Winning the RACE TRACK Challenge

Successful collaboration delivers high-performance pavement for Corvette Museum Race Track

by Tom Kuennen

When it comes to ensuring high performance, sometimes you need more than one expert. At the National Corvette Museum Motorsports Park, when the first cars took to the track last year, the drivers enjoyed the high-quality results made possible by the collaborative effort between a contractor, a design firm, an engineering firm, a mix consultant, two asphalt-modifier companies, and Corvette Racing.

High-performance tracks attract users, whether they are weekend warriors pushing their limits or professional racing teams fine-tuning their machines. "It really doesn't make a difference whether we are talking about amateur motorsports enthusiasts or professionals," said Mitch Wright, General Manager of the NCM Motorsports Park in Bowling Green, Ky. "If a team comes here to test equipment, and they know they can get valid, consistent data without having their tires chewed up, we know we will have a winning facility that will appeal to drivers. Word gets around: We have a surface here that's really, really good on tires, and has good wet-weather grip."

The NCM Motorsports facility at Bowling Green, Ky. The autocross pad is located in the upper left of the photo, the National Corvette Museum at the upper right. ***Photo credit: NCM Motorsports Park***

The track was designed by Crawford and Associates with input from Corvette Racing and Pratt & Miller Engineering, and includes features reminiscent of the world-famous Circuit de la Sarthe in Le Mans, France. Scotty's Contracting & Stone LLC of Bowling Green was the general contractor and won a NAPA Quality in Construction Award from the National Asphalt Pavement Association for the quality work performed.

The $18.5 million, 189-acre facility consists of twin circuits, a 2-mile, 13-turn, high-speed west course, and a 1-mile, 10-turn east course. Both circuits feature technical turns with straightaways and elevation changes, and the tracks can be combined to create multiple configurations. An adjacent 22-acre paddock and autocross/skid pad area is available for autocrosses — timed competitions in which drivers thread their way one at a time through a course defined by pylons or traffic cones — as well as for controlled skids, vehicle dynamics testing on wet and dry surfaces, drifting, and car and motorcycle shows.

Quality control of every element of the modified surface mix was critical to the successful project.
Photo credit: Advanced Material Services LLC

Track vs. Highway Mixes

Asphalt race track mixes differ from highway pavements significantly. For race tracks, the main concern is raveling, not rutting, which for a road course like the NCM Motorsports Park track can be dangerous due to downdrafts that produce suction beneath a car great enough to pull out loose chunks of pavement, aggregate, or even manhole covers. The lateral forces, which can cause shearing, transmitted to the mat from tires are greater on a road course, too.

Ultimately the project required more than 58,000 tons of asphalt pavement mixture, including 20,000 tons of a mix optimized for the track surface; the rest went into lower lifts. This surface mix was a 75-blow Marshall design with a heavily modified PG 82–22 binder, designed and produced at Scotty's own terminal.

"The upper two lifts were Marshall-designed using a Superpave PG binder," said mix consultant Brian D. Prowell, Ph.D., P.E., principal engineer, Advanced Materials Services LLC (AMS). "For race track applications, the Marshall method tends to ensure a little higher asphalt content in the mixture, which we need for cohesiveness and durability."

Modified Mix

The PG 82–22 binder used was highly modified with an SBS polymer developed by Kraton Polymers, which was added at a rate of 7.5 percent by volume, more than twice as much as would be used in conventional polymer-modified binders. Evotherm, a warm-mix asphalt additive, was also incorporated to improve workability for compaction and to serve as an antistrip agent.

"Brian wrote a very tough set of specifications," said Mike Law, P.E., Vice President of Materials for Scotty's. "Some of it we had never seen before. For liquid asphalt, he spec'd PG 82–22 with a 180°F softening point. We'd never seen a PG 82–22 and never looked at the softening point, either. We partnered with Kraton and Evotherm to develop the formula."

The use of the warm-mix additive was a twist for the mix consultant. "We had to convince Brian and Mitch to allow it" said Law. "We are very familiar with using it on state jobs and find it critical for high-profile, skid-resistant state mixes that get high-density compaction.

"In this case, we had a PG 82–22 mix that would be extremely stiff and difficult to compact," added Law. "The mixture had very angular aggregates. We've had great success in the past getting densities and better, more consistent mats using the warm-mix additive, and we were adamant that we wanted it in the mix to give them the product they wanted."

"Scotty's approached us about using highly modified asphalt (HiMA) polymer modifier and Evotherm combined as an alternate to our typical mix design," said Prowell. "The proportions that were worked out met our performance parameters for a track mix, so we let the different ingredients into the mix without changing our end-result performance specifications."

"The stresses on a race track are much higher than those on a conventional pavement," said Bob Kluttz, Kraton Polymers US LLC. "It's not just shear vs. direct loading. With HiMA, you are increasing the resilience of the material, and its ability to 'bounce back' after the strain. Also, it increases the strength of the material, making it more resistant to cracking.

"Existing race track mix binder specs lean more toward the empirical tests, rather than the performance-related tests," said Kluttz. "With HiMA, we were able to formulate a binder with a much lower viscosity polymer, making life a lot easier for the constructors. We met the longstanding empirical tests, but we also ran the more current AASHTO M 320 standard Superpave and next-generation high-temperature M 332 test protocols on the binder, generating data that can be used to specify the material in the future."

Workability of the modified mix was the main goal. "Use of the HiMA compared to a conventional

continued on page 20

polymer results in a binder with much lower viscosity," said Kluttz. "That results in a more workable mix. The warm-mix asphalt additive lets the contractor get a very good quality pavement down in the first place, and HiMA gives it durability."

Softening Point Spec

For this project, another parameter was added to the typical PG binder test, a softening point requirement, said Prowell. "The softening point indicates where the asphalt binder changes phase from a semi-solid to a more viscous liquid," he said. "We set the temperature at the point where aggregate might be pulled toward the surface by a hot tire. The value we specified was 180°F for the Corvette Museum track."

With a 180°F softening point, polymer modification would have to be used to ensure elastic recovery.

A sulfur crosslinking agent was added, which helped stabilize the HiMA polymer network. "You shear the polymer into the hot asphalt, and it starts to react with the asphalt," Prowell said. "The sulfur helps stabilize the internal web-like network that develops within the binder."

Texture to Provide Grip

The mix gradation was intended to provide optimum macrotexture with the aim of minimizing damage from lateral shear forces induced by tires moving at high speed.

To enhance friction, skid-resistant aggregates were researched and analyzed by Scotty's and aggregate supplier Vulcan Materials Co. to determine the best, most cost-effective material for the track. The team selected a silica-rich limestone from the Fort Payne formation in Springfield, Tenn. It featured a 40- to 50-percent silica content, and indicated 10.8 percent wear on the ASTM D7428 Micro-Deval test, and an L.A. abrasion test loss of 14 to 15 percent.

"They wanted an aggregate that gave a proper grip without too much tire wear," said Scotty's Law. "For most people that's granite aggregate, but the closest granite to us was in Georgia, a five-hour haul with all the costs that implies. We use skid-resistant aggregates on our state projects around here, and we thought the best quality would be a high-silica limestone out of Tennessee, a 40-mile haul."

Typical auto race track mixes utilize a polish-resistant 9.5 mm (3/8 inch) nominal maximum aggregate size (NMAS) aggregate in a 75-blow Marshall mix, and a stiff PG 82–XX binder, with the lower end depending on the climate. But the NCM track mix was different;