Farm Lane Road Underpass Project
(Fast Track Design of Two Rail Bridges on the Campus of Michigan State University)

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Word Count = 7,005
ABSTRACT

The Farm Lane Road Underpass Project on the campus of Michigan State University in East Lansing, Michigan provided an opportunity to incorporate innovative contracting solutions with streamlined railroad and utility coordination to save construction time, reduce client costs, and offer significant reductions in impacts to pedestrian and vehicular traffic on campus due to the daily train delays. The project required design of two rail bridges (steel thru girder type) over a lowered Farm Lane Road vertical alignment. Each single span bridge is 115’ long and carries two tracks. The relatively large quantity of structural steel required on this project combined with the University’s desire to minimize closure of this main arterial roadway, provided a design challenge for the project given the long lead times required for structural steel. In response to this challenge, the design team developed a concept that would construct the project in two phases (steel fabrication and bridge construction). Rail project coordination, pitfalls to avoid with technical design issues, constructability, project management, and separating the steel fabrication from the construction contract are reviewed, along with the importance of utility coordination and its impact on the cost of a project.

INTRODUCTION

After decades of planning and completion of several studies, the Farm Lane Underpass project on the campus of Michigan State University is becoming a reality. As the University has developed and expanded over its 153 year history, a small two rut road has transformed into a primary access arterial for pedestrians and vehicular traffic into the heart of campus. As you travel into the main campus, Farm Lane Road crosses two separate mainline railroads within 2100 feet of one another. In the 1930’s public traffic began using this unimproved road without any warning devices at either of the two rail crossings. Correspondence obtained from the Ingham County Road Commission’s records dating from the ‘30s indicates a push by then Michigan State College to have the railroad owners provide warning signals for
the safety of the traveling public. As traffic increased, the University became more concerned for traveler’s safety at these two locations and in the late 1940’s worked with the Ingham County Road Commission and the rail owners to construct gated crossings. The University transferred ownership of the Farm Lane corridor to the Ingham County Road Commission in order to signalize the grade crossing. Pedestrian and vehicular traffic continued to increase due to development on campus and the number of trains using the rail lines also multiplied, resulting in growing user delays and safety concerns. Previous studies, beginning in the 1950’s, indicated that a grade separation was needed at each of the grade crossings and in 2007; the Bergmann Associates team was selected to perform the design of this project.

When complete, the proposed Farm Lane Road corridor will serve as a southern gateway into Michigan State University’s 5,200 acre main campus. The two rail structures will become recognizable landmarks associated with the University for generations to come. The corridor will be returned to the University by the Ingham County Road Commission, who had assumed ownership over 60 years ago in order to improve the safety of this roadway.

Figure 1 – Artist’s rendering of the proposed Canadian National Railroad bridge
PROJECT DESCRIPTION

The Farm Lane Underpass project lowers Farm Lane Road at the two rail crossings to allow the existing railroad tracks to remain on their current vertical alignment. The reconstruction of the roadway extends approximately 2 miles in length from Mt. Hope Road to Wilson Road. Widening from two lanes to five lanes and the addition of bicycle lanes and sidewalks will result in an out-to-out road cross section of 98 feet under the proposed rail bridges. The widening also required shifting the Farm Lane Road horizontal alignment to the west avoiding impacts to the 114 year old protected Baker Woodlot which is highly regarded by the University and local arborists.

Figure 2 – Aerial view of the project

Wetland ponds used for research by the University are located on either side of Farm Lane Road just north of the CN tracks, and minimizing impacts to them was critical. Cutoff walls are being installed parallel to, and on each side of, a portion of the new Farm Lane Road. The cutoff walls consist of continuous interlocking steel sheet piling having joints sealed with a two part urethane system to make
them watertight. The design called for a portion of these cutoff walls to function temporarily as a tied-back retaining wall during the proposed bridge abutment construction and during the swamp treatment near the CN bridge that will require wall-to-wall excavation to remove all organic material in the cut section. However, the Contractor has proposed an alternate construction sequence, utilizing trench boxes, to eliminate the need for tie backs. Once the Contractor has excavated the poor soil and backfill along the cutoff walls with trench boxes, they will then open cut the remaining poor soils between the walls.

In order to maintain a nearby large steam tunnel without costly relocation and service interruption, the proposed Farm Lane Road profile was adjusted to maintain sufficient cover over this utility. To accomplish this, a 6% maximum roadway grade was used in combination with utilizing a shallow, yet efficient, superstructure floor system. A 10” high pressure gas main had to be relocated to allow for construction of the east abutment, a water main was relocated for the construction of the west abutment, and overhead railroad communication lines were removed and replaced with coded track.

The University preferred that the two bridges be the same type and look similar in their general style. To reduce impacts to the campus landscape, the roadway will be lowered under the railroad tracks as part of the grade separation. A single span thru-girder steel structure was chosen for each site to meet the design constraints presented. Each bridge carries two tracks and consists of two thru-girders spanning 115 feet. The floor system is rolled W36 steel beams, a steel floor plate, and a ballasted deck. The superstructure at each location is supported by reinforced concrete abutments with U-walls, all founded on steel H-pile foundations.

The bridges will be built by first constructing a two track temporary shoo-fly to the south of each railroad followed by installation of a temporary earth retaining structure between the shoo-fly and existing tracks. Track design was based on 40 mph. The proposed bridges will be constructed on the existing rail alignments with the current track spacing of approximately 14 feet maintained. Allowance has been made in the width of the bridge for future 15 feet track centers. Once the proposed structures are
completed, CSX and CN rail traffic will be shifted back on to their respective original alignments, the
temporary earth retaining structure and shoo-flies will be removed, and the roadway underpass
completed. Pedestrian traffic is not permitted through the construction zone. The University worked with
the municipal bus agency to provide additional capacity of the Lot 89 parking area during the school year.
Vehicular traffic is being detoured away from the construction site.

Figure 3 – Sheet piling for temporary wall at the CSX with shoo-fly track work shown

Construction of the project is being completed in two major phases consisting of a total of three
construction contracts, railroad force account work, and utility force account work. Phase I consisted of
two construction contracts, one of which is a fabrication contract for the bridge structural steel, as well as
several utility force account tasks. Phase II consists of the main construction contract and railroad force
account work. The driving forces behind completing the construction in Phases were primarily
construction schedule and funding considerations which would allow savings for the owner (Michigan
State University).
The Phase I - Contract 1 work is now complete and primarily consisted of grading the proposed detention ponds for each underpass; grading the temporary shoo-fly up to the existing Farm Lane Road (prolonged traffic closures were not allowed during Phase I); relocating water mains running north-south along Farm Lane Road; construction of a new roadway off of Farm Lane Road to access the University’s power plant, and installation of a sewer west of Farm Lane Road to service new development planned in the area.

Phase I - Contract 2 work is ongoing and consists of fabricating all structural steel for the two railroad bridges. Phase I railroad force account work, completed in the Fall of 2007, included temporary relocation of fiber optic utilities; relocation of a 10” high pressure gas main; and removal of overhead railroad communication lines along each railroad.

The Phase II construction contract is also underway and is scheduled to be completed in August of 2009. For this project, the CN will be constructing the ballast, ties, and tracks for both the temporary shoo-fly and for the permanent track on the bridge and approaches. The Phase II Contractor is responsible for constructing the CSX shoo-fly and permanent track work using CSX-supplied materials.

**CSX RAILROAD BRIDGE**

Designed for Cooper E-80 train loading the proposed CSX bridge is oriented on a 20 degree skew. There are about 5 trains per day utilizing this section of rail currently.
The reinforced concrete wall type abutments and return U-walls are supported by 8,100 lineal feet of HP 14x73 steel piling (192 piles averaging 42 feet in length). The railroad surcharge loading, in addition to the “U” shape of the substructure resulted in significant lateral loading on the piles. A reinforced concrete tie beam was designed for tension to help resist the outward lateral pressure on the lower wingwalls and for bending to help resist sliding of the abutment stem by engaging passive pressure of the soil.

![Abutment view showing tie beam and stepped wingwall](image)

The abutments will be located behind raised sidewalks (six feet above proposed Farm Lane Road at the bridges.) An ornamental pedestrian/bicycle railing is proposed along the raised sidewalk. Architectural insets were detailed in both the abutment face and the wingwalls where future artwork may be displayed.

The thru girders for the CSX structure are spaced 35'-6” on center and are built up from 3-inch thick, 30 inch wide flanges and 1 1/8” thick web plates that are 129” deep. The floor beams are W36x170 rolled steel shapes spaced 2'-6” on center. The end floor beams are W36x231 rolled steel shapes. Transverse web stiffeners and built-up plate knee braces are spaced at 7'-6” on center. The ballast is retained by a ½” thick steel floor plate welded to the floor beams. CSX required the proposed floor system to be
shipped in panels consisting of four floor beams with the floor plate shop welded (no overhang). Field splices for the floor system were also designed and include both field welding and field bolting.

![Diagram of floor panel shop fabrication](image)

**Figure 5 – Typical floor panel shop fabricated and delivered to the site**

Due to the panelized floor system used for this structure, the design plans included a recommended erection sequence. The width of the thru girder flanges (30") combined with the width, depth, and length of the panelized floor system required that one girder be erected in its final position while the other girder is erected "wide". The floor system can then be installed and connected permanently to the first girder while the other end of the floor system is supported temporarily on false work. Once the entire floor system is erected, the second girder is then “slid” in to its final position and connections are made to the floor system.

After the structural steel is erected, the Contractor will proceed with the ballast and track construction in preparation for shifting rail traffic back on to the permanent alignment. Construction of the bridge will be completed next to a temporary retaining wall (supporting the temporary shoo-fly tracks.) The temporary retaining wall is comprised of continuous steel sheet piling with walers and tie backs. This wall type was
selected because the same wall type was required at the CN bridge to control ground water and retain the wetland ponds during construction. Similar details and materials made construction and design more efficient. CSX required that the wall be monitored (surveyed) on a daily basis throughout construction with the temporary shoo-fly tracks being monitored for the first two weeks of shoo-fly use. Daily survey reports will be prepared by the Contractor and submitted for review by the Engineer and the CSX.

The offset of the temporary retaining wall from the bridge abutment will not allow for construction of the aesthetic pilasters on the south side of the bridge until after rail traffic is shifted back on to permanent alignment and the wall is removed. The pilasters consist of reinforced concrete (8 feet x 5 feet by 30 feet tall) and will be faced with brick and cast stone insets.

The vertical clearance provided by the structure meets State requirements of 14’-9” for this classification of roadway, however, the CN requires either 17’-4 1/2” under-clearance, a sacrificial beam, or advanced warning signal device is required. To make the CSX bridge similar and to provide an opportunity for supporting a decorative screen for enhancing the bridge aesthetics, sacrificial beams were added to it as well.

The sacrificial beam is designed to protect the bridge from vehicular collisions which would result in a closure of both the Farm Lane Road and rail traffic for repairs. Prestressed concrete box beams (39” deep by 36” wide) with heavily reinforced webs, weighing 55 tons each, were designed for a TL-4 vehicle impact at 30 mph. Each web is 7 1/2” thick and encases 17-#10 reinforcement bars. The continuous web reinforcement, in addition to the prestressing strands in the bottom flange will prevent the beam from falling to the roadway below should it be hit. Spanning 114’-4” the sacrificial beams are secured with full height threaded bars tightened at the top of the beam with plate washers and nuts to prevent overturning of the box beam as well as provide shear resistance at the supports during a vehicular impact.
The proposed CN bridge is not skewed to the roadway, but the abutments are angled away from the sidewalk by approximately 10 degrees. The bridge was designed for Cooper E-90 train loading in accordance with CN’s design requirements. There are an estimated 40 trains per day utilizing this section of rail now.

The reinforced concrete wall type abutments and return U-walls with tie beams are similar in design to that of the CSX bridge described above.

The thru girders for the Canadian National Railroad structure are spaced 35'-6" on center and are built up from 3-inch thick, 30-inch wide flanges and 1 1/8" thick web plates that are 144" deep. The floor beams are W36x150 rolled steel shapes spaced 2'-6" on center. The end floor beams are W36x231 rolled steel
shapes. Transverse web stiffeners and built-up plate knee braces are spaced at 7'-6" on center. The ballast is retained by 7/8" thick steel floor plate bolted to the floor beams and designed to act compositely. Note the lighter floor beam size as compared with the CSX bridge even though the span is similar. CSX would not allow the steel floor plate to be designed as acting compositely with the floor beams. The floor system for this structure will be fabricated and shipped as individual pieces so temporary supports during erection will not be required as they are with the CSX structure.

Once the structural steel is erected, the CN will do the ballast and track construction under force account. Similar to the CSX structure, construction of the bridge will be completed next to a temporary retaining wall (supporting the temporary shoo-fly). Due to the ponds located near this structure, as well as the possibility of groundwater above the proposed excavation, the use of a water tight wall system was proposed. Cutoff walls, extending for the full "cut" section of Farm Lane Road for the CN bridge, are being installed which consist of continuous interlocking steel sheet piling with two part urethane sealant injected into the joints. The temporary retaining wall will also match this wall type to prevent ground water from flooding the excavated site during construction of the bridge.

The cutoff walls parallel to Farm Lane Road will also act, temporarily, as a retaining wall for construction of the bridge abutments and for undercutting poor soils identified during the geotechnical investigations. A layer of soft clay with traces of organics exists just north of the CN bridge requiring an undercut of approximately 20 feet below bottom of footing from cutoff wall to cutoff wall.

The vertical clearance provided by this structure also meets the State requirements of 14'-9", however, the CN requires 17'-4 1/2" or a sacrificial beam or advanced warning signal device must be provided. A prestressed concrete box beam was designed, similar to the box beam described above for the CSX bridge, to protect this structure per the requirements of the CN. The railroad does not specify loading requirements for the sacrificial beam so our design team estimated a loading based on AASHTO’s LRFD manual Sections 3 and 13. A TL-4 loading (vehicle impact tested at 50 mph) was proportioned down based on the project’s design speed of 30 mph. While the TL loading is based on an impact at a level of
4’ above grade, it was assumed that the center of gravity of the vehicle striking the beam being well below
the sacrificial beam, would be conservative in the analysis. The result is a design load on the beam of
150 kips which was distributed over a 5 foot length of beam for determining design stresses. The loading
was placed at mid span for designing the steel reinforcement in the tension web. The loading was
applied at the barrier/sidewalk wall for determining the shear force to be resisted at the end supports.

![Diagram](image)

**Figure 7 – Midspan section through the**

prestressed concrete sacrificial box beam

(architectural treatments not shown)

**DESIGN AND COORDINATION**

The design of this highly complex project was completed in less than fourteen months. This duration is
impressive when considering the breadth of the engineering challenges faced alone, but the immense
amount of coordination that was required in addition to these design challenges made the schedule extremely aggressive. CN officials; CSX Railroad officials; CSX review staff (provided by HDR Engineering); University architects and planners, engineering staff, maintenance and utility staff, student and wildlife groups, and administration staff; Michigan Department of Transportation administrative staff, and road and bridge reviewers; Michigan Department of Environmental Quality staff; four fiber optic owners (Level 3, Sprint, AT&T, and Rogers Telecom); Consumers Gas company; Capital Area Transit Authority (CATA Bus) officials; Ingham County Drain and Road Commission officials; and City of East Lansing officials were all involved throughout the project.

In order to progress with the design while coordinating with numerous stakeholders, the project was divided into finer subtasks with specific key stakeholders identified and participating in each task. Meetings and coordination with each individual group of stakeholders were then handled on a more manageable scale.

Michigan State University Committees

- Planning Team - 14 members
- Context Sensitive Solutions Team - 17 members
- Water Resources Team - 28 members
- Landscape Team - 21 members
- Pump House Team - 12 members

Related to the design for this project, stakeholders consisted of George Nowak and Mark Dupuis (CN), Steven Lorek and David Krafft (HDR Engineering representing CSX); a Michigan State University bridge aesthetics committee comprised of architects, historians, landscape architects, and administrative staff; and several MDOT staff (including Mark Harrison, MDOT’s Project Manager). This core group focused on issues specific to the bridge and coordination of those issues with other project specific items was handled by Bergmann’s Project Manager, Michael Isola.
Several bridge design challenges were met on this project. Design standards from AREMA, CN, CSX, and MDOT were referenced and consulted throughout the design.

One of the first design challenges consisted of preparing a Type, Size, and Location study for the proposed rail bridges. The type of bridge was selected during a previous study and confirmed as the most appropriate type by our team. The width of the bridge was of specific interest in the beginning of the project to determine the offset required for the temporary shoo-fly from the existing tracks.

![Figure 8 – Typical bridge section proposed](image)

The typical bridge section was developed based on preliminary design of the primary structural members and the horizontal geometric requirements of the new tracks. While the existing track centers are approximately 14 feet, the bridge width was set to allow for future 15 feet track centers. The CN bridge geometry was set to maintain the alignment of the north track with provisions for pushing the south track out to obtain 15 feet track centers per the railroad’s preference. The CSX bridge geometry was set to push the north and south tracks out an equal distance to obtain the future 15 foot track centers.

The horizontal clearance envelope was governed by AREMA and State guidelines for railroad safety. A variance was sought and granted for the State of Michigan clearance requirements which do not allow “clipped” corners at the bottom of the clearance envelope which would allow the proposed knee braces within the State’s clearance envelope. The variance allowed the floor beams to span less distance, minimizing the overall floor depth of the structure.
The bridges include a level ballast walkway for train and maintenance crews to walk across the bridge and a horizontal deck closure plate between girder knee braces for refuge in the event of a train crossing.

![Figure 9 – Clearance envelope required by AREMA](image)

Outside of the steel superstructure, sacrificial beams were designed per CN requirements for structures over roadways with vertical clearance less than 17'-4 1/2". Several beam alternatives were investigated, including prestressed concrete I-Beams, cast-in-place concrete beams, fabricated steel plate girders (box shape), and the chosen type, a prestressed concrete box beam.

A 3 foot wide architectural pilaster was assumed early in the project with aesthetics meetings scheduled later in the design process to finalize the details of such elements. The remaining offset for the shoo-fly was comprised of an assumed temporary cut-off wall thickness and an 11 ft offset from the temporary wall to the centerline of the nearest shoo-fly track centerline.
To ensure sufficient offset to the proposed shoo-fly temporary retaining wall, an additional 5 feet was provided for a final offset of 50 feet from the north permanent track center to the north temporary shoo-fly track center. The proposed shoo-fly offset was approved by each of the railroad owners so that agreements could then be negotiated between the University and railroads to allow use of University property by the railroad during construction (the proposed shoo-fly extended outside the limits of the existing railroad Right of Way). As the design progressed and considerations for aesthetics on the bridge were fine tuned, it became apparent that the 50 foot offset would not be sufficient. The primary difference in the offset assumed early in the project and the final offset was the width of the proposed pilasters developed during the architectural design of the structure, the depth of waler required for the temporary wall, and size of the thru girder bearings. As a result, a conflict between the waler for the proposed temporary wall and the pilaster core required details in the plans to construct the south side pilasters after the bridge is put into service and the temporary wall is removed.

**Figure 10 – Typical bridge section during construction (pilaster core will be completed after the temp wall is removed)**
Another design issue of note dealt with the sizing of the bridge floor beams and their interaction with the steel floor plate. Given the standard connection details for both the CN and CSX standards (counter sunk bolts and continuous fillet welds, for the CN and CSX bridges, respectively), our design team sought to take advantage by counting on composite action of the steel floor plate in limiting live load deflection for serviceability. The proposed design sought to utilize the extra stiffness to meet deflection limits only (live load deflection controlled the size of the member), with strength of the floor beam alone resisting the applied loads. CSX would not consider composite action of the floor plate in the analysis so a heavier floor beam was required (W36x170 vs. W36x150 for required for the CN who allowed consideration of composite action in the analysis).

Lateral earth pressures generated by the train live loads were significant. The effects of these loads were amplified by the geometry of the abutments (the return wingwalls create a “U” shape) creating a quasi at-rest earth pressure. AREMA guidelines recommend modifying the equivalent fluid weight of the soil backfill by 1.25 to account for partial fixity of the walls. The resulting earth pressures exceeded the lateral capacity of the piles contributed by their 1H:3V batter. The excess lateral loading for the abutment stem portion amounted to 10 kips per pile for the controlling load case (train on bridge approach) and the excess lateral loading on the lower wingwall pile groups exceeded 10 kips per pile, both of which were unacceptable given the underlying soils. To resist the excess lateral loading on the piles, a reinforced concrete tie beam (5’6” thick x 5’-0” wide) was designed for tension to resist excess lateral loads from the wingwalls and for bending of the beam to resist passive pressure engaged to offset excess lateral loading on the abutment stem piles.

The sacrificial beams that were designed to protect the bridge from vehicular collision, as well as to support an aesthetic screening, were provided on each side of each bridge. The design assumed a lateral impact loading from a truck (TL-4 at 30 mph), self weight of 55 tons, weight of architectural treatments, and wind and ice loading (fiber optic utilities for the CN bridge were also included).
Several alternatives were investigated during the design with the following results. A cast-in-place concrete beam option was considered but the span length of over 114 feet raised concerns for long term serviceability and required prolonged closures to Farm Lane Road for repairs. A built-up steel box girder was also considered but found to be cost prohibitive when compared with prestressed concrete. A prestressed concrete I-girder was considered but lacked the lateral capacity that could be obtained from the selected alternative, a prestressed concrete box beam with heavily reinforced webs.

The estimated cost of a built-up steel box was between $300 and $400 per foot of beam while the prestressed concrete box beam was estimated at $200 per foot of beam.

The prestressed concrete box beam provided a cost effective, aesthetic, and durable option that could be replaced overnight if required.

**UTILITY COORDINATION**

An existing 10” high pressure gas main, a 16” water main, and a total of five fiber optic cables needed to be relocated as part of this project. These utilities were in direct conflict with the construction of the rail bridges and cutoff walls. Several other utilities were also relocated to accommodate the proposed roadway construction which is not described in detail here.

The original gas main was located east of Farm Lane Road and parallel to it. The line was permanently relocated to the west side of proposed Farm Lane Road to avoid conflict with the proposed CSX bridge abutment. Although a public utility, the $300,000 cost of the relocation was borne by the project as the gas main serviced only the University’s coal power plant and not the general public. Since the main had to cross under the CSX tracks in a new location, permits and a steel protective sleeve were required under the permanent tracks and the temporary shoo-fly.
A University water main which parallels Farm Lane Road on the west side was relocated outside of the limits of bridge construction. The new line crosses under the CSX tracks west of Farm Lane Road. Similar to the gas main, permits and additional protection of the line were required by the railroad for this $460,000 crossing.

Five fiber optic cables in three conduits (two cables in a single conduit located north of the CN and three cables in two conduits located south of the CN) had to be temporarily relocated during bridge construction. The lines were parallel to the railroad tracks and within CN’s Right of Way. The University would not allow the fiber companies to remain on University property with a permanent easement so after the bridges are constructed, they will be relocated on to CN’s Right of Way (on the sacrificial beams.) The fiber optic companies involved preferred to jack and bore their utilities below proposed Farm Lane Road and stay within the CN’s Right of Way throughout construction, but the installation of the cutoff walls made this option cost prohibitive. The lines were relocated temporarily on to the University’s property in the Fall of 2007 and will be relocated back on to CN’s Right of Way in the Winter of 2008 under force account. The total cost of the two relocations for all of the fiber lines is estimated at $1,300,000.

The utilities that were in conflict with the construction of the bridges were relocated as part of Phase I activities completed in the Fall of 2007. Consequently, certain design activities had to be advanced to ensure that the relocated utilities would be located a safe distance away from Phase II construction influence. The permitting process for relocating the utilities under the CSX tracks also required lead time for approvals, further pushing certain design activities to the forefront. Coordination of utilities on a project such as this is very important and the cost of relocating these utilities can be significant.

**PROJECT FUNDING**

A study was completed in October 2001 by another design consultant which was used by the University to secure funding through a federal earmark for the design and construction of this project. The estimated construction cost of the project developed in the study was $13.1 million while the current construction estimate stands at $27.7 million (not counting utility and railroad force account work or
construction engineering services.) $5.6 million will be required for railroad force account work and relocating private fiber optic utilities.

It was immediately evident that the estimated construction cost developed during the study was considerably low. Consequently, upon award of the design project, the design team began seeking alternative funding sources and ways to reduce the project’s cost wherever possible without compromising the University’s goals and vision for this project.

One partial financing solution was to take advantage of a State funding source dubbed “Jobs Today” which was initiated in order to boost Michigan’s economy through the creation of construction jobs in the State by providing additional construction funding for local agencies. The “Jobs Today” funding was set to expire in late September 2007 which did not allow adequate time to complete full design of the project or secure the required agreements between each of the two railroads and the University, both of which were required in order to advertise and bid the entire project. By developing a phased design and construction approach to the project, two construction contracts (Phase I-Contract 1 and Phase I-Contract 2) were eligible for “Jobs Today” funding which resulted in a savings to the owner of $3.7 million.

To take full advantage of the “Jobs Today” funding and to minimize the overall construction schedule duration anticipated for the project, Bergmann Associates developed a list of construction items that could be completed without closures to Farm Lane Road and those that would require closures. The result was the creation of two project phases and three total contracts.

It was determined that the tasks in Phase I could be designed ahead of the “Jobs Today” deadline and construction would not impact the traveling public. However, this presented a challenge to the design team since Phase I would be advertised and awarded for construction while Phase II design was ongoing and agreements between the University and each railroad were still being negotiated.
While phasing the project as described above did present some challenges, it provided clear advantages as well. One obvious advantage was the funding source through “Jobs Today”. Another advantage was that by fabricating the structural steel ahead of the construction contract, the completion of the two railroad bridges (and the cutoff wall at the CN RR crossing) would be possible in a single construction season. This is important since the remainder of the construction tasks on the critical path for the project’s completion could now be performed in early spring and summer of 2009. The anticipated “open to traffic” date of August 2009 will ensure Farm Lane Road will be open to traffic prior to beginning fall classes in 2009. Closure of Farm Lane Road during fall 2008 and spring 2009 will cost the University an estimated $1,000,000 in increased busing costs for increasing capacity to augment the expected rise in ridership associated with closure of the roadway. Another second fall closure would have meant another $1,000,000 plus cost to the University.

**INNOVATIVE CONTRACTING SOLUTIONS**

With the project split into two phases, one of the most significant challenges in designing the two railroad bridges was ensuring the structural steel details developed in Phase I were sufficient for fabrication while still finalizing design of the substructures to be built in Phase II. The solution was to include a comprehensive special provision in the Phase I and Phase II construction contracts. Special attention was required in developing each set of contract plans and a steel fabrication and erection specification which clearly defined the responsibilities of each contractor, something MDOT’s Standard Specifications for Construction did not specifically provide. In our case, the General Contractor and the fabricator were working under separate contracts. To address this, the design team authored a Special Provision for the bid documents for both the fabrication contract and the erection contract. The plan sets for each phase were coordinated to define which contractor is responsible for performing specific work tasks.
Our team sought an independent review of the structural steel details by a retired steel erector with experience in building steel thru-girder rail bridges. Mr. John Gast performed a review of the steel details and the steel specifications prior to advertising and bidding, and provided several steel detailing improvement recommendations, assisted in the development of an erection sequence for the CSX bridge, and provided constructive feedback on the Special Provision for steel fabrication and erection. His review was highly valued given the importance of having a complete understanding of the fabricator and erector’s individual responsibilities.

The steel specification required the fabricator to transport the structural steel to the site and made the fabricator responsible for all traffic control, permits, and police assistance required for the transport. The erector is responsible for coordinating the movement of the delivery trucks through the construction zone and to the unloading area designated by the erector. An on-site inspection with representatives of the fabricator, erector, and resident engineer were specified to identify any damaged coatings or materials caused by shipping. After the materials are accepted by all three parties, they become the property of the erector who will unload and store all materials until erection. Damage caused by unloading or erection is the responsibility of the erector.

Provisions were included to reduce or eliminate the possibility of delay claims by the erector, in the event they are ready to begin erecting the steel but it has not been delivered yet by the fabricator. The provisions also were developed to defend against storage claims by the fabricator, in the event the erector is not ready to receive the materials at the scheduled delivery times. Liquidated damages were specified for the fabricator for each day past the deadline for steel delivery. Early delivery was subject to the approval of the Engineer and the erector. Delivery of the structural steel prior to the executed contract of the Phase II erector was prohibited. The delivery window specified was approximately one month ahead of the anticipated time to begin erection in order to ensure that the erector would not be delayed. The provisions also allowed, however, for the erector and fabricator to mutually agree to modify the delivery schedule to eliminate double handling of the materials (such as the 82 ton, 115-foot long girders).
Detailed shop drawings, shop assembly, match marking, storage, and specific payment terms were defined in the special provisions to accelerate the construction schedule, reduce project costs, and minimize problems during erection by the Phase II Contractor which might delay the opening of the bridge to rail traffic.

To address the limited time period (seven months) between execution of the fabrication contract in Phase I and the required delivery date of the structural steel in Phase II, an accelerated shop drawing submission and review process was developed for this project. The project used a file transfer protocol (FTP) site for transferring drawings and review comments in PDF file format. The use of the FTP site allowed for large file sizes to be transmitted quickly and efficiently with no delays and at lower cost. The exclusive use of electronic files enabled instant distribution to all reviewers and saved several days for each submission.

To reduce the risk of encountering fit-up or erection issues in the field during Phase II construction, the provisions required that the fabricator perform a complete shop assembly of each structure and to provide match marks for pieces to be field connected. This greatly reduced the risk of delay during construction and the potential for contract dispute between the Phase I and Phase II contractors in addressing any field fit up problems.

While the project area has available land for storing the steel materials, awarding a fabrication contract in advance of a construction contract does introduce some risk associated with the claims due to a delay in the construction contract letting. To minimize this risk, the provisions included a specific pay item for storing the structural steel (per calendar day) beyond the delivery deadline specified in the Special Provision. Including this provision allowed the owner to obtain a competitively bid price for steel storage up front.
To reduce financing costs that would likely be passed on to the owner if payment was made for fabrication in accordance with the MDOT Standard Specifications for Construction, progress payments were included in the special provisions for the fabrication contract. The provisions allowed the fabricator to invoice the project for all materials purchased as long as approved proof of the order was provided.

The progress payment schedule also had a provision for retaining 10% of the total Phase I steel fabrication costs until after the rail bridges are successfully erected in the field. The retained amount provides further incentive for the fabricator to assist with any questions and/or issues that are encountered in the field in a timely manner.

In addition to the construction scheduling and delivery coordination discussed above, the provisions required that the erector unload the delivery trucks in a timely manner so that the fabricator’s delivery equipment and labor were not sitting idle for unknown periods of time. By clearly defining the time periods of acceptable unloading durations, risk to the owner due to claims by either the fabricator or the erector were further minimized. The erector was required to unload the thru girders within two calendar days of their arrival and acceptance and all other materials were limited to 2 hours after the acceptance of the materials on site.

**SUMMARY**

When complete, the proposed Farm Lane Road corridor will serve as a southern gateway into Michigan State University’s campus. The two rail structures will become recognizable landmarks associated with MSU well into the future. Construction of this new corridor, however, must be completed with sensitivity to the University’s present needs for this important roadway. By phasing the construction of this project, several months will be shaved from the anticipated construction schedule, and the closure of Farm Lane Road will be limited to impacting only one Fall academic and football season.
Utility coordination, rail coordination, and coordination with the various stakeholders played a very important role in the design of this project. Project funding challenges led to innovative contracting solutions that also benefited the construction schedule. Construction is currently underway with an interim scheduled bridge completion date of October 2008 and a project completion date scheduled for August 2009. For more information on this project, please visit the following website: http://www.michigan.gov/farmlane

ACKNOWLEDGEMENTS

Thank you to the Consultant design team members from Bergmann Associates, JJR Group, URS Great Lakes, Soil & Materials Engineering, Access Engineering, Woolpert Design, HH Engineering, and Somat Engineering for their efforts on this project.

The many independent reviewers for their comments and professional feedback including George Nowak with CN, Steven Lorek and Dave Krafft with HDR Engineering (representing CSX), and John Gast. The many committee members from Michigan State University who assisted in the design process. And to the MDOT design review staff and administrative staff, especially Mr. Mark Harrison for their support on this project.
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