

WORLD'S STRONGEST INTERSECTION LEAVES TEENAGE YEARS BEHIND

By Wayne Jones, P.E. and Timothy Murphy, P.E.



Thornton Quarry is one of the largest aggregate quarries in the world, located in Thornton, Illinois just south of Chicago.

PAVEMENT EXPERTS have always known that as the stress applied to a pavement goes up, the attention to detail during the design and construction must also go up to build a long-lasting pavement. Heavy, slow-moving vehicles that are stopping, standing, turning and accelerating apply the highest stress levels possible to a pavement, and all these compounding factors can be found at intersections.

SUCCESS THROUGH THE AGES

In the mid-90s the Asphalt Institute recognized the need for a process to deal with intersections and other high-stress applications and formalized a basic four-point strategy.

AI's intersection strategy consists of four steps:

- Assess the problem
- Ensure structural adequacy

- Select high-performance materials and confirm the mixture design
- Use proper construction techniques

One of the first intersections to be rebuilt using this four-step process was the intersection of Williams and Margaret Streets in downtown Thornton, Illinois, in 1998. A sign near the intersection proclaims "Thornton Quarry, Largest Limestone Quarry in the World."





Thornton quarry produces up to 50,000 tons of stone each day and most of this aggregate is shipped by truck and passes through the intersection of Williams and Margaret streets. The quarry provides most of the mineral aggregates used throughout south Chicago and northwest Indiana, and even gets trucked as far away as southwest Michigan. Because of the quarry's excellent quality, paving contractors are able to utilize this aggregate source to ensure consistent asphalt mix production.

During construction season, over 1,200 heavily loaded trucks per day enter the intersection, most of them stopping at the traffic light or making turns in the narrow 11-foot-wide lanes, which heavily channelizes the load applications. On several previous occasions, the intersection had been paved, repaved and even reworked to the sub-base. Until the intersection's rehabilitation in 1998, however, regardless of the effort or dollars expended, the performance of the pavement surface continually fell short of Illinois Department of Transportation (IDOT) expectations. Typically, it required some sort of maintenance or rehabilitation even before a year had passed.



**When we
were young,
we used our
imagination
to go places.**



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SMA continues to prove it's the pavement of choice when addressing high stress intersection and roadways, that's why industry organizations will be hosting the first international conference on SMA in November."

– Dan Gallagher, COO of Gallagher Asphalt

IDOT decided to follow AI's Intersection strategy and enlisted the help of representatives from everyone involved in the project; Seneca Petroleum, Gallagher Asphalt, Chicago Testing Laboratory, National Slag Association member companies, Material Service and the Asphalt Institute to meet the challenge.

Step 1 (assessing the problem)

This intersection pavement endures around-the-clock pounding of hundreds of fully loaded semi-trailers hauling stone and asphalt pavement material to construction sites and material producers throughout the greater metropolitan area. The pavement never fully relaxes which leads to additional distresses.

Step 2 (ensuring structural adequacy)

The team met for numerous technical discussions and analytical sessions to develop the pavement design. The surface mix and the intermediate layers would have to handle the torture of the extraordinarily high traffic loads in order to meet the mix team's high expectations.

As a result of the analysis, the experts determined that a previously placed asphalt overlay had not failed, but instead found the older mix below it showed signs of serious deformation to a depth of approximately six inches. IDOT decided to mill the existing intersection pavement full-depth to ensure that the new mix would be placed on a solid foundation.

Step 3 (select high performance materials)

IDOT specified that a Stone Matrix Asphalt (SMA) mixture using the Quarry's own dolomitic limestone as an intermediate course be placed directly on the milled surface and then topped with a 2-inch SMA surface mix. The aggregate for the SMA surface was specified to be steel slag, a byproduct of the steel manufacturing in the region. Steel slag can be considered a "green" sustainable material that can be reclaimed and reused multiple times, helping to preserve natural resources.

Based on numerous environmental tests, studies, reviews by governmental agencies and the iron and steel industry, iron and steel slag has proven to be a safe and valuable resource. Since slag is a recycled material that comes from the manufacturing of iron and steel; both slag products score high on first use per the Greenroads™ rating system.

Step 4 (use proper construction techniques)

Including the contractor's personnel on the evaluation team ensured the contractor's buy-in on the four-part strategy and what needed to be accomplished during construction. Finally, with input from everyone on the team, it was determined it was indeed possible to remove the existing pavement by milling and then construct the intermediate layer, followed by the properly applied SMA surface mixture all within the time constraints imposed by the quarry owner.

FAST FORWARD BACK TO THE FUTURE

While it feels good to develop and deliver a project that is expected to perform over a longer period of time, how do you know if you have succeeded? You reassemble the same team 20 years later to perform the forensics to understand what performed well over the intervening years. The Illinois Department of Transportation (IDOT) did just that bringing back the original contractor, Gallagher, and consultant test company, Chicago Testing Laboratory (CTL). IDOT and CTL performed forensics on recovered asphalt for Performance Grading (PG) and penetration testing, mixability and flow testing, Hamburg Wheel Testing, I-FIT, in-place density, asphalt content and gradation. Edw. C. Levy Co. performed a steel slag pick via magnetic separation.



Material separation

The primary findings were that the installation of the SMA mixture 20-years ago:

- Maintained the original cross-section
- Provided high friction
- Maintained stability
- Reduced fatigue, longitudinal and transverse cracking
- Maintained essentially the original gradation as installed.



The cross-section photo of the pavement (above) shows that the reflective cracks from the old joints in the original PCC pavement did not migrate through the two new layers of SMA, even after twenty years. Giving special attention to these areas at Williams and Margaret ensured that the highly-stressed areas of the pavement delivered the same outstanding performance as mainline asphalt. During the Illinois Asphalt Pavement Association's Annual Meeting, IDOT District 1 Materials Engineer George Houston stated that the intersection has appeared to tame both rutting and cracking challenges.

CONCLUSIONS

Based on follow-up interviews with the individual forensic team members, a great deal of credit for the long-term performance in this high-stress environment can be attributed to:

- High in-place density measured (96 percent)
- Retained flexibility index based on the recently adopted I-Fit test for cracking resistance
 - >12 for binder, which passes the current specification requirement
 - >4 for surface
- Continued stability >3,500 lbs.
 - Possibly due to lack of tertiary breakdown of the strong SMA aggregate structure
 - Generally attributed to the highly polymer-modified liquid asphalt binder
- Increased effective asphalt content
- Implementation of very tight quality control and quality assurance
- Well documented specification compliance during the original construction
- New pavement section selected by IDOT with:
 - Adequate thicknesses
 - Strong durable SMA binder and surface lifts.

After 20 years and nearly 20 million equivalent single axle loads (ESALs), IDOT evaluated the intersection last year, and elected to perform what now has become a routine all over the Chicagoland area, a resurfacing with SMA. ▲

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