



The Ohio Department of Transportation Office of Research & Development Executive Summary Report

Evaluation of Pavement Performance on DEL-23

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Problem

In 1994, the Ohio Department of Transportation (ODOT) initiated construction of an experimental pavement on US 23 north of Columbus containing 40 test sections in the Long-Term Pavement Performance (LTPP) portion of the Strategic Highway Research Program (SHRP). Dynamic instrumentation was installed in 33 sections to measure strain, deflection and pressure responses generated in the pavement structures during controlled vehicle testing and Falling Weight Deflectometer (FWD) loading. Environmental instrumentation was installed in 18 sections to continuously monitor temperature, moisture and frost depth in the pavement structures. An on-site weather station recorded climatic conditions and a weigh-in-motion (WIM) system monitored traffic loading on the test sections. This research contract represents the latest in a series of contracts initiated by ODOT to continue collecting and analyzing data from the SHRP test pavement, and to document any trends or findings of interest. Three other instrumented pavements were also monitored under this contract.

Objectives

- Develop a comprehensive database containing all pertinent data related to the response and performance of sections on the test pavement. This includes a table of peak strain, deflection and pressure responses measured during the controlled vehicle tests.
- Coordinate the collection of roughness, FWD, visual distress surveys, rut depths and controlled vehicle tests by ODOT and ORITE, and enter these data into the database.
- Process and analyze other types of data, such as transverse profiles, WIM and skid resistance, and enter these data into the database.
- Continue coordinating the collection of environmental data.
- Use various pavement models to predict the performance of the various original and replacement test sections.

- Conduct up to three forensic investigations of sections which become distressed and are replaced with other sections.
- Continue monitoring experimental pavements on ATH 50, LOG 33 and ERI/LOR 2, and develop a database to store data from these pavements.
- Prepare five technical notes related to the performance of all four pavements.

Conclusions

DEL 23

1. A comprehensive database containing all pertinent information relating to the Ohio SHRP Test Road has been completed for dissemination on CD. In addition, peak dynamic strains, deflections and pressures measured during nine series of controlled vehicle tests are available with corresponding truck geometries, wheel loads, speeds and lateral offset distances on a separate CD.
2. AC pavement sections in SPS-1 with normalized maximum FWD deflections greater than about 1.5 mils/kip were distressed within a few months, those with normalized maximum deflections between 1.0-1.5 mils/kip provided service for about five years, and those with normalized maximum deflections less than 1.0 mils/kip remain in service after ten years. The combined thickness of AC pavement and ATB in the weakest group ranged from 4 – 8 inches, from 7 – 12 inches in the second group, and from 12 – 19 inches on sections still in service.
3. Maximum FWD midslab deflection on new PCC pavement sections in SPS-2 ranged from 0.35-0.51 mils/kip on sections with 8 inches of concrete and from 0.20-0.29 mils/kip on sections with 11 inches of concrete.
4. PCC sections with high strength concrete showed increased transverse cracking and surface friction in the low thirties while sections with standard ODOT Class C concrete had skid numbers in the low forties.
5. Peak high and low ground water levels occurred about two months earlier than corresponding peaks for subgrade moisture. Maximum subgrade moisture occurred in July-August.
6. Data collected from the resistivity probes did not appear to provide any useful information on frost depth. These probes and/or the electronic interface with the data logger need to be redesigned.
7. Actual material properties measured in the field must be used to accurately predict pavement performance.

8. Stiff base materials, such as lean concrete, should be used under flexible pavement and less stiff materials, like ATB, should be used under rigid pavement.
9. Approximately 620,000 ESALs were carried annually by the SPS-2 sections and approximately 515,000 ESALs were carried annually by the SPS-1 sections.
10. Class 9 trucks comprised 70-80% of the total volume of trucks, and about 85% of the total truck weight and ESALs carried on the test road.
11. Passing lanes carried approximately 10% of the volume of Class 4-13 trucks carried in the driving lanes.
12. WIM files should be reviewed monthly to verify that the systems are operating properly.
13. Subgrade moduli calculated with different models varied widely.
14. The AREA5 method is better than the AREA7 method for backcalculating the modulus of subgrade reaction (k) because the maximum deflection, which can be variable, is not used. The best path for collecting FWD data is along the centerline of PCC slabs.
15. The critical life of AC pavement layers, as determined by the Asphalt Institute's DAMA program, does not correlate well with actual service life determined by surface distress.
16. Traffic loading tables currently used for pavement design should be divided into separate front single-axle and rear dual-axle tables.
17. Pavement cores from some PCC sections showed air contents well below the 4% minimum value, but no signs of freeze-thaw damage. The lean concrete base had air contents well above the 8% maximum, probably due to poor consolidation.
18. There was some evidence of alkali-silica reactivity in Section 206, but no signs of concrete degradation resulting from this process.
19. The overall quality of concrete mixes used on the Ohio SHRP Test Road was very good.

Other Pavements

20. Load transfer measurements on ATH 50 indicated that PCC joints with fiberglass dowel bars had load transfer about 50% less than joints with standard epoxy coated steel dowel bars or concrete filled stainless steel tubes.
21. From data obtained on LOG 33, flexible pavements with stiff bases performed better than flexible pavements with less rigid bases.
22. On ERI/LOR 2, PCC sections with a 13' joint spacing performed better than those with 25' joint spacings, and PCC sections with flexible bases performed better than those with stiff bases.

Recommendations

Based upon data obtained during the continued monitoring of various experimental pavements in Ohio, it is recommended that:

1. From FWD measurements on the Ohio SHRP Test Road, new flexible pavement sections with maximum normalized deflections greater than 1.5 mils/kip were distressed within a few months, sections with deflections less than 1.0 mils/kip remained in service after 10 years, and sections with deflections between 1.0 and 1.5 mils/kip provided service for about five years. These ranges can be used to estimate the projected life of other pavements.
2. Revise the unified traffic loading tables into front single-axle and rear tandem-axle tables to account for the differences in stress under single and dual tires.
3. Rigid pavements should have bases which accommodate the curling and warping of concrete slabs and flexible pavements perform best with stiff bases.
4. From ERI/LOR 2, PCC pavement with a 13' joint spacing and/or less rigid bases performed better than 25' joint spacing and/or rigid bases. ODOT should continue to use of short slabs and non-rigid bases on rigid pavement.
5. High-strength concrete should not be used in PCC pavement because of its tendency to crack more and have lower skid resistance.
6. From ATH 50, data suggest that fiberglass dowel bars do not transfer load as effectively as steel bars. Other sites with fiberglass dowels should be reviewed to see if this trend can be confirmed and if the use of fiberglass dowel bars affects overall performance.
7. Review WIM files monthly to maintain the accuracy of traffic loading data. Parameters that should be checked include: hourly total truck volumes, weights and ESALs by lane to verify that all lanes are functioning properly; daily distribution of the various truck classes to verify that the systems have been programmed properly; average weight and ESALs per truck by lane; percent of Class 9 trucks by lane; front-axle weight of Class 9 trucks; and the distribution of spacings between the first and second axles, and between the second and third axles on Class 9 trucks.

Implementation Potential

1. Consider the routine monitoring of selected AC and PCC pavements with the FWD and/or Dynaflect from the time of construction, and the development of a database to store and analyze the data. These data could be used to provide initial estimates of performance, to identify areas where distresses may be expected to occur, and to plot trends with which to assess condition and project future maintenance activities. Performance estimates and maintenance projections will improve as more NDT data become available.
2. Revise the ODOT Pavement Design Manual as follows:
 - a. Divide the single-axle loading table into one table for front single axles and another table for all other single axles to account for the effects of single and dual tires.
 - b. Use short slabs on rigid pavement and limit base materials to those which accommodate the curling and warping of PCC slabs, such as PATB, ATB or DGAB.
 - c. Use stiff bases, such as 304 NJ, 304 IA, PCTB and LCB, on flexible pavement.
 - d. Eliminate the use of high-strength concrete on rigid pavements.
 - e. Continue the experimental use of fiberglass dowel bars on PCC pavement until their affect on long-term performance becomes clear.
 - f. Incorporate nondestructive testing into the approval of subgrades on high level pavements, and add a pay item for correcting deficient subgrade.
3. Periodically evaluate the output from WIM scales installed across the state. Excel spreadsheets were developed on this project to calculate truck volumes by lane and hour, truck classifications by hour, truck weight by lane and hour, ESALs by lane and hour, and a combined load spectra for all truck classifications. From calculations performed with these spreadsheets, truck weight seems to be the most reliable indicator of pavement loading since it is not affected by axle grouping, classification, or the calculation of ESALs, all of which require additional WIM processing and are possible sources of error.