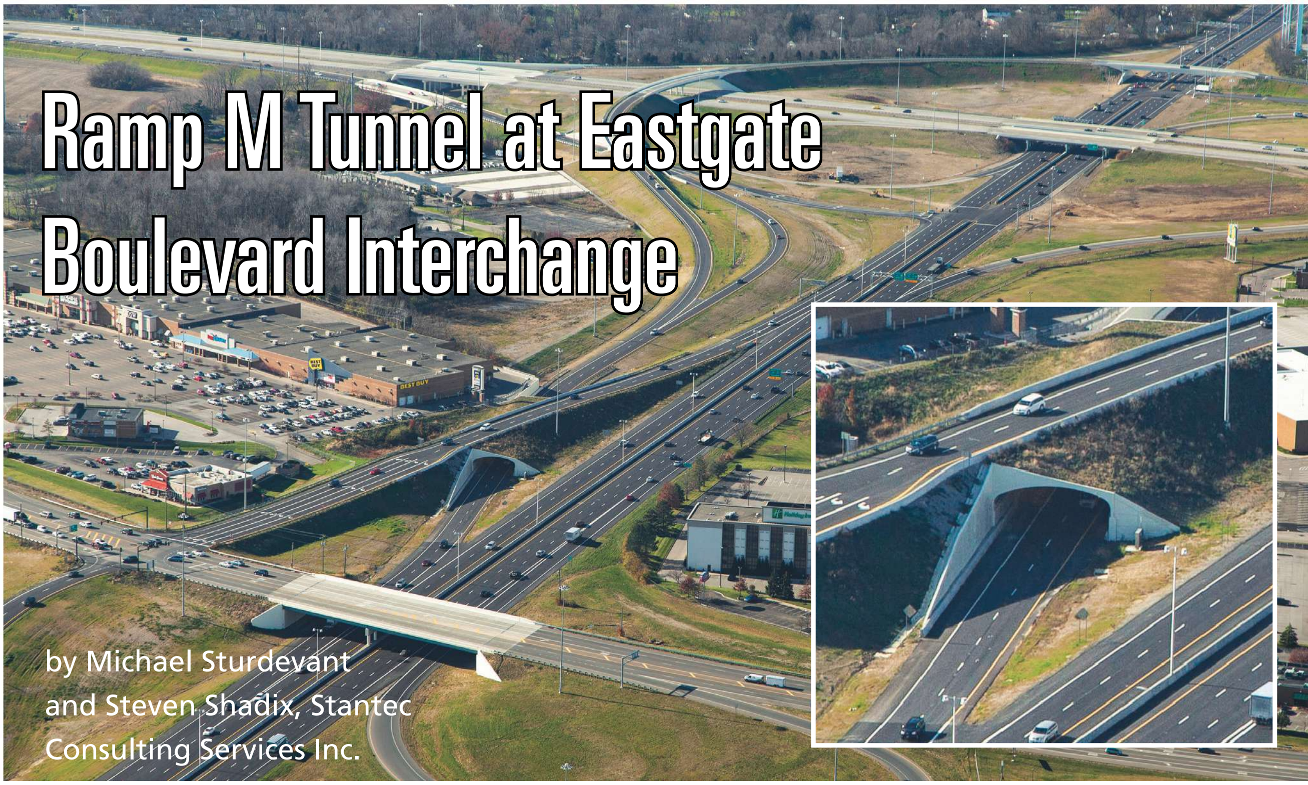
PROJECT

Ramp M Tunnel at Eastgate Boulevard Interchange

by Michael Sturdevant and Steven Shadix, Stantec Consulting Services Inc.



Aerial view of project site. Tunnel indicated near center of photo. Photo: ©1800topsite.com.

Over the past 35 years, many communities along the 85-mile Interstate 275 (I-275) beltway, which extends through Ohio, Indiana, and Kentucky, have experienced significant growth. Nowhere is this more apparent than on the eastern portion of the beltway, in the Eastgate commercial district of Union Township in Clermont County, Ohio.

The existing partial cloverleaf interchange of I-275 and State Route (SR) 32 servicing this area is the preferred route for residents from the east traveling to employment centers around Cincinnati. However, the area was plagued by severe traffic congestion during rush hour, resulting in numerous accidents. The situation was primarily caused by the weave of traffic on SR 32 between the exit and entrance ramps of the cloverleaf, as well as the weave of eastbound SR 32 traffic attempting to exit onto Eastgate Boulevard, just 0.5 mi east of the interchange.

The Ohio Department of Transportation determined a redesign of the interchange was required to reduce the congestion and number of accidents. After extensive study, the preferred solution for the redesign of the interchange involved eliminating two loops of the cloverleaf, adding a flyover ramp, revising two entrance ramps, and reworking the interchange at Eastgate Boulevard. The revised interchange layout with ramp braiding required seven new bridges, several with significant skews relative to the crossing roadway.

At one proposed bridge, carrying entrance ramp D to Eastgate Boulevard over the exit ramp M from I-275, the skew between the crossing roadways was approximately 70 degrees. While studying various layouts for different bridge types, engineers determined that the severe skew would significantly impact the span lengths, construction procedures, construction costs, and the durability of the bridge. An alternative to a bridge was needed. The design team proposed a tunnel consisting of a precast concrete three-sided culvert supported on cast-in-place concrete walls. Each section was 4 ft wide and weighed approximately 22.7 tons. This buried structure eliminated the skew issues, and reduced both the construction cost and maintenance cost over the life of the structure.

The resulting structure consists of a precast concrete arch or three-sided culvert, with a clear span width of 48 ft

profile

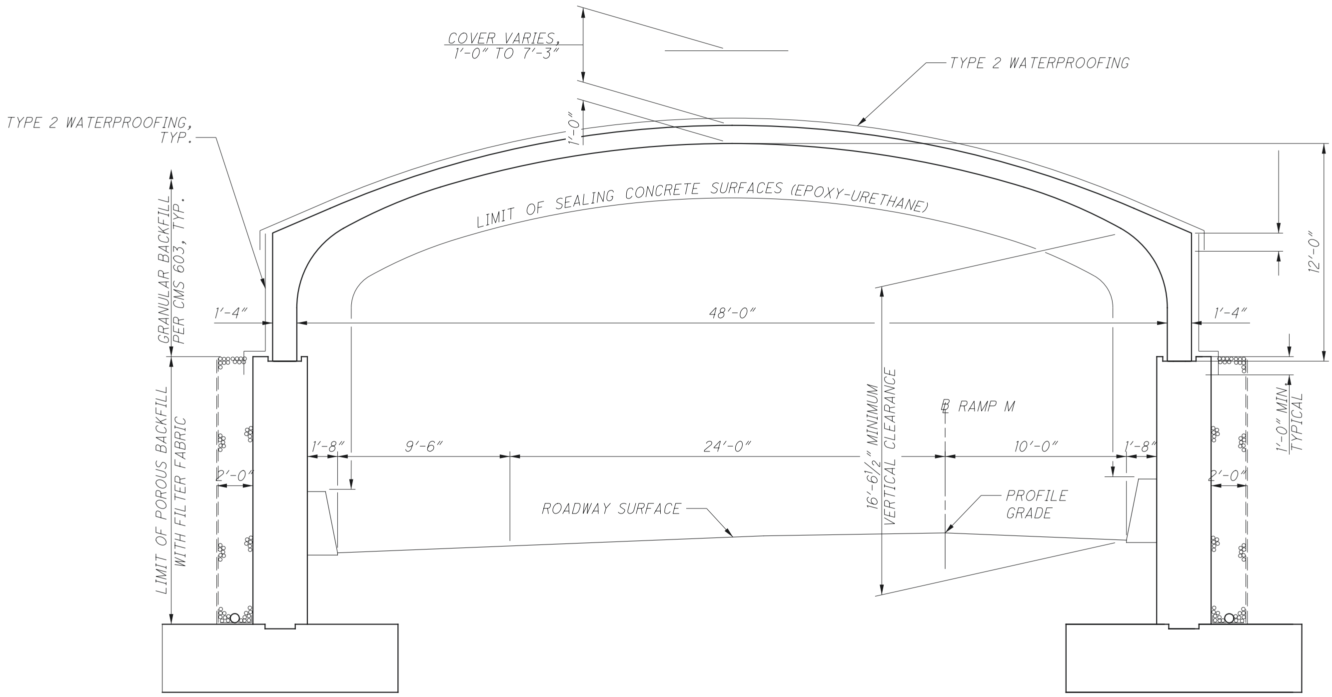
RAMP M TUNNEL AT EASTGATE BOULEVARD INTERCHANGE / CINCINNATI, OHIO

BRIDGE DESIGN ENGINEER: Stantec Consulting Services Inc., Cincinnati, Ohio

PRIME CONTRACTOR: John R. Jurgensen Company, Cincinnati, Ohio

PRECASTER: Contech, West Chester, Ohio

OTHER CONSULTANTS: Lighting design: AECOM (formerly URS Corporation), Akron, Ohio; Geotechnical: Gannett Fleming Inc., Columbus, Ohio



Typical section of tunnel. Figure: Stantec.

and a rise of 12 ft, that sits on cast-in-place concrete walls. The tunnel length was set to accommodate headwalls located just outside the concrete barrier along ramp M, resulting in a total length of 268 ft.

To provide sufficient clearance (16.5 ft minimum vertical) for traffic through the structure, the three-sided precast concrete structure sits on top of cast-in-place concrete walls that are approximately 19 ft high. A 3-in.-deep groove is formed into the top of the cast-in-place concrete walls, about 6 in. wider than the leg of the three-sided unit. The precast concrete section is set in the groove and grouted in place. There are no anchors or reinforcement attaching the precast concrete unit to the cast-in-place concrete walls, so it is a hinged connection. The walls are 3 ft thick to accommodate the base of the precast concrete section. The structure is supported on spread footings founded on bedrock. Approximately half the length of the structure is on a 5-degree 45-minute curved alignment to match the roadway passing through the structure; the remainder is on a tangent alignment. The roadway through the structure consists of two 12-ft lanes with 10- and 4-ft shoulders.

The tunnel was constructed by the open-excavation method. The sides of the excavation were laid back where possible, with only a short length of temporary sheet piles used where necessary to protect an adjacent parking lot. The end sections were supported temporarily during construction due to the weight of the headwalls along the outside edge of the section. The headwalls were detailed in the plans as cast-in-place concrete; however, the contractor elected to use precast concrete headwalls. The two headwalls varied greatly in height due to the extreme skew, ranging from 13 ft 3 in. to 1 ft 0 in. This made design and fabrication of the precast concrete headwalls more challenging.

Three of the wingwalls for the tunnel were designed using mechanically stabilized earth walls because a new embankment was being placed behind these walls. The walls varied in height from 3 ft to 33 ft. The fourth wingwall, which varied in height from 8 ft to over 20 ft, was designed using a soldier-pile wall with hardwood lagging to support an existing parking lot drive and building. To enhance the aesthetics of the structure, a concrete facade was added to the soldier piles when the excavation was completed.

OHIO DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: A 268-ft-long precast concrete three-sided arch culvert sections with 48-ft-long clear span and 12-ft-high rise on cast-in-place concrete walls

STRUCTURAL COMPONENTS: 69 precast concrete arch sections, 708 yd^3 of concrete in walls, 948 yd^3 of concrete in wall footings

BRIDGE CONSTRUCTION COST: $2.5 million on a 28-month construction schedule, which was completed in September 2015

East end of tunnel during construction. Note precast concrete headwall and temporary supports below precast concrete end section. Photo: Stantec.

View of completed tunnel looking east, with computer-controlled lighting system. Photo: Stantec.

Long-term durability of a structure is always a goal of the client and the designer. To improve durability, the Ohio Department of Transportation requires the use of epoxy-coated reinforcement in all precast concrete three-sided culverts, as well as in all cast-in-place concrete. To further enhance the durability of the structure, a rubberized asphalt peel-and-stick membrane was applied to the exterior surfaces on the top and sides of the precast concrete sections after they were placed. On the interior faces, an epoxy-urethane sealer was applied to both the precast and cast-in-place concrete surfaces to protect the concrete from deicing materials during the winter.

Due to the length of the structure, lighting was required to assist the driver while passing through the tunnel. A computer-controlled lighting system was installed inside the tunnel that adjusts the intensity of the lights throughout both day and night, providing safe passage for motorists.

Rehabilitating two interchanges immediately adjacent to one another in a large retail and office environment was challenging. The key was to design a transportation plan that provides safeguards to local business, while at the same time preserving the corridor's vitality and ensuring that it satisfies the safety and traffic flow concerns of motorists. The flow of traffic has significantly improved due to the new geometry and ramps, with the tunnel providing a unique entry point into the Eastgate commercial area.

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