ACEC
American Council of Engineering Companies
of Michigan

OFFICIAL ENTRY FORM

2020 ENGINEERING & SURVEYING EXCELLENCE AWARDS

ABOUT THE PROJECT

Project Name I-696 Innovative Design Project (45 character limit)

Enter in the following category (check one):

- ☐ Studies, Research, and Consulting Engineering Services
- ☐ Building/Technology Systems
- ☐ Structural Systems
- ☐ Surveying and Mapping Technology
- ☐ Environmental
- ☐ Waste and Storm Water
- ☐ Water Resources
- ☒ Transportation
- ☐ Special Projects
- ☐ Energy
- ☐ Industrial and Manufacturing Processes and Facilities

Project Location City Warren, Centerline, Roseville in Macomb County State Michigan

Completion/Use Dates Scheduled August 30th, 2019 Actual October 2019

Studies, Research, and Consulting Engineering Costs Budgeted $ 3,786,401 Actual $ 2,167,490

Construction Costs Total Project Budget $ 89,121,198 Total Project Actual $ 95,000,000

***Entrant's Portion of Total Project Budget** $ 3,786,401 **Entrant's Portion of Total Project Actual** $ 2,167,490

☒ **Check box if project was awarded through a QBS process.**

***NOTE:** The Entrant's Portion of the Total Project Budget includes the design fees paid to the entrant for the services provided for this project.

ABOUT THE FIRM SUBMITTING THE PROJECT

Entering Firm Tetra Tech

Firm Representative Jayson Nault

Address (no P.O. Box) 7927 Nemco Way, Suite 100 City Brighton State MI Zip 48116

Phone (810) 225-8427 Email jayson.nault@tetratech.com

I hereby authorize submission of this project into the American Council of Engineering Companies of Michigan 2020 Engineering and Surveying Excellence Awards competition.

Senior Executive/Principal Jayson H. Nault, PE Title Vice President

Signature _____ Date 9/27/19

ABOUT THE OWNER(S) OF THE PROJECT (NOT PRIME CONSULTANT/CONTRACTOR)

Owner(s) Michigan Department of Transportion

I believe the work of the engineer meets the intended uses and expectations for the project and hereby grant permission to enter this project in the ACEC/M 2020 Engineering and Surveying Excellence Awards competition, and authorize publication of its outstanding features, unique aspects, or innovations. I confirm the project was substantially completed and ready for use between November 1, 2017 and October 31, 2019.

Owner Representative Spiro Kotsonis, PE

Title Project Manager Signature _____ Date 9/27/19

A fee of $325 per entry for ACEC members ($1,200 for non-ACEC members) must be attached (less deposit paid with Intent to Enter). Visit acecmi.org for an electronic version of this form and additional category guidelines.

GRETCHEN WHITMER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF TRANSPORTATION
MACOMB TRANSPORTATION SERVICE CENTER

PAUL C. AJEGBA
DIRECTOR

September 25, 2019

ACEC Michigan
530 W. Ionia Street, Suite D
Lansing, MI 48933

Re: ACEC Engineering Excellence Entry
I-696 from Dequindre to Nieman Innovative Design Project

Dear ACEC Engineering Excellence Judges:

On behalf of the Michigan Department of Transportation (MDOT), this letter indicates my strong support for the entry of our project as a candidate for the 2020 Engineering Excellence Awards.

In 2017, MDOT made a QBS selection of Tetra Tech to retain their professional services for the design of I-696 from Dequindre to Nieman in Macomb County. The pavement within these limits had been in poor condition for several years and required substantial maintenance to allow for safe passage of the traveling public. The goal of the project was to provide a high-quality pavement improvement on an expedited schedule to allow for seamless construction of future adjacent projects. The project accomplishments include:

- Design of the improvements in a short, unprecedented time frame.
- Use of innovative design features such as project PDF and contractual 3D line strings.
- Maintenance of traffic that allowed for access to major crossroads in this highly urbanized freeway corridor.
- Completion of the mainline driving surface in one construction season.
- Incorporation of adjacent I-696 work in Oakland County to allow for a full corridor improvement.

MDOT and other project stakeholders have supported this improvement to Michigan's transportation system. We appreciate the consideration of the committee to receive an engineering excellence award.

Sincerely,

Spiro Kotsonis, P.E.
Project Manager

26170 21 MILE ROAD • CHESTERFIELD TOWNSHIP, MICHIGAN 48051
www.michigan.gov • (586) 421-3920

This project involved the design of 8 miles of depressed interstate freeway including 8 urban interchanges and associated ramps. The project design consisted of concrete inlay construction including a recently developed specification for cement treated open graded drainage course (OGDC). The project utilized several innovative concepts including a corridor-wide project PDF, contractual 3D line strings, and utilized the PQS spreadsheet in lieu of quantity breakdown displays. Design was on an accelerated schedule and completed in less than four months.

Role of entrant's firm in the project

Tetra Tech was the prime consultant for this project performing the road design and 3D modeling of I-696 and interchanges from Mound Road to Nieman. Tetra Tech also performed the safety studies, hydraulics, and utility coordination for the entire project.

Role of other consultants participating in the project

- AECOM – road design and 3D modeling of I-696 from Dequindre to Mound, permanent signing and pavement marking, and freeway lighting
- Access Engineering – maintaining traffic plans and provisions, including road design for temporary staging
- Surveying Solutions, Inc. (SSI) – LiDAR survey and 3D model reviews
- GeoTran Consultants - geotechnical
- The Prewitt Group – public relations assistance

Uniqueness and/or innovative application of new or existing techniques

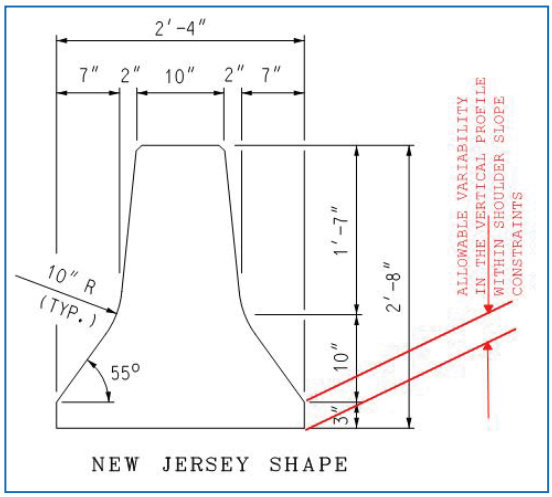
Schedule Challenge

In late summer 2017, MDOT was faced with the question of how to deliver a much-needed pavement improvement project for the I-696 corridor. At the time, news reports of loose concrete damaging vehicles were commonplace due to the condition of the pavement. The I-696 pavement improvement project from Dequindre to Nieman could not wait. MDOT needed to act.

Simultaneously, MDOT had announced the implementation of the I-75 corridor reconstruction project from 8 Mile to Coolidge that would begin construction in 2019. Due to its proximity to the I-75 work, it was a necessity to construct the mainline I-696 project improvements in 2018 in one construction season. Inlay pavement construction was proposed.

Tetra Tech's original design contract called for a service completion date of May 1, 2019. To meet the requirements imposed by the adjacent I-75 project and to meet the immediate needs to provide a safe corridor for the traveling public, it was necessary for plan completion to occur in time for a March 2018 letting. This necessitated submittal of contract documents in January of 2018; so, the design of a $90M construction project needed to be completed in roughly a four-month timeframe!

Innovative Techniques for Project Completion

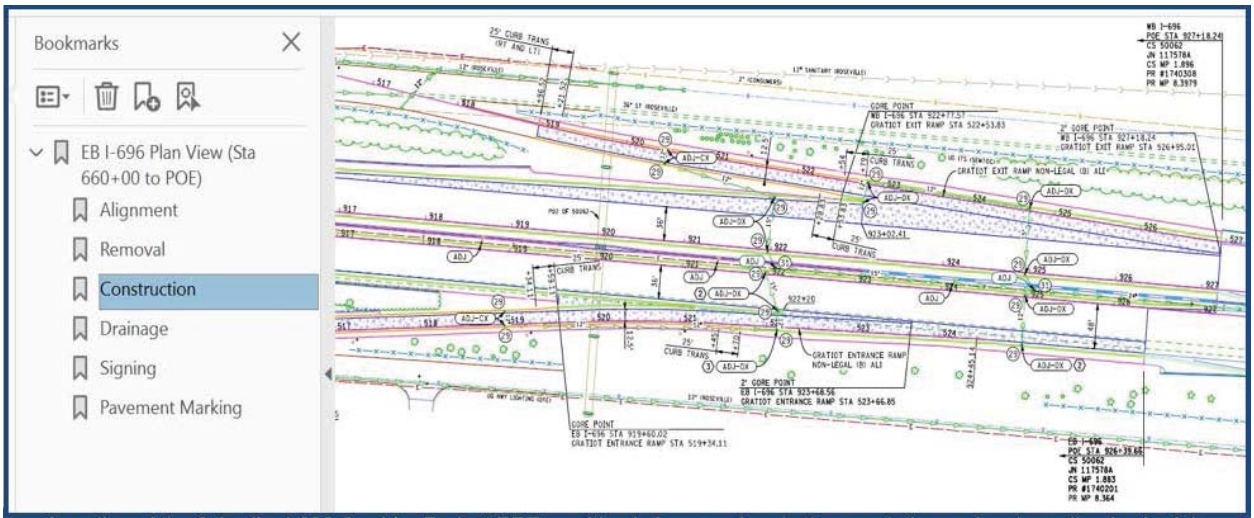


LiDAR Survey. There was no time for a conventional survey. Therefore, it was necessary to use mobile LiDAR technology. Data was gathered at traffic speed and incremental deliverables were provided to allow for concurrent work. Tetra Tech, AECOM, and SSI worked carefully together to initially develop alignments from extracted data and then to develop the existing 3D model. It was critical that the alignment meet geometric requirements while allowing certain features to be maintained such as the concrete median barrier wall, outside barrier wall, and bridge abutments. This required very detailed extraction of point cloud information of the joint between the edge of the median lane and shoulder so the alignment could be developed. The design needed to maintain a constant 11.83 ft. median shoulder width and 12 ft outside shoulder width so the existing median and outside barrier wall could be maintained.

The LiDAR survey also needed to provide critical data for the design of the vertical profile. The data extraction needed to provide sufficient detail at the existing median and outside barrier wall interfaces. It was necessary that the profile and shape of the barrier be modeled in 3D to allow the slope of the shoulder to vary with the vertical profile of the freeway using the 3-inch vertical face at the base of the barrier. It was also necessary to provide a 3D model of the underside of each bridge on the corridor to ensure vertical clearance was not compromised. Tetra Tech and AECOM designers utilized advanced modeling techniques to meet the median and outside constraints and the additional vertical constraints which consisted of maintaining the existing sand subbase and the vertical clearance to bridge beams.

Project PDF. While all this roadway design was occurring, traffic control concepts were being developed and MDOT was working on the life cycle cost analysis pavement design (LCCA). The schedule was further complicated when the preliminary results of the LCCA indicated the need to consider an alternate pavement design. Therefore, it was going to be necessary to develop quantities, typical cross sections, and contract provisions for both Hot Mix Asphalt (HMA) and concrete (note that MDOT ultimately approved concrete for the proposed design, but the alternate bid concept was carried through until the very end of the project design). The schedule did not allow for any type of conventional plan preparation which, for an over 8-mile multi-lane freeway project, would have involved hundreds if not thousands of sheets. For a project of this magnitude, something innovative was needed to meet the schedule while providing clear bidding information to the contractors.

A project PDF was proposed. MDOT had experimented with the concept, but at a much smaller scale at locations such as intersections and ramps. This would be the first time a project of this magnitude would utilize a project PDF deliverable. The project PDF was a continuous, corridor long electronic file of the entire project (envision a digital version of taping together plan sheets from beginning to end).



A portion of the 8.4-mile, I-696 Corridor Project PDF resulting in improved project presentation and a streamlined schedule

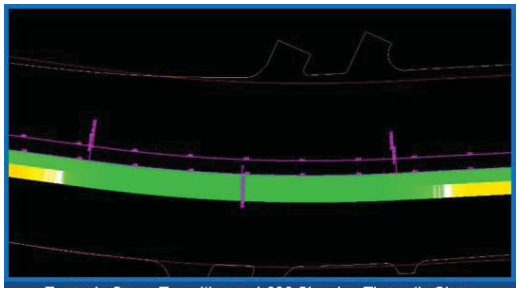
The file included separate pages bookmarked in an overall corridor PDF for alignment, removal, construction, profiles, pavement marking, and signing. This method of providing bidding documents streamlined plan production since it was not necessary to issue separate plan sheets broken out by length or by discipline (current design standard procedure) which is generally very labor intensive. A separate corridor PDF was prepared for maintenance of traffic that included bookmarks for each stage that can be viewed independently. Furthermore, layers were isolated to depict any view that was desired to portray a particular situation. There was also a feature to snapshot smaller views for use by reviewers, contractors, or inspectors.

For a project PDF, instead of breaking out quantities on plan sheets that are common to conventional plan deliverables, quantity breakouts can be set up in an Excel Project Quantity Summary (PQS) file for any increment or location so there is more flexibility in the way pay items are reported. For the I-696 project, quantities were broken out by one-mile increments for ease in preparation and to allow for an understanding by bidders of material requirements for these segments of the project. The project PDF concept was even carried through to construction, with engineering and inspection staff using the PDF for quantity tracking, contractor progress, and an as-built set of plans.

Some plan sheets were still necessary such as a title sheet, typical cross sections, miscellaneous details, and detour plans but the sheet requirements were a fraction of what would have been required with a conventional design.

3D Line Strings. Even though the project PDF was set to be utilized as a project deliverable, it was still necessary to find additional ways to streamline the design procedure and make use of electronic information in lieu of conventional displays of plan data. Current design practice requires the display of detail grades at locations such as gores, superelevation transitions, and shoulder slopes. Furthermore, coordinates are provided for every change in alignment, curve PCs, PIs, and PTs, and deflections. Rather than providing this mountain of grade and alignment information on numerous plan sheets, it was much more efficient to provide the information in electronic format. On typical MDOT projects, consultants provide 3D models as reference information for the contractor to use at their risk, but never before had any 3D data

been a contractual deliverable until the I-696 improvements. The I-696 project utilized contractual 3D line strings of the roadway and ramp surfaces that could be used by the contractor for automated machine grading and modeling purposes. This concept saved massive time and effort by not providing redundant information on plan sheets and details.


Example Super Transition on I-696 Showing Thematic Slope Display

Since the line strings would be contractual, it was necessary to ensure that the 3D deliverable provided would meet MDOT ride quality specifications. SSI was able to simulate ride quality for the proposed 3D models that Tetra Tech and AECOM developed. Ride quality issues became apparent where the surface made linear transitions such as for superelevation and tapers within the horizontal and vertical profile geometric shapes. At those locations, the model needed to be smoothed to ensure that ride quality specifications could be achieved with the 3D line strings. Techniques such as thematic slope display were utilized to ensure smooth transitions were provided in the model (slopes and transitions are displayed in different colors so issues can be easily flagged).

Base Course. To meet the required structural number for the pavement design while maintaining the subbase, a relatively new base course material was utilized. MDOT elected to construct a cement treated OGDC. This material was essentially placed as a paving operation that needed to account for curing and equipment clearances similar concrete placement. This complicated the schedule along with constructability considerations such as cure time, placement of test strips, and the need for depth checks that needed to be accounted for when determining MOT provisions and the progress schedule. The “prior to construction” and “7 day” compressive strength requirements of the cement treated OGDC must also be met. It should also be noted that delivery vehicles were not permitted to drive on the prepared grade during the placement of the cement treated base requiring use of a material transfer device that needed to be considered in the design and staging.

Future value to the engineering profession and enhanced public awareness/enthusiasm of the role of the engineer

It is essential that the engineering profession transforms the way we deliver our work product and that it can demonstrate that already limited funds are being used in an efficient and cost-effective manner. Time constraints are becoming more restrictive and, with an increased focus on infrastructure funding, the expectation for expedited delivery is only heightened. Electronic deliverables are representative of this transformation and are the future of engineering. Owners, consultants, and contractors that have a willingness to embrace the use of new technology will only enhance the stature of our profession and will ultimately attract more people to the field of civil engineering. Projects such as the I-696 Innovative Design Project represent the type of commitment to new technology that will elevate the role of the Engineer. This project can be a footprint for future project delivery that uses the latest technology to overcome scheduling obstacles.

Social, economic, and sustainable development considerations

By completing I-696 a year earlier than planned, the public was spared an adjacent, disruptive project next to the I-75 corridor construction. Imagine the congestion and crashes that would have occurred with I-696

and I-75 being constructed concurrently. Earlier completion of the I-696 project also enhanced safety by providing the public with a roadway surface free of broken and loose concrete and disruptive lane closures for maintenance. Use of cement treated open graded base course and high-performance concrete is expected to sustain the pavement for years to come. The long-term asset that is the I-696 pavement is attractive for residents looking to move to the area and businesses considering expansion. The benefits and confidence that the traveling public has with a new and reliable transportation corridor cannot be overstated.

Complexity

The project complexity is rooted in designing new urban freeway mainline pavement and ramps while maintaining a substantial amount of the infrastructure with restrictions in all directions. An urban depressed freeway with numerous curves, ramps, and interchanges is a complex entity. Design of a completely new freeway would itself be tremendously complicated – throw in the need to maintain median barrier, bridge abutments/foundations, subbase and bridge vertical clearance, and you have a project where fractions of inches can be the difference between success and failure. As previously discussed, the side conditions were stringent. The tie-in point for the outside and median shoulder was limited by a 3-inch vertical face at the base of the concrete barrier. The 3D line strings generated for the mainline pavement had to be designed to ensure that no variance beyond that restriction occurred – even a small deviation over the 8-mile corridor at the four barrier interfaces could not be tolerated without sacrificing safety for a vehicle that may impact the barrier. Since these 3D line strings were contractual, the designer's modeling skills were paramount to ensure the pavement and base was constructed as intended.

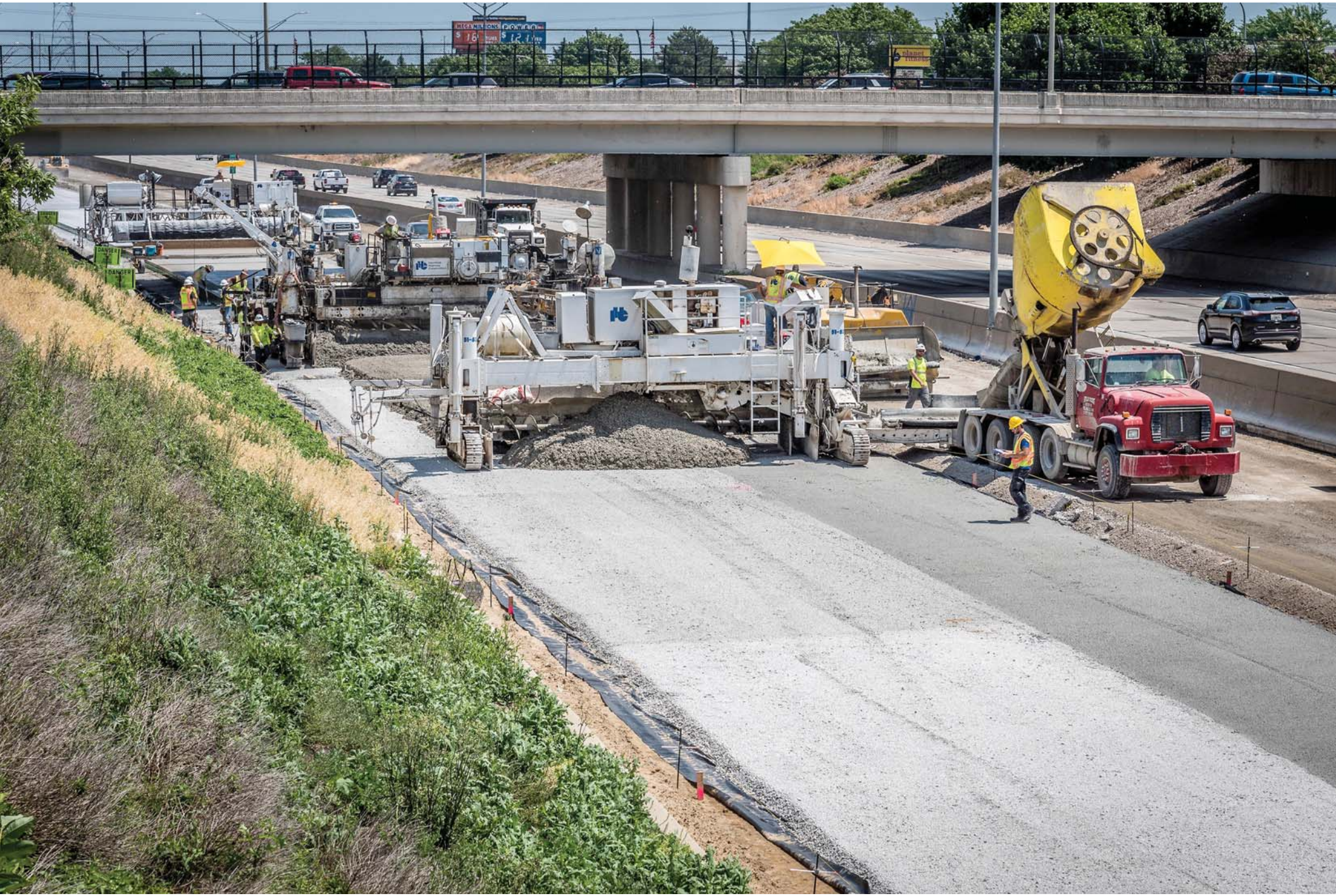
Crown correction from parabolic to 2% was also a necessity. The crown modification raised the centerline grade above the existing since the side constraints could not be changed and the sand subbase needed to be maintained. The vertical profile had to be designed to allow for this crown correction while maintaining the vertical clearance under the 40 bridges along the corridor. To achieve this, the bridge superstructure was also included in the 3D model. It was often possible to raise the centerline grade slightly to achieve crown correction since the point of least bridge vertical clearance was usually, but not always, located nearer to the outside lanes. Similar restrictions were in place for the 23 gores that needed to be designed within rollover tolerances which required an integrated model of mainline and ramp profiles. Only the use of advanced modeling techniques in a 3D design environment could aid the creation of a design that could meet the requirements of these competing constraints.

Successful fulfillment of owner/client needs

Tetra Tech worked with the MDOT Macomb TSC and Metro Region staff to ensure project objectives were achieved. Several public meetings were held to obtain stakeholder input and to answer questions that had a substantial impact on their daily lives. As an added benefit, Tetra Tech packaged an adjacent I-696 rehabilitation and bridge project from I-275 to Dequindre with the concrete inlay project. This allowed MDOT to utilize a common contractor for the construction of both projects.

In summary, MDOT needed to have a new pavement surface for the I-696 corridor while allowing for their I-75 program to move forward on schedule. These objectives were met by providing quality design deliverables on an extremely expedited schedule.


EXIT 24
Hoover Rd
3/4 MILE
Schoenherr Rd
WEST
INTERSTATE
696
DANGER


MEGA MILLIONS
POWER
planet fitness
DANGER
DANGER


CAT
0239


Groesbeck Hwy 1¼
Hoover Rd 3¼
Van Dyke Ave 4¼


YIELD

Photo 1
I-696 Paving of Concrete Inlay

Photo 2
Paving of Concrete Inlay over Cement Treated
Open Graded Drainage Course

Photo 3
Pavement Removal Operation Near the
Mound Road Interchange

Photo 4
I-696 Completed Project Looking West
Towards M-3 (Gratiot)

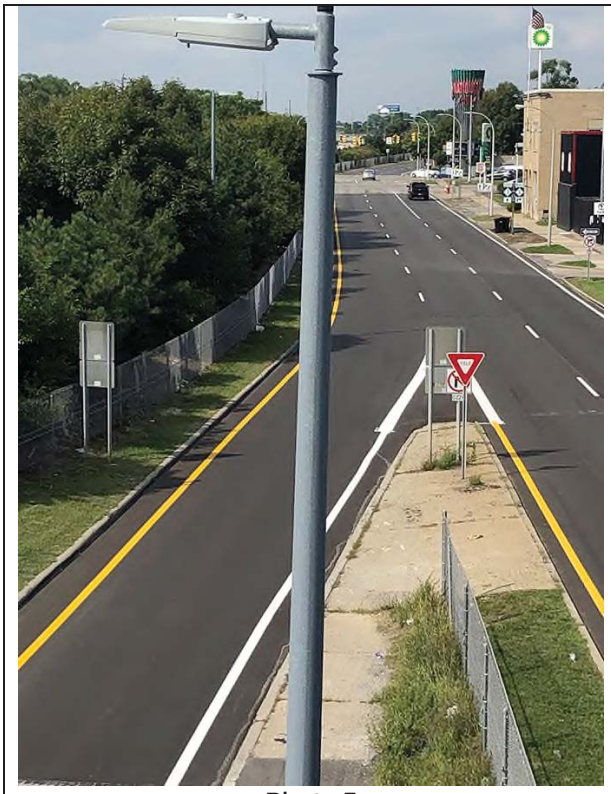


Photo 5
I-696 WB Service Drive and Entrance Ramp

Photo 6
I-696 Completed Project West of the
Mound Road Interchange

The I-696 Dequindre to Nieman project involved the design of 8 miles of depressed interstate freeway including 8 urban interchanges including ramps. The project design consisted of concrete inlay construction including a recently developed specification for cement treated open graded drainage course (OGDC). Several innovative concepts were utilized, including a corridor-wide project PDF, contractual 3D line strings, and a PQS spreadsheet in lieu of quantity breakdown displays. Design was on an accelerated schedule and completed in less than 4 months.

Brochure Text

Project involved the design of 8 miles of depressed interstate freeway including 8 urban interchanges. The project design consisted of concrete inlay construction including a recently developed specification for cement treated open graded drainage course. Innovative concepts were utilized including a corridor-wide project PDF and contractual 3D line strings.

Award Information

Title: I-696 Innovative Design Project
Firm: Tetra Tech
Owner: Michigan Department of Transportation

I-696
Innovative Design
Macomb County

The I-696 Innovative Design Project involved the design of 8 miles of depressed interstate freeway including 8 urban interchanges and associated ramps. The project design consisted of concrete inlay construction including a recently developed specification for cement treated open graded drainage course.

Several innovative concepts were utilized for this project including a corridor-wide project PDF, contractual 3D line strings, and the use of a PQS spreadsheet in lieu of quantity breakdown displays.

The necessity of two much-needed highway improvement projects (the I-696 pavement project and the reconstruction of the I-75 corridor) dictated an accelerated schedule. The Tetra Tech team successfully completed the design project in less than four months.

The benefits and confidence that the traveling public has with a new and reliable transportation corridor cannot be overstated.

This project represents the type of commitment to new technology that will elevate the role of the Engineer. This project can be a footprint for future project delivery that uses the latest technology to overcome scheduling obstacles.

ACEC
American Council of Engineering Companies of Michigan

Client: Michigan Department of Transportation, Macomb TSC, MI
Firm: Tetra Tech, Brighton, MI
Subconsultants: AECOM; Access Engineering; Surveying Solutions, Inc.; GeoTran Consultants; The Prewitt Group

TETRA TECH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