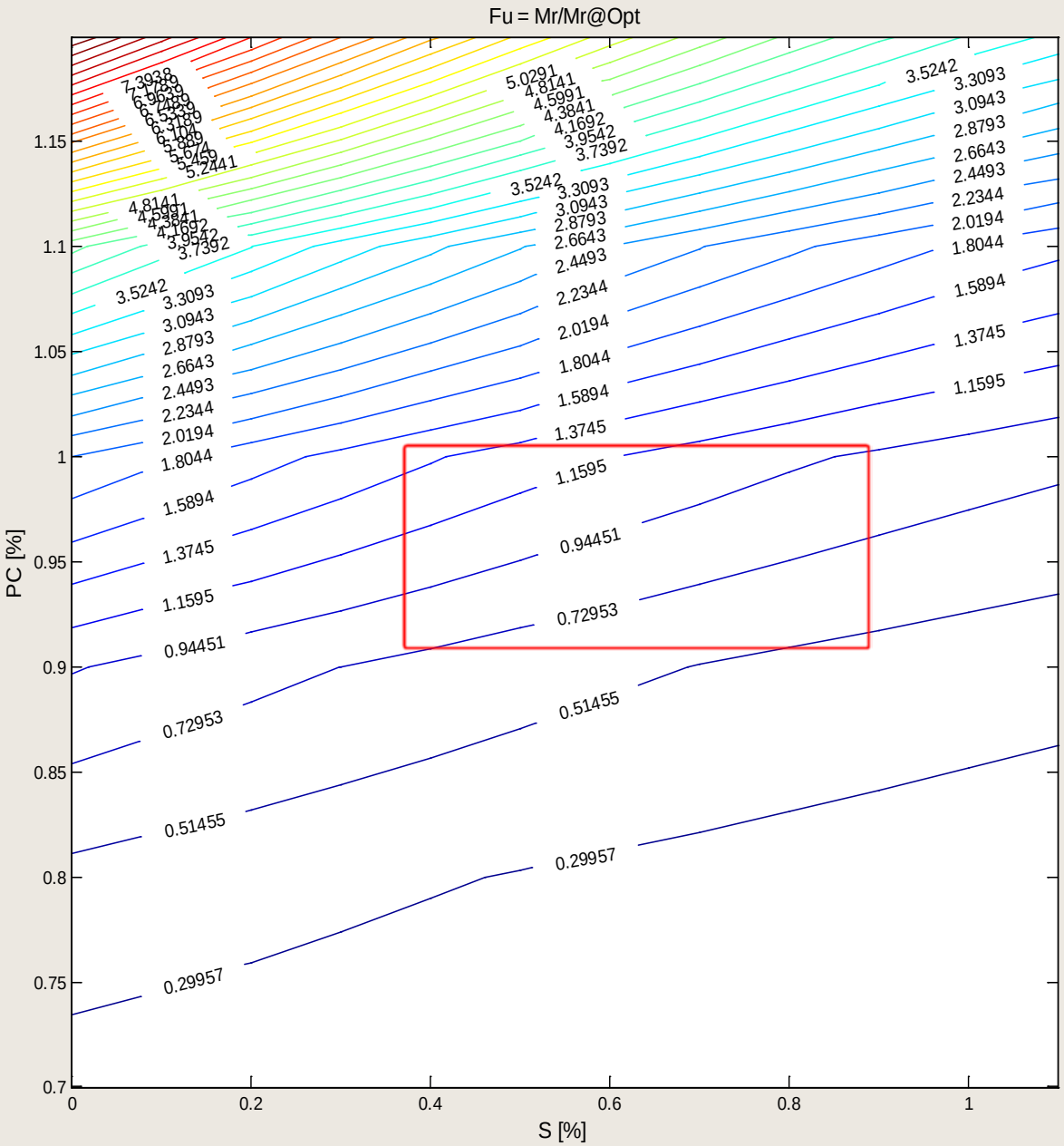
# LWD Tests on Mold

**Lessons learnt from tests performed on LWD molds using Olson LWD-1**



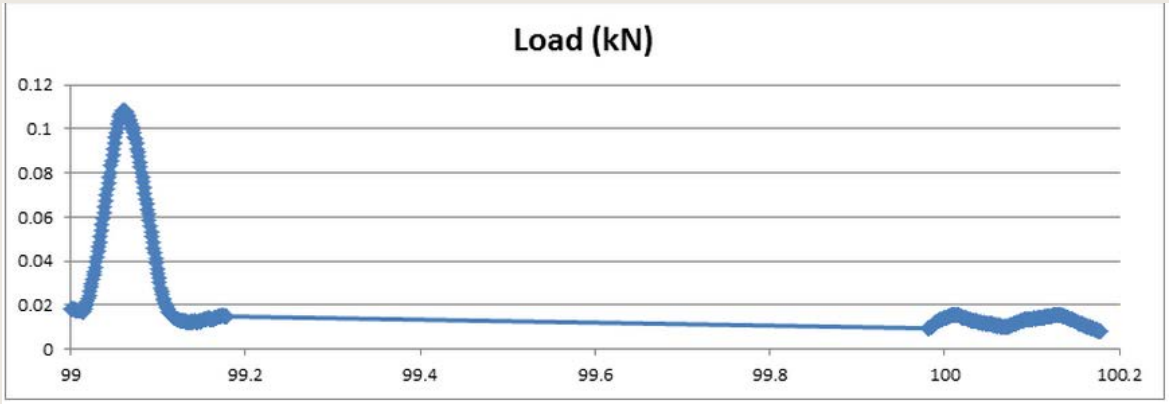

| | Standard | Modified |
|---|---|---|
| E [MPa] | 77.9 | 76.7 |
| S @testing [%] | 38.4 | 55.6 |
| PC [%] | 93.3 | 99.8 |
| MC@Compaction [%] | 3.8 | 3.8 |
| MC@Testing [%] | 3.8 | 3.8 |

# LWD Tests on Mold

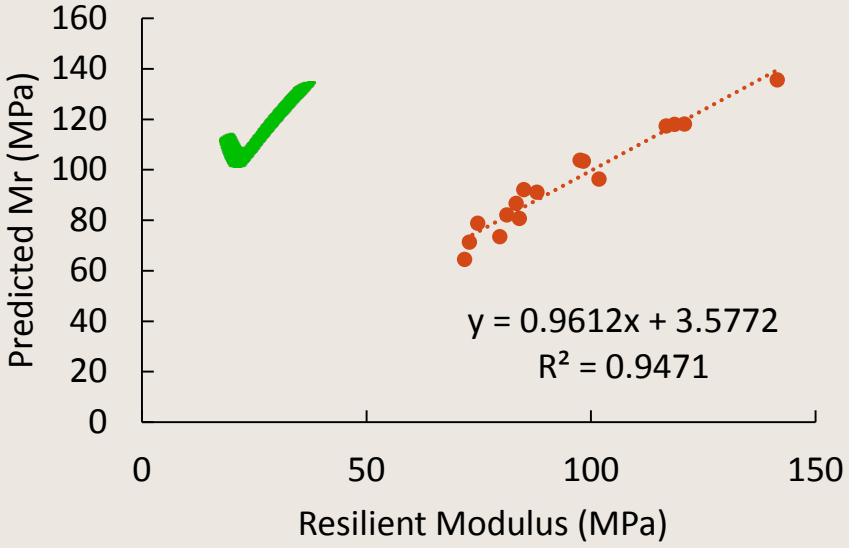


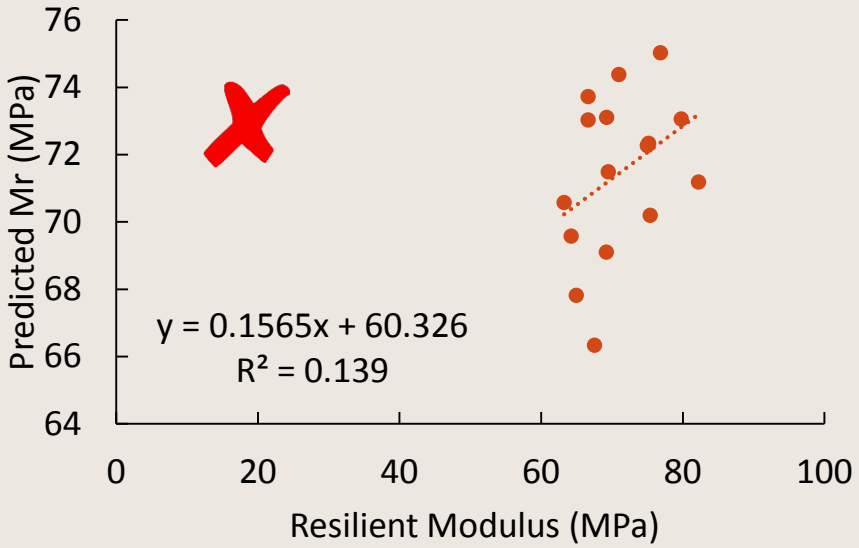
# Resilient Modulus Testing and Modeling

A. Data quality




B. Data analysis and fitting the k1-k3 model

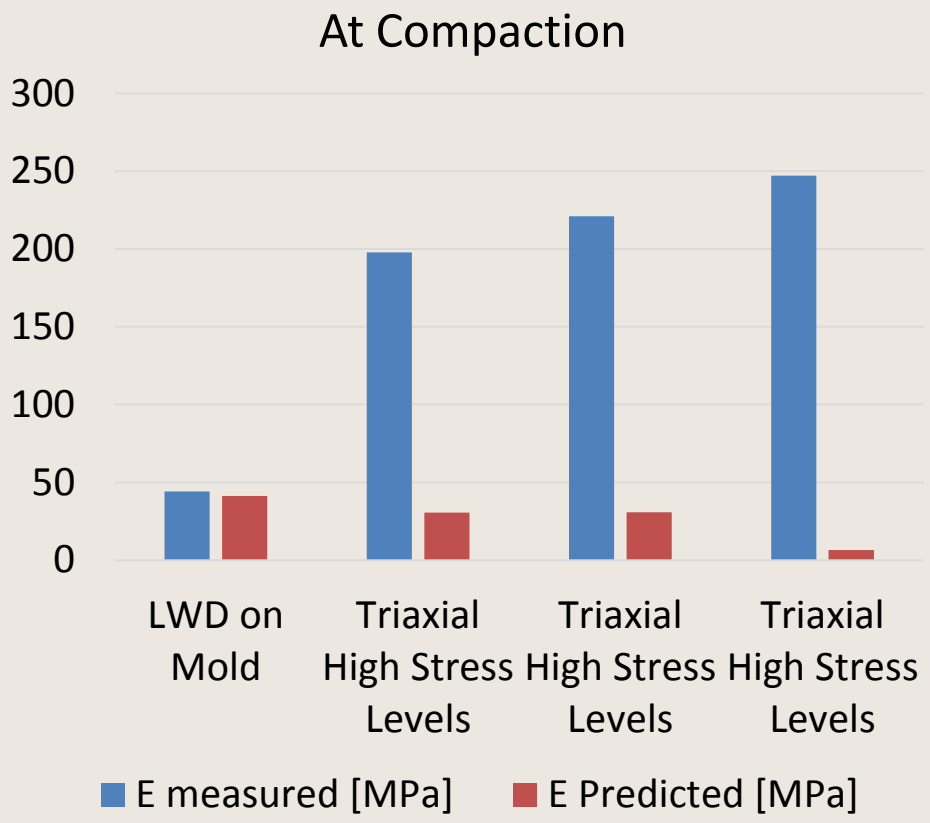


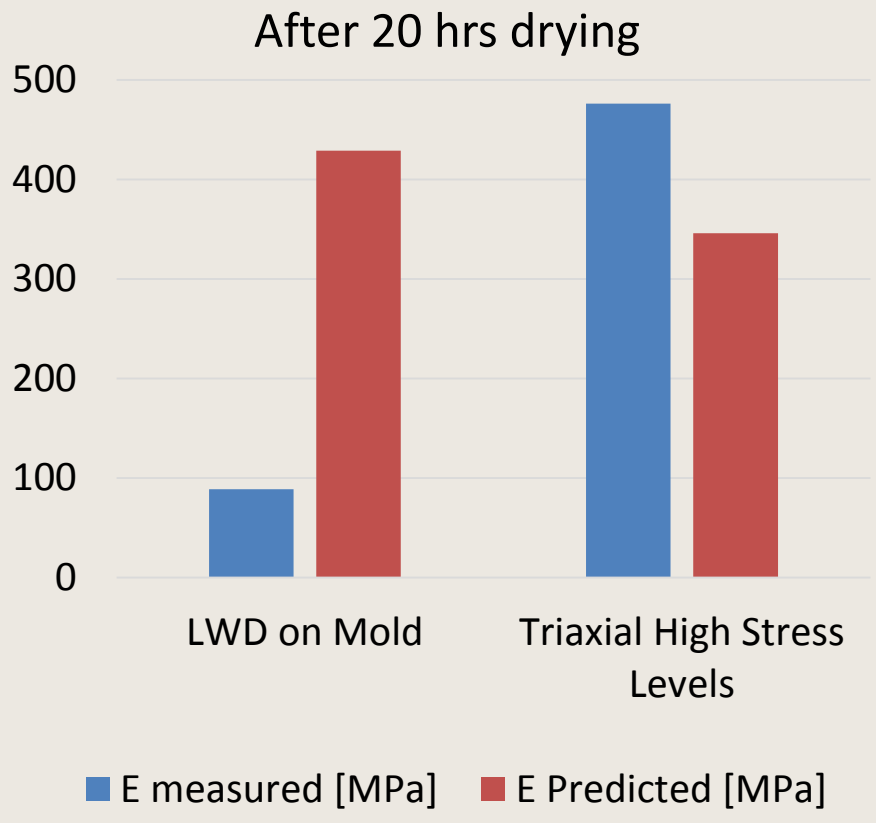



# Resilient Modulus Testing and Modeling

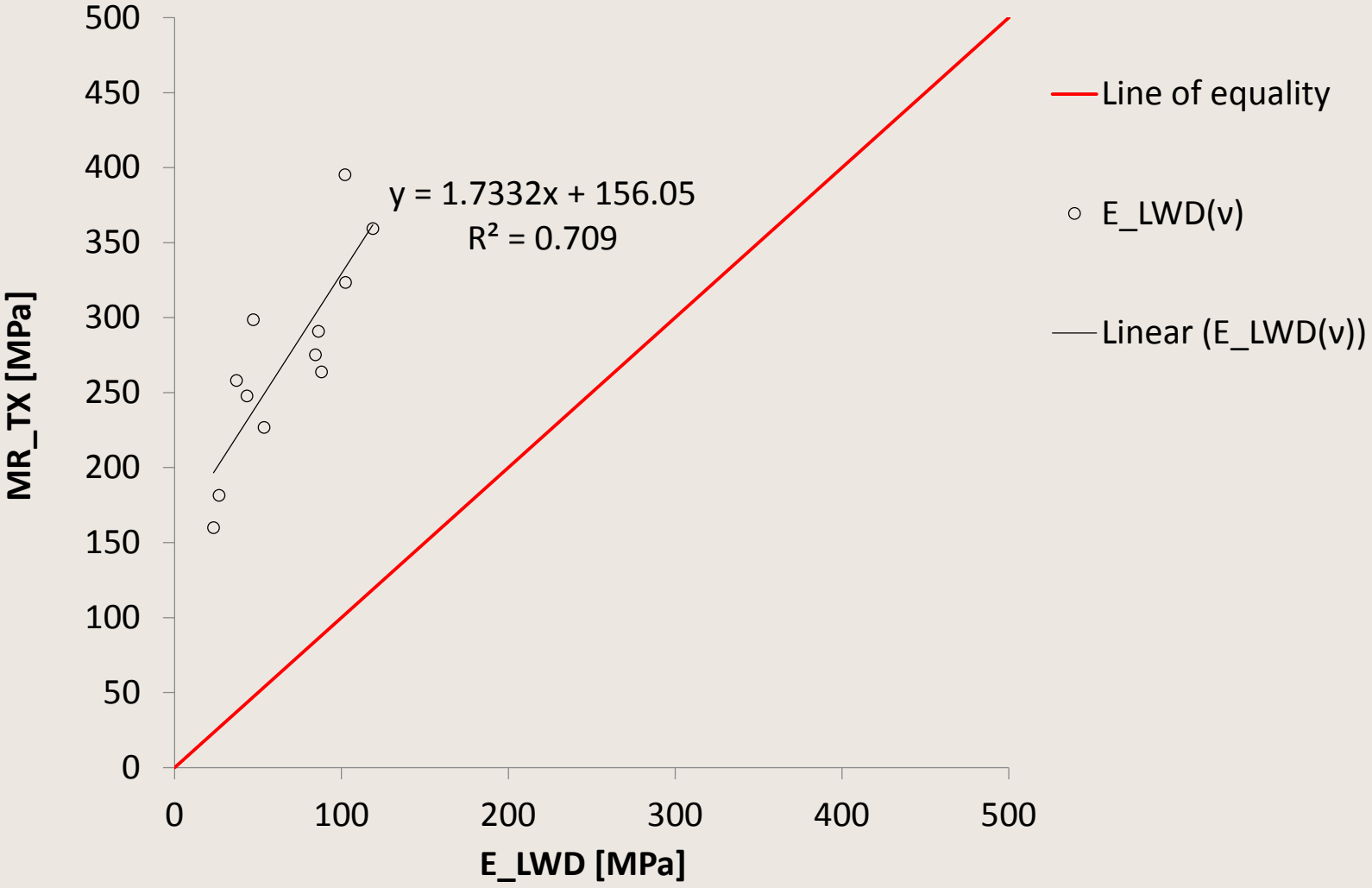
Use MEPDG k1-k3 model to predict

A. Triaxial resilient modulus at LWD stress levels
B. $E_{LWD}$ on Mold



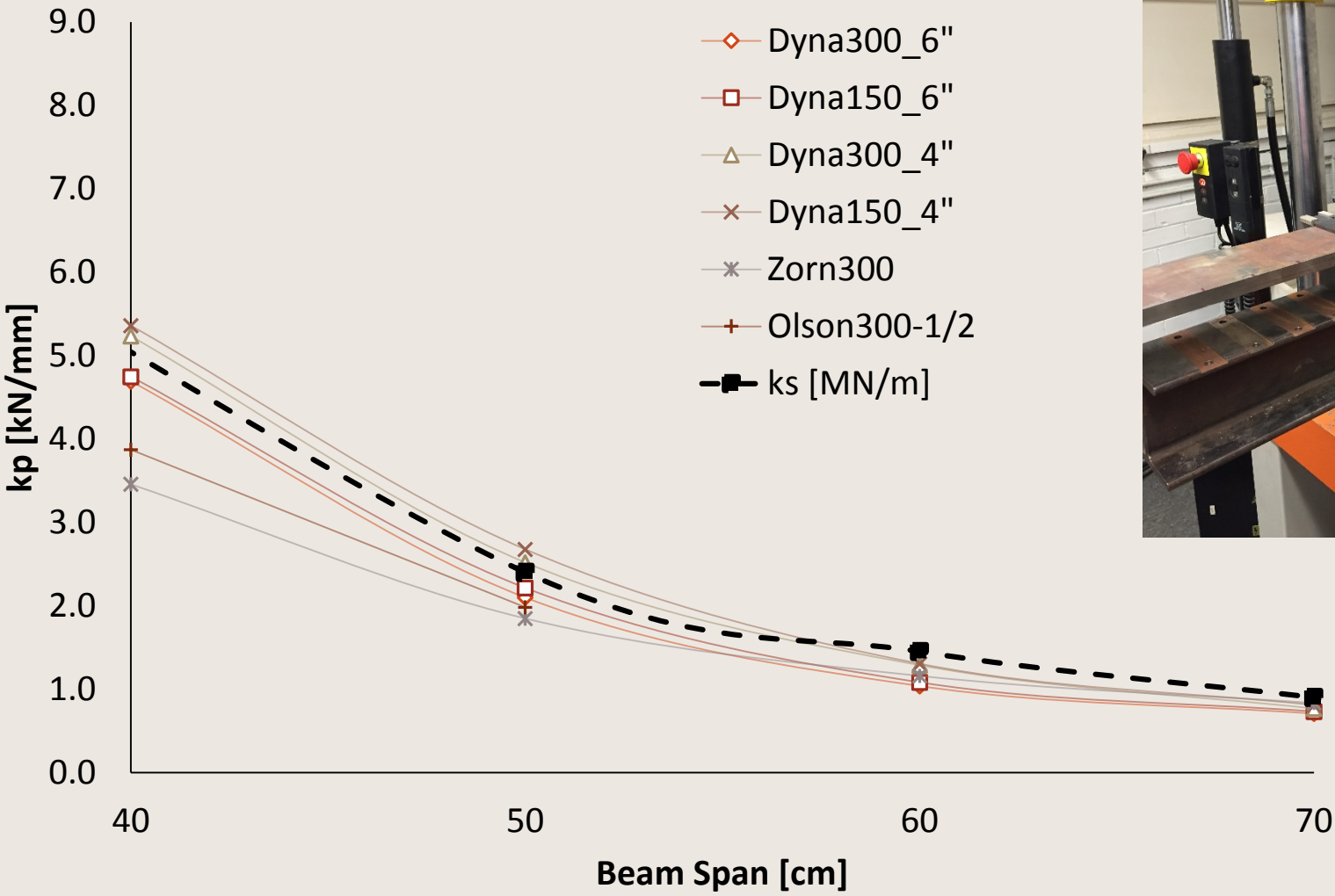



# Resilient Modulus Testing and Modeling



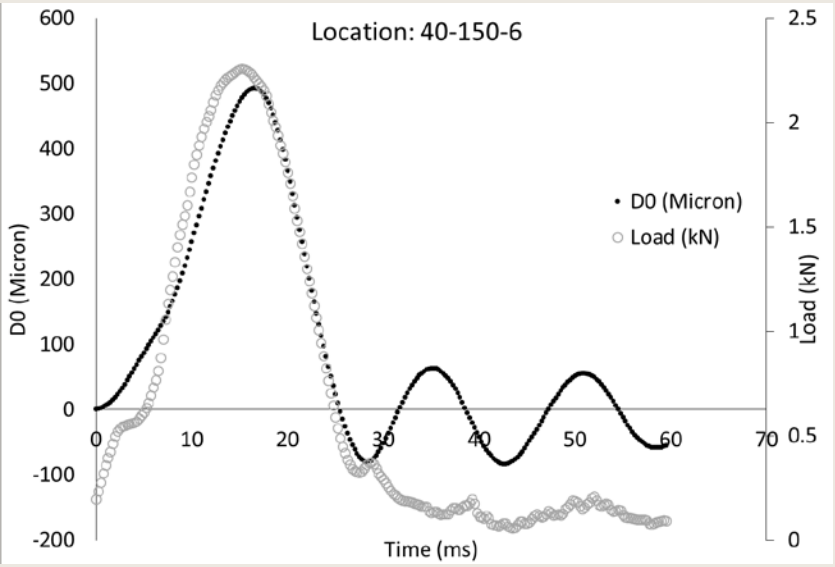

Triaxial $M_R$ ($M_R$-TX) vs LWD modulus for the 4 evaluated soils

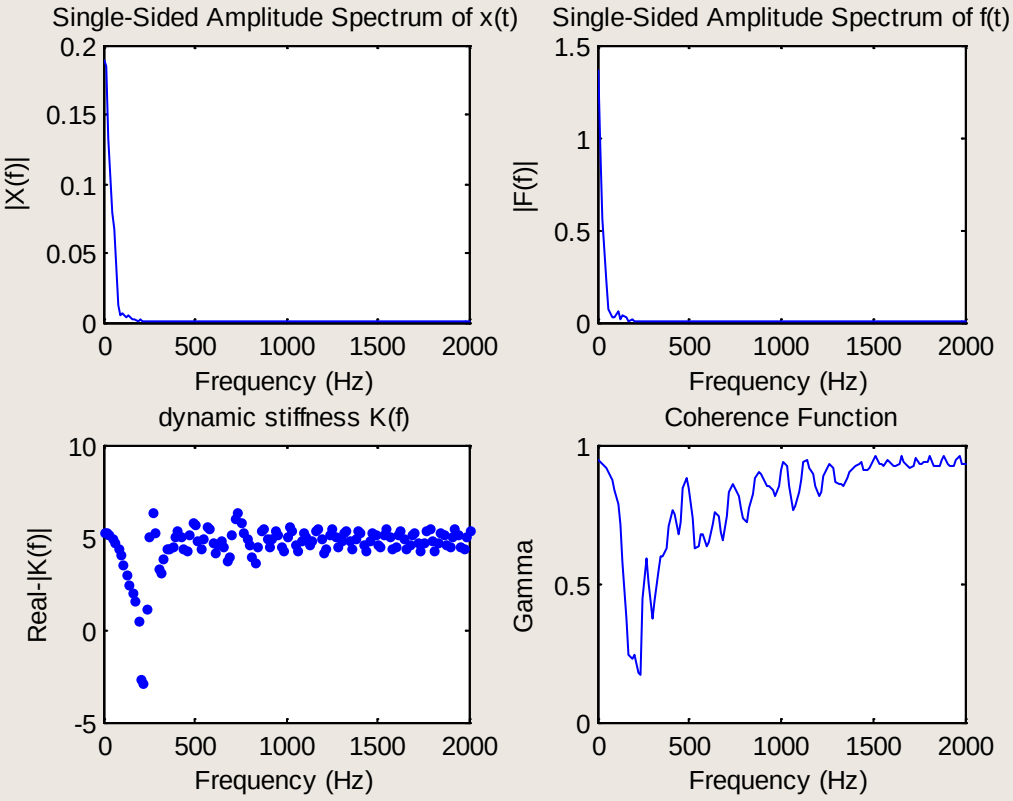
# Beam Verification Tester

# Beam Verification Tester

| | $k_p$ [kN/mm] | $k_s$ [kN/mm] |
|---|---|---|
| 40-150-6 | 4.7 | 5.2 |
| 40-150-4 | 5.3 | 5.2 |

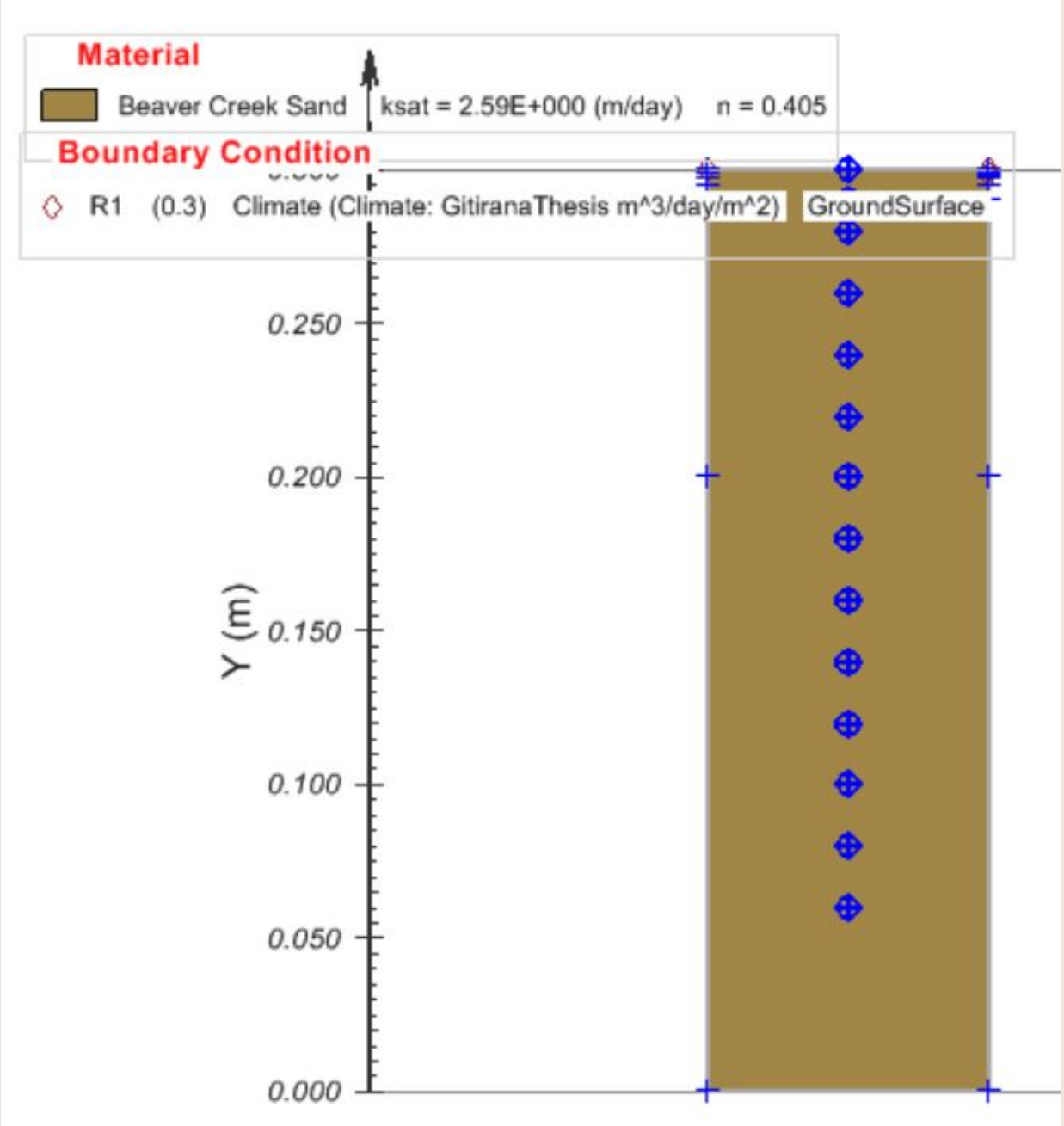



**Dynatest:**
**40-150-6”**

# Flux 1D and SoilVision

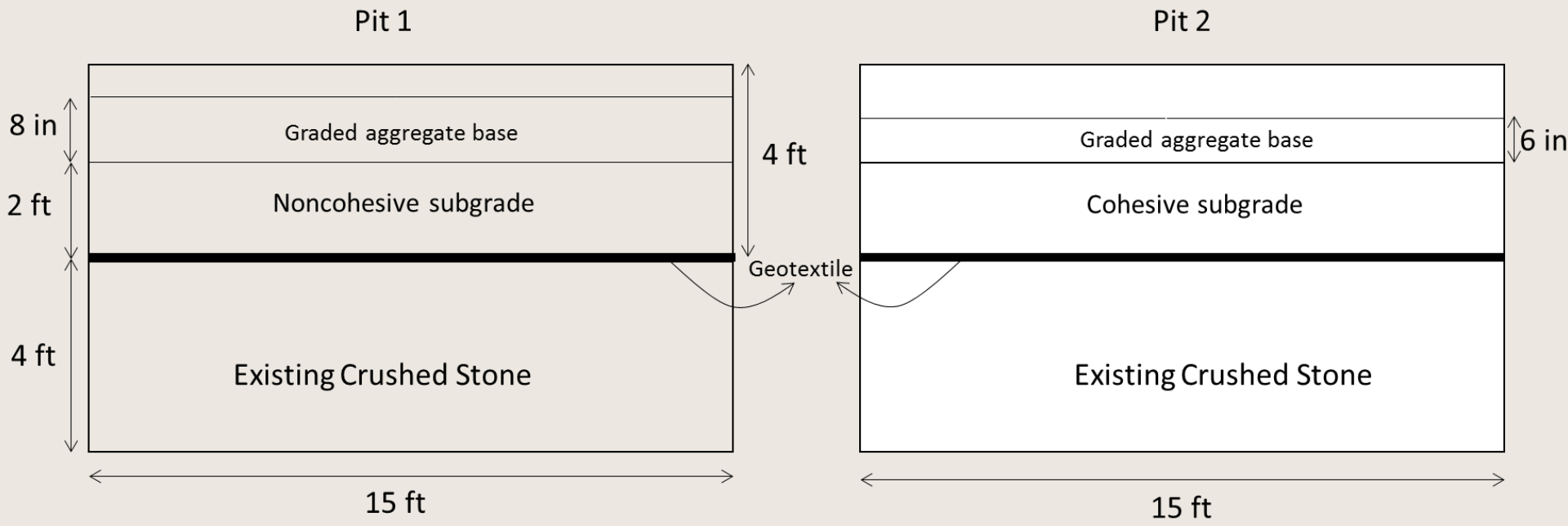
Wilson Sand Column Example Model in SoilVision Software



# Flux 1D and SoilVision

# Test Pit Design

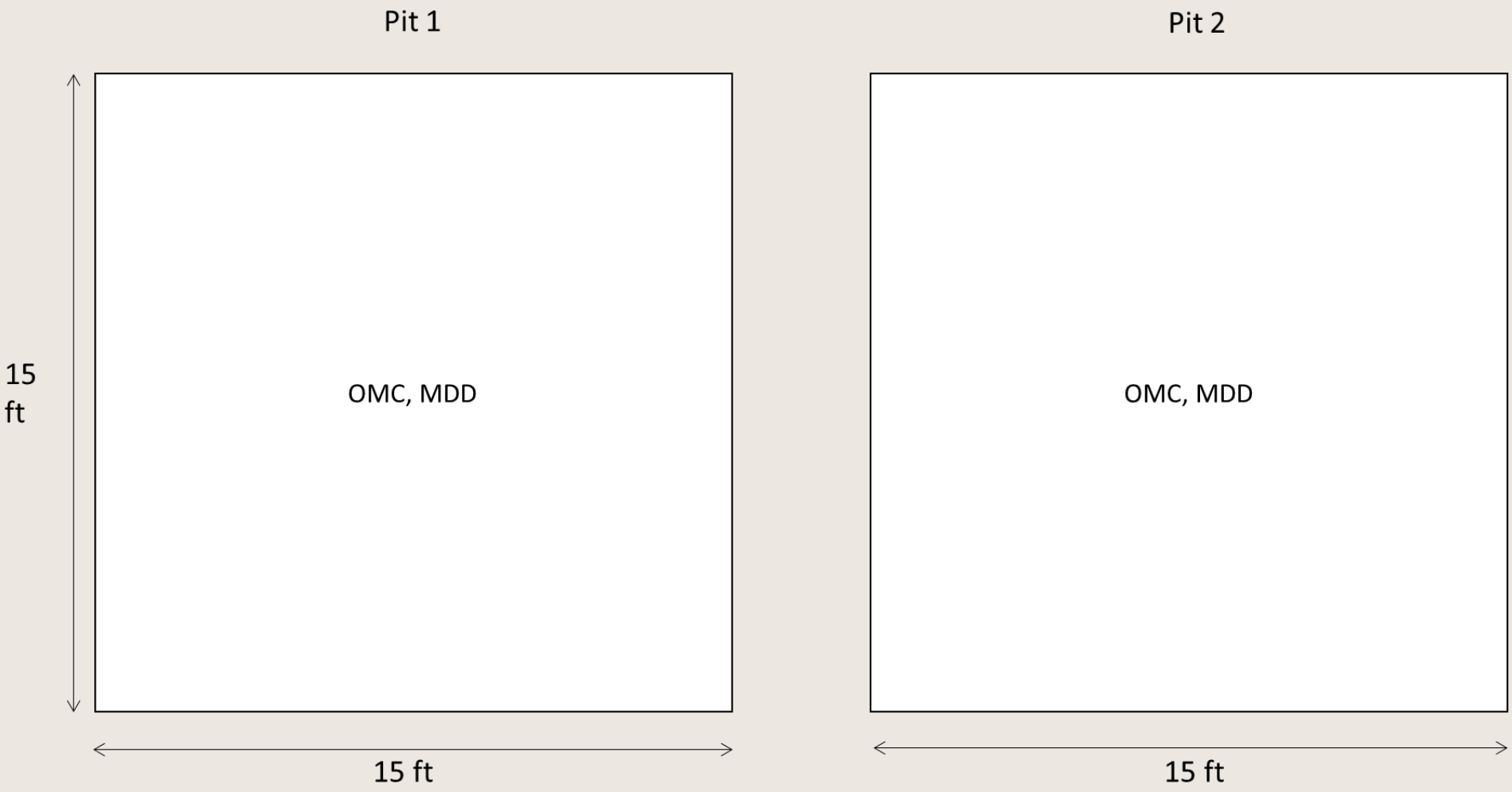
Front view



# Test Pit Design

Priority Number 1

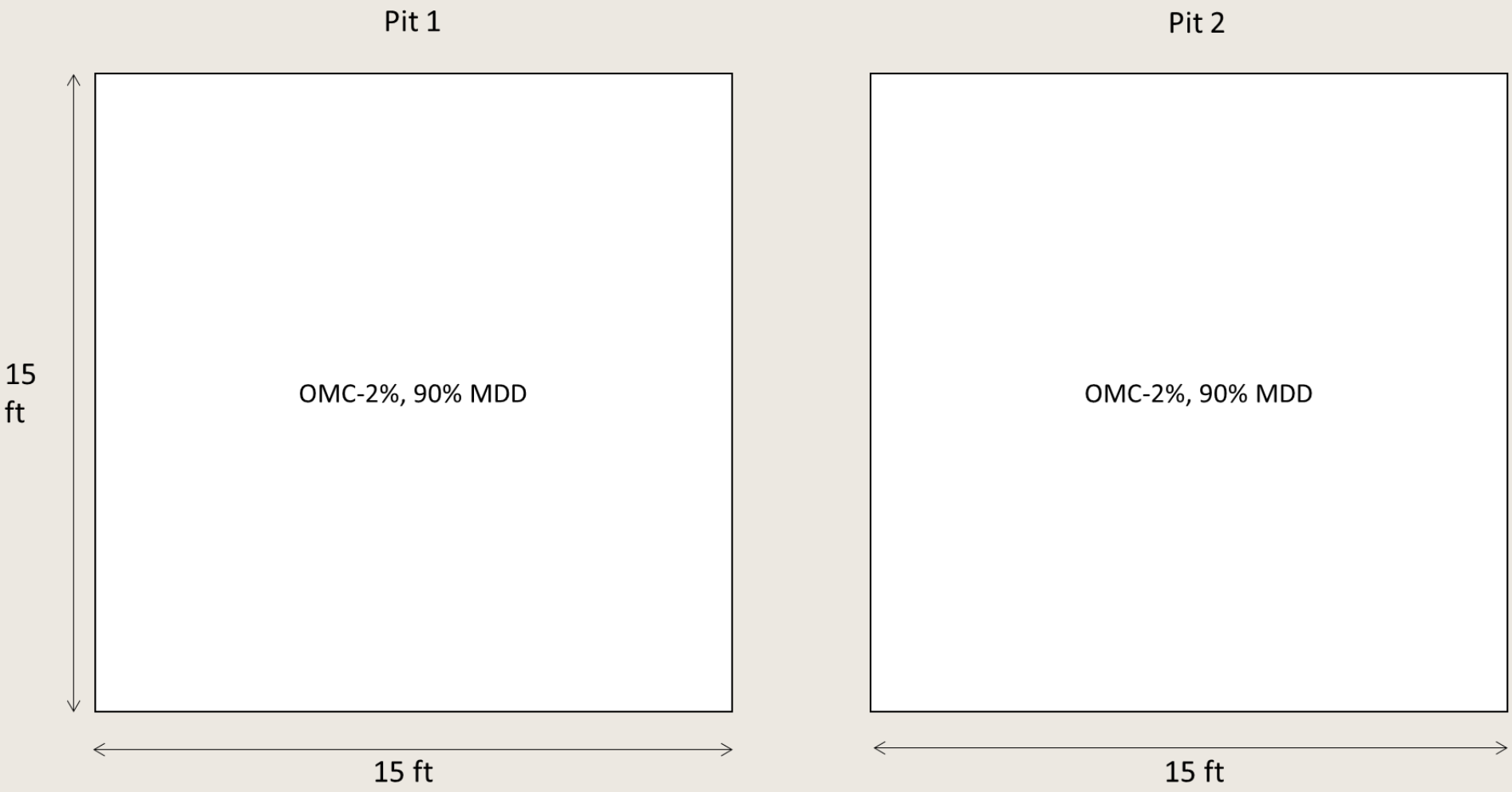
Top view



# Test Pit Design

Priority Number 2

Top view



# Field Validation

| | | |
|---|---|---|
| Project Info | Site ID | |
| | Address | |
| | Construction Dates | |
| | Project Length | |
| | Agency Contact | |
| Layer thickness | Base | |
| | Sub-base | |
| Soil Classification | Base | |
| | Sub-base | |
| | Subgrade | |
| Local availability of test equipment | LWD-Zorn | |
| | LWD-Dynatest | |
| | Nuclear Gauge | |
| | Other equipment | |
| Comments | | |

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