Perpetual Pavement - Validating the Design

Dr. Sargand (left) discusses the Perpetual Pavement instrumentation with Lloyd Welker of ODOT.

There is growing interest among pavement engineers in the potential of extra long-lasting bituminous pavement, known as "perpetual pavement." The latest research has culminated in the development of this pavement design, which researchers believe can perform for more than 50 years without major structural rehabilitation or reconstruction.

Perpetual pavement is constructed of three very durable layers. Materials are mixed to achieve maximum performance qualities specialized to the demands of each layer. Factors such as traffic and environmental conditions are also taken into consideration. The top layer is made of impermeable material that is resistant to ruts, weathering and general distress, and the middle layer also holds up against ruts and wear. The base layer is highly durable and has superior resistance to fatigue cracking. Due to the strength of this multi-layer design, wear is limited to the top layer, so periodic resurfacing is the only maintenance required. When distress is observed on the pavement surface, the top pavement layer can be removed and replaced to the same depth, resulting in significant savings of both money and time.

The use of long-life pavements has been proposed in Europe, and the idea is rapidly gaining ground in the United States. While the ability currently exists to produce perpetual pavements, the engineering community is working to establish guidelines and procedures for building these structures. Studies are also being conducted in an effort to validate the promising expectations of this pavement technique before it is implemented on a broad scale. As part of this verification effort, Interstate 77 in Ohio has been instrumented with a number of strain gauges and pressure cells, and a controlled truck test is also being conducted.

I-77 Instrumentation (North Canton)

On Aug. 25, 2003, a preliminary test section was instrumented on I-77 in North Canton. The test pavement consisted of six inches of Dense Aggregate Base (DGAB, Ohio Department of Transportation (ODOT) 304), followed by 13 inches of Bituminous Aggregate Base (ATB, ODOT 302). This base layer was placed in three lifts. A 1.75-inch intermediate surface layer was also placed. The final 1.5-inch surface layer has not yet been placed.

This 20-foot section in the driving lane of northbound I-77, between 38th Street and Everhard Road, was instrumented with Geokon strain gauge pressure cells, Dynatest quarter bridge AC embedment gauges and thermocouples. Figure 1 illustrates the instrumentation detail, and shows the location of the sensors in the pavement profile.

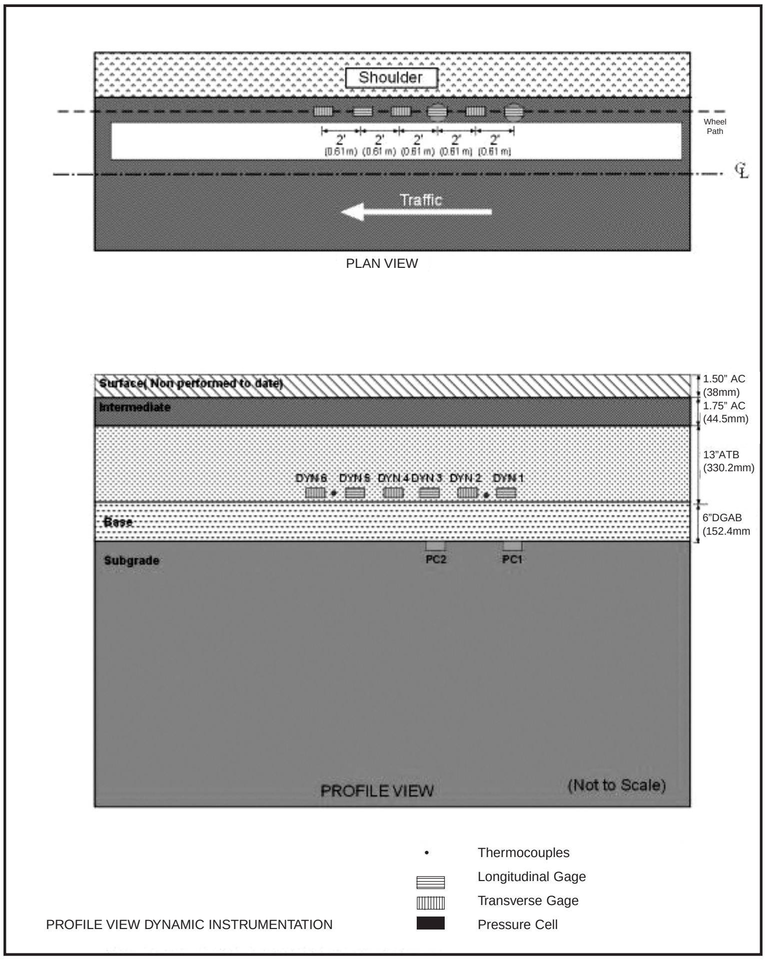

Fig. 1 I-77 Instrumentation plan and profile

Ohio University personnel install strain gauges beneath the I-77 perpetual pavement.

On Dec. 15, 2003, data was collected from these sensors in response to a load applied using an ODOT single-axle truck. The axle weight of the truck was approximately 26,000 pounds and the truck's speeds varied between 5 miles per hour (mph) and 50 mph. During the tests, which were conducted at night due to traffic restriction, the average surface temperature of the asphalt was approximately 31ºF, and average pavement temperature, as measured by the thermocouples, was 36 ºF.

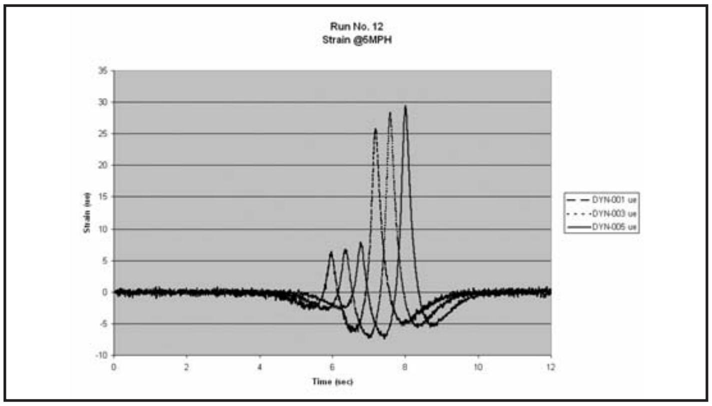

Fig. 2 Longitudinal Strains at 5 MPH

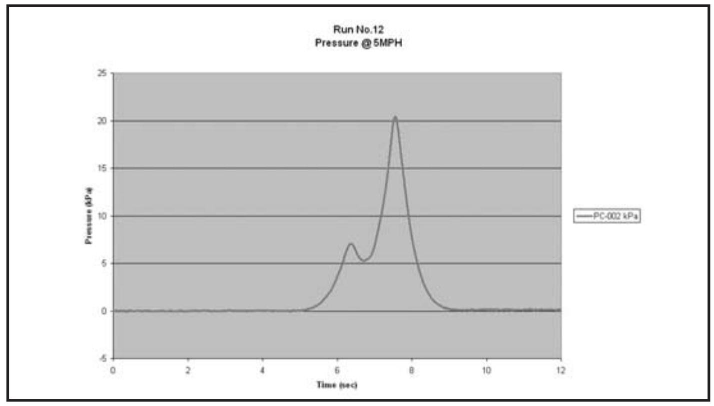

Fig. 4 Pressure Cell Reading at 5 MPH

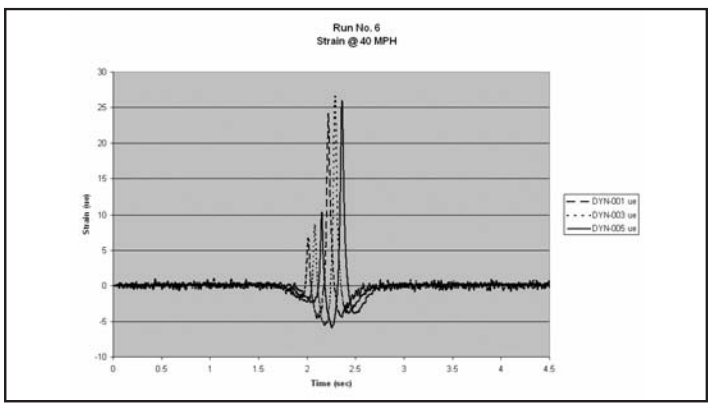

Fig. 3 Longitudinal Strains at 40 MPH

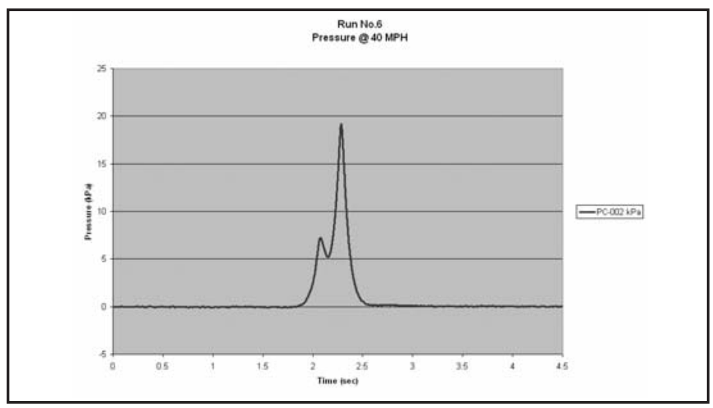

Fig. 5 Pressure Cell Reading at 40 MPH

Figures 2 and 3 show the response from the longitudinal strain gauges for speeds of 5 and 40 mph. Figures 4 and 5 show the response of the pressure cells for the same speeds.

Generally, pavement is designed to withstand a maximum strain of 60 microstrain. Figures 2 and 3 show the strain on these test sections is less than half the maximum allowable. As expected, the maximum strain for a speed of 5 mph is greater than the strain for 40 mph due to the visco-elastic properties of asphalt.

These experiments were conducted at 31ºF. At higher temperatures, the asphalt stiffness will decrease and strain will increase. However, due to the thickness of the asphalt, the temperature at the bottom of the asphalt pavement will not fluctuate significantly. Therefore, the strain will still potentially be less than the maximum design strain.

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