Perpetual Pavement Investigation on SH-152 in Oklahoma County, Oklahoma City Area

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Perpetual Pavement Concept:

- A perpetual pavement is designed as a thickened pavement section (pavement layer, base course, and stabilized soil subgrade) strong enough that only the “Wearing Surface” needs to be replaced over time to maintain a smooth ride.
SH-152 Perpetual Pavement:

- 50mm (1.97 in) Type SM Wearing Surface
- 80mm (3.15 in) Type S3 AC Asphalt Base
- 75mm (2.95 in) Asphalt Concrete (2 Lifts)
- 75mm (2.95 in) Type RBL Asphalt Base
- 200mm (7.87 in) Flyash treated subgrade / subbase

Total Thickness: **555mm (21 in)**
Pavement Problems at the Site

- Cyclic Heaving Pavement.
- Rough Ride over affected area.
- Longitudinal Cracking – Shoulders / Right Lanes.
- Surface Depression over Structure No. 6 and 7.
Site Location
The predominately mapped soil series at the site are the following:

- Kirkland 35.3 %
- Renthin 18.3 %
- Bethany 3.1 %
- Grainola 2.3 %

A total of 62.8 % of the area of interest (AOL) contain these soil series.
Site Photographs
Plan view of the level survey lines
Fieldwork

- Hand Auger and Standard Penetration Test (SPT) Borings.
- Piezocone (Electric Cone) Soundings (6).
- PushTube Sampling (1).
- Pavement Profiling.
Laboratory Tests

- AASHTO T99A – Moisture Density
- AASHTO T265 – Natural Moisture Content
- AASHTO T89/90 – Atterburg Limits
- AASHTO T88 – Grain Size Distribution
Investigation
Data
Key Points

- The predominate soil series in the AOL is the Kirkland silt loam which is a high shrink-swell soil.
- Along with four other shrink-swell soils in the AOL, 62.8 percent of the surface soil are expansive clay soils.
- Embankment borrow sources came from these soils.
- Construction took place during a drying cycle based on the TMI versus time.
- The pavement profiling suggests that the pavement is undergoing a cyclic heaving condition.
- No construction records were available for review as to what the initial compaction moisture content was.
- Two other notable settlements were over structures 6 and 7.
- A moisture-density from embankment cuttings: MDD = 109.1pcf OMC = 15.5%.
Cyclic Heave Analysis

1. Based on the pavement defects seen in the cause of the heaving was thought to have occurred due to a water uptake since the time of construction.

2. To confirm this thesis it was necessary to back-calculate the initial moisture content in the embankment soil material following the completion of construction from the following equation for “free field heave” (i.e. heave due to soil suction changes only with no change in effective stress):

\[ \rho = \Sigma [ C_w \Delta m] z_i \quad (\text{Clod Test Method}) \]

\[ 1 + e_o \]

3. The solution to the equation opted to use water content change instead of soil suction changes because moisture content much easier to measure.
Analysis (continued)

4. All of the parameters were known except the initial moisture content. A spreadsheet was set up to back-calculate the initial moisture content with depth.

5. The final moisture content profile was assumed to be the moisture content measured on April 08, 2009, approximately (3) three following the completion of the embankment construction.

6. Two cases were estimated:
   a.) Moisture content change occurring since the completion of the surfacing contract.
   b.) Moisture content change occurring assuming that there is a time gap between the end of the grading and start of the surfacing.
Surface Depression over Structure No. 6 and 7

- An analysis of structure no. 6 (750 mm RCP) and structure no. 7 (3 barrel RCB) using the classic Marston load theory.
- The analysis makes the assumption that in the installation that both structures were in a ditch condition.
- The plane of equal settlement for both structures was greater than the fill heights.
- The interior prism moves downward much more than the exterior prisms.
- This translates to the effect of probable poor compaction around the RCP and RCB in the ditch condition.
Conclusions

1. Cyclic Pavement Heaving – Result of water uptake in the clay subgrade of 3.3 % for case a and an additional 0.8 % for case b. The perpetual pavement being much thicker hastened the accumulation of moisture content by vapor condensation.

2. Shoulder Longitudinal Cracking – Result of climatic conditions and the development of tensile stresses due changes in soil suction due to the moisture deficit shown to have occurred in the TMI versus time plot.

3. Subsidence above structures 6 and 7 was calculated to be due to to most probably poor compaction of backfill around and above the RCP and RCB structures.

4. The initial soil survey had advised the Roadway Design Division that there was potential for expansive clays from likely borrow sources in their geotechnical reports, but Design did not act upon any recommendations.
Recommendations

- Limited Milling of Surface in affected areas.
- Thin Asphalt Level-up.
- Sealing Longitudinal cracks.
- Horizontal Membrane Barriers placed to prevent further cracking.
- Specific PVC “Flashing” recommended to go along with the Horizontal Membrane Barrier locations.
Thank You!

Questions?