Light Weight Deflectometer (LWD)

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LIGHT WEIGHT DEFLECTOMETER
ITM-508
Outline

- LWD Equipment and Testing Procedure, ITM 508
- INDOT Standard Specs, 203.24,
- Test Section Construction, ITM 514
- LWD Repeatability, Maintenance and Storage
- LWD Limitations
LWD Setup

Boussinesq Half Space Equation

\[ E_{LWD} = \frac{2(1 - \mu^2)q * R}{s} \]

Where \( q \) = applied stress, \( R \) = plate radius, \( \mu \) = Poisson ratio, \( s \) = deflection

Three Major Elements:
(a) Weight to induce the pulse
(b) The loading plate
(c) Accelerometer
(To determine the deflection)
INDOT permit LWD testing on the following materials:

- Aggregate No.53, No.73, structural backfill size 1, 1.5 and 2 in
- Chemically Modified soils
Test method covers the determination of the plate deflection,

Test surface shall be clean and smooth as possible with loose granular material,

Load plate deflection should be equal to the surface deflection under the plate,

Select site and set up LWD connection to its computational unit,

Set the plate on a prepared surface and seat it by turning it left and right by 45 degrees. Do not drop the loading plate on the prepared surface.

LWD plate should not translate laterally with each successive drop.
- Perform 3 seating drops before collecting the data. If noticing excessive deflection.
- Material needs additional compaction.
- Following seating drops, perform three drops from a fixed height.
- Record the average of 4th, 5th and 6th drops.
Sec. 203.24

- Aggregate moisture shall be between 4 \% and optimum moisture content when delivered to the project,
- Water shall not be added in aggregate at grade,
- Sample of the moisture content will be taken on the grade from the first truck of the day
- Frequency for the moisture shall be minimum one test per day,
- Test section shall be constructed for other materials when not included in the table,
Acceptance test shall be obtained randomly in accordance with ITM 802,

Frequency of LWD test will be three tests / 800 t of aggregates or 1400 cyd of chemically modified soils

Location of 3 tests will be at two feet from the edge of the construction and at ½ of the construction area.
Maximum Allowable Deflection

The maximum allowable deflection for #53 will be in accordance with the following:

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Maximum Allowable Deflection (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime Modified Soil</td>
<td>0.30</td>
</tr>
<tr>
<td>Cement Modified Soil</td>
<td>0.27</td>
</tr>
<tr>
<td>Aggregates over Lime Modified Soil</td>
<td>0.30</td>
</tr>
<tr>
<td>Aggregates over Cement Modified Soil</td>
<td>0.27</td>
</tr>
</tbody>
</table>

*Materials not included in the table need a test pad.*
### LWD Data Recording Sheet

**INDIANA DEPARTMENT OF TRANSPORTATION**

**LWD AND MOISTURE ACCEPTANCE TESTS**

**AGGREGATES OVER SOILS**

<table>
<thead>
<tr>
<th>CONTRACT NO.</th>
<th>PROJECT NO.</th>
<th>ROAD NO.</th>
<th>DATE</th>
<th>WEATHER</th>
</tr>
</thead>
</table>

**FIELD TEST NO.**

<table>
<thead>
<tr>
<th>SITE MANAGER TEST NO.</th>
<th>SITEMANAGER SAMPLE I.D NO. (R+12 digits)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Test Site Data**

<table>
<thead>
<tr>
<th>Line No.</th>
<th>Ref. To Centerline</th>
<th>Elevation or Lift No.</th>
<th>Subgrade</th>
<th>Subgrade</th>
<th>Subgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comp. Agg. over Soils**

<table>
<thead>
<tr>
<th>LWD Assigned Test Number</th>
<th>Test Deflection ($L_d$) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Deflection (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Maximum Allowable Deflection (mm)**

<table>
<thead>
<tr>
<th>Material Name and Type</th>
<th>Lab. SM ID (R+12 digits)</th>
<th>Optimum Moisture Content (OMC) (%)</th>
<th>Determined Moisture (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Laboratory Test Site Data**

<table>
<thead>
<tr>
<th>Difference (Sp.Prov.-3% to CMC)</th>
<th>Comments 1</th>
<th>Comments 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PASS OR FAIL OR INFORMATION**

**REQUIREMENTS:**

<table>
<thead>
<tr>
<th>ITME 505 DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**REMARKS:**

CA = Crushed Stone, G = Gravel, S = Slag

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tested on Material Passing (No. 4 or 3/4&quot; Sieve)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 1. Wt. of Pan & Wet Material (W1)(% or g) |
| 2. Wt. of Pan & Dry Material (W2)(% or g) |
| 3. Wt. of Moisture (lb) Line 1 - Line 2   |
| 4. Wt. of Pan (W3)(% or g)                |
| 5. Wt. of Dry Material Line 2 - Line 4   |

| % Moisture (0.1%) (Line 3 / Line 5) x 100 |

**LWD SD Card**

<table>
<thead>
<tr>
<th>LVFD Serial Number</th>
<th>RECORDERD IN SITE-MANAGER</th>
<th>Qualified Technician</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Test section requirements:
2. Subgrade shall be proof-rolled.
3. Test Pad area is 100 ft. by 20 ft. (part of the roadway).
4. One moisture test is based on AASHTO T-255. Moisture shall be between 4% and OMC. Perform moisture on aggregates before placing on grade.
5. Shall be 4 roller passes in vibratory mode and one with static on the aggregates.
6. 10 randomly selected LWD Tests (Deflection) based on ITM-802 and take average of 10 tests.
A Test Section Layout

100 ft

½ Width of Placement
7. Perform an additional passes in vib. and static mode each.
8. Retest the previous 10 test locations and take the average.
10. If difference is 0.02 mm or below, test section is complete.
11. The average deflection of step 8 is the maximum allowable deflection and would be used for the remaining project.
12. If the difference is greater than .02 mm, additional roller passes in vibratory and static are required prior to LWD test.
### Test Pad Worksheet

**Test Site**

Maximum Allowable Deflection (mm) | 0.267

**Laboratory Report Data**

- Material Name and Type: Test Number
- Filled on Material Passing (No. 4 or 3/4" Sieve): 111
- Moisture Determined Moisture (%): 12%<br>34%<br>28%<br>38%<br>27%<br>26%<br>27%<br>26%<br>25%<br>27%<br>26%<br>25%<br>24%<br>25%

**Remarks**

- Remarks: This procedure will continue until the difference of the average of the 10 LWD test between consecutive roller passes is equal to or less than 0.02 mm.

- V: VIBRATORY S: STATIC

**VIBRATORY S: STATIC**

**LWD Serial Number**

- Field Setup Test Number: 4V+1S
- Avg. Test Deflection (S m) (mm): 0.379 0.387 0.375 0.388 0.375 0.392 0.389 0.394 0.372 0.354 0.365

- Avg. Test Deflection (S m) (mm): 0.273 0.269 0.278 0.278 0.273 0.269 0.275 0.265 0.279 0.270 0.274

- Avg. Test Deflection (S m) (mm): 0.267 0.266 0.267 0.275 0.298 0.268 0.272 0.269 0.256 0.244 0.255

**Cohesive or Granular (Fill or Cut)**

- Avg. Test Deflection (S m) (mm): 0.267

**Comments**

- Comments 1
- Comments 2
- Comments 3
INDOT Repeatability Procedure

Repeatability will comply with ASTM  E 2835

Office of Materials Management is in process of developing an Indiana Test Method, ITM

Recommend the repeatability as follows
- Immediately upon receipt of a newly purchased device,
- Immediately after full calibration
- After significant repairs
- Annually
- When Measurements are no longer repeatable or are questionable
Office of Geotechnical and Materials Management is in the process of developing “INDOT LWD Care, Storage, and Maintenance procedure.”

The documents will include the following:

- Care and storage guidelines
- Maintenance and Repair guides
- LWD testing on Chemically Modified soils or in pH environment
- Troubleshooting Notes
Limitations:

- The aggregates larger than 1.5 in. shall not be over 15% in testing location.
- The testing location shall not exceed 5% inclination.
- The testing location shall not be frozen.
- Measurement shall not be executed when deflection measurements are less than 0.2 mm.
- LWD test is questionable in case of shallow ground water (2 feet) or soil with high moisture content.
Any Questions?