Lessons Learned Report

I-215; 4500 South Structure Project

PROJECT NUMBER F-I215(126)13

STRUCTURE NO. C-953

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HDR

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Disclaimer

The I-125; 4500 South Structure Project was sponsored by the Utah Department of Transportation (UDOT). HDR documented the information contained within this report and is solely responsible for its accuracy.

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Table of Contents

1.0 Project Background **1**

2.0 Design Challenges **2**

2.1 Geometry *2*

2.2 Superstructure *4*

2.3 Substructure *5*

3.0 Construction Challenges **6**

3.1 Schedule *6*

3.2 Substructure Construction *6*

3.3 Temporary Construction *8*

3.4 Survey *10*

3.5 Existing Bridge Removal *10*

4.0 Lessons Learned **12**

4.1 Contracting Process *12*
Benefits 12
Areas of Improvement 12

4.2 Design *12*
Benefits 12
Areas of Improvement 12

4.3 Construction *13*
Benefits 13
Areas of Improvement 13

4.4 SPMT *14*
Benefits 14
Areas of Improvement 14

4.5 Public Involvement *16*
Benefits 16
Areas of Improvement 16

5.0 Summary **17**

Appendix A Project Photos

Appendix B Plan Drawings, Animation, and Information

List of Figures

Figure 1. **Existing Bridge Elevation**
Figure 2. **Existing Bridge and I-215**
Figure 3. **Geometric Layout**
Figure 4. **Superstructure Layout**
Figure 5. **Superstructure**
Figure 6. **Abutment #2 Foundation**
Figure 7. **Abutment #2 Construction**
Figure 8. **Abutment #1 Construction**
Figure 9. **Temporary Abutment**
Figure 10. **Superstructure on Temporary Abutment**
Figure 11. **Temporary Demolition Site**
Figure 12. **Temporary Demolition Layout**
Figure 13. **Temporary Staging Area**
Figure 14. **Bridge Move Preparation**
Figure 15. **SPMT Set-up**
Figure 16. **SPMT Move**
Figure 17. **SPMT Movement Capability**
Figure 18. **Public Viewing West Area**
Figure 19. **Public Viewing East Area**

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1.0 Project Background

The I-215; 4500 South Structure Project replaced Structure F-156 on SR-266 over I-215 and reduced impacts to the traveling public by using accelerated bridge construction (ABC). The new superstructure was constructed off-site. The new substructure was constructed under the existing bridge. Once the new structure was complete, the existing structure was removed and the new superstructure was moved into its final location. The structure was moved using a self-propelled modular transporter (SPMT) system. The innovative practice of Construction Management General Contractor (CMGC) contracting was also incorporated in this project.

The goals of the proposed improvement project included:

- replacing the structure,
- minimizing environmental and community impacts,
- proving that ABC is a cost-effective solution (even for structures with difficult geometric constraints), and
- making the best use of available funding.

The existing 243.5-foot structure was built in 1971 and was a four span, prestressed concrete girder bridge. The existing bridge deck was approximately 76-feet 10-inches wide with sidewalks. The sufficiency rating for the existing structure was 40.

Figure 1. Existing Bridge Elevation

Figure 2. Existing Bridge and I-215

2.0 Design Challenges

2.1 Geometry

The geometry and layout for this bridge is extremely complicated. The I-215 northbound and southbound roadways have final grade elevations that differ by approximately 5 feet. The I-215 vertical profile is a 4% grade with a 2% cross slope. The 4500 South roadway is on a 12% grade with a varying cross slope. All of these factors created a very challenging project.

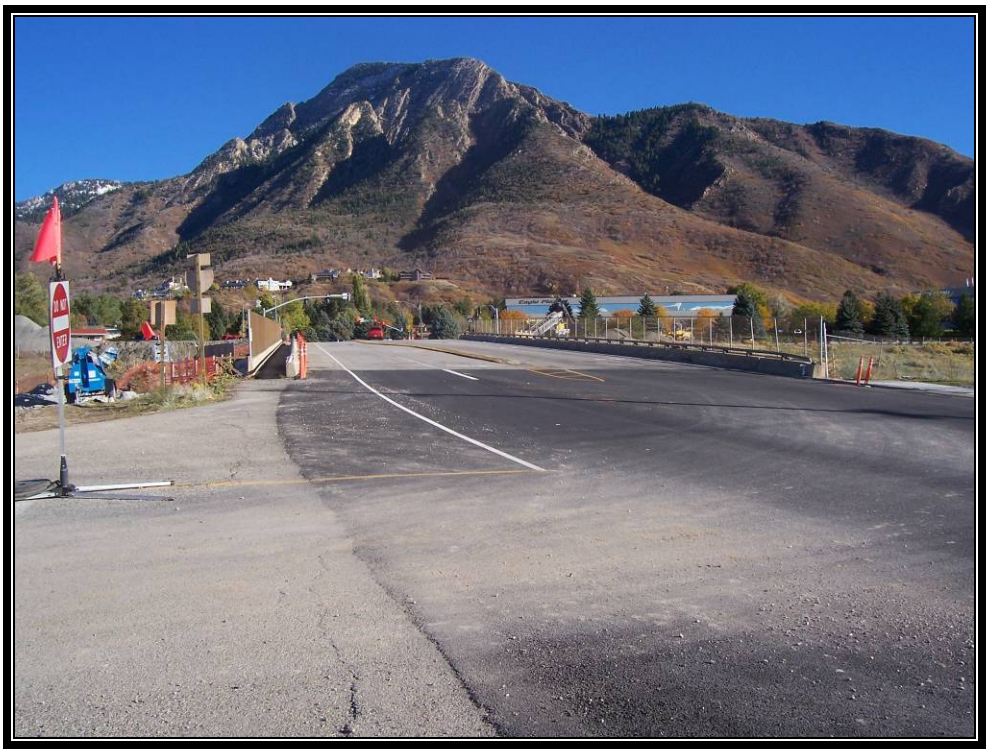

Figure 3. Geometric Layout

The superstructure was built in its temporary location at a 9% grade to allow it to properly fit its final location at a 12% grade. As the bridge moved onto I-215, it rotated longitudinally upward at 3% to a final position of a 12% grade. All vertical components of the superstructure were tilted during construction to accommodate the movement from the temporary location to the final location. Jacks were used to tilt the superstructure transversely at 4% to accommodate the grades on I-215. With all the variables in geometry, the deck elevations were calculated for both the temporary and final bridge locations.

Figure 4. Superstructure Layout

2.2 Superstructure

A single span structure replaced the existing four span structure. Shallow girders were required to meet vertical clearance requirements. Using a single span created a bridge with no joints, a simplified seismic design, and a bridge easier to move. Using a single span also created a very flexible structure during picking and transporting. The deck steel was increased to handle the stresses during the move, and the end diaphragm was designed for maximum tolerances during placement.

Figure 5. Superstructure

2.3 Substructure

The abutment was designed to accommodate the minimal work area under the existing bridge. A spread footing was used to avoid the restrictive and costly use of driving piles. The vertical cuts were secured with soil nail walls to support the existing bridge. Abutment #2 required a 40-foot high wall with a 12% back slope and counter forts.

Figure 6. Abutment #2 Foundation

3.0 Construction Challenges

The project was extemely labor intensive and required significant overtime on the part of the contractor.

3.1 Schedule

Schedule challenges included:

- Designing and constructing the bridge in eight months.
- Removing and replacing the bridge in 58 hours.

The design evolved weekly creating a very dynamic project. Hour-by-hour schedules were developed with a crew-by-crew assignment sheet.

3.2 Substructure Construction

Substructure construction challenges included:

- Retaining the existing abutments.
- Excavating and constructing the new abutments in a confined work area and beneath the existing bridge.

Maintaining continuous traffic on 4500 South and on I-215 created a complicated substructure construction. Extensive height and width restrictions existed. Holes were created in the existing deck to pour the new foundation walls. The new girder seats actually touched the bottom of the existing girders.

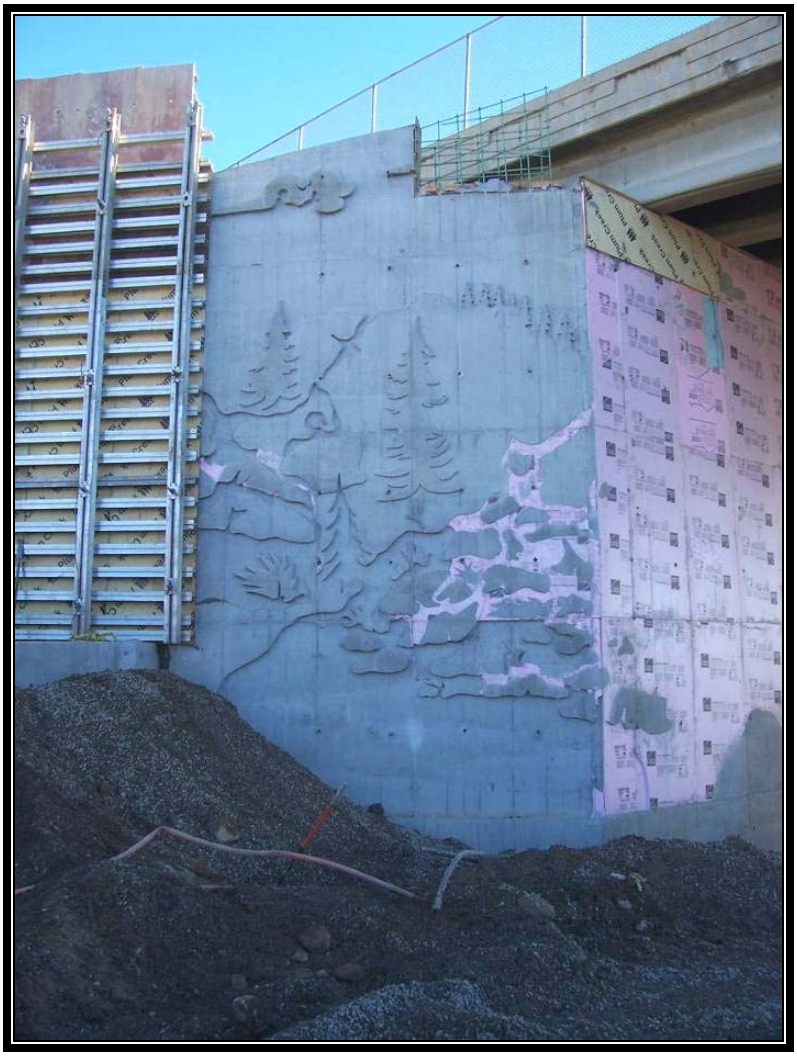

Figure 7. Abutment #2 Construction

Figure 8. Abutment #1 Construction

3.3 Temporary Construction

Temporary construction challenges included:

- Designing and constructing the temporary abutments for the new superstructure.
- Designing and constructing the new superstructure.
- Building the existing bridge demolition site.

The design of the temporary construction elements needed to be quick and cost-effective. The designer worked closely with contractor on the materials readily available to determine the most efficient design for temporary works.

Figure 9. Temporary Abutment

Figure 10. Superstructure on Temporary Abutment

3.4 Survey

Survey challenges included:

- Constructing the bridge in different locations at different grades.
- Checking elevations multiple times for assurance.
- Obtaining two independent surveyors.

Due to the extremely complicated geometry, elevations were checked multiple times using several methods to ensure the final fit of the bridge.

3.5 Existing Bridge Removal

Existing bridge removal challenges included:

- Building temporary supports to accommodate demolition.
- Knowing the condition of the existing bridge.

Rail shipping containers were used as supports for the existing bridge at the demolition site, creating a very cost-effective solution. A portion of the existing bridge from the joint to the lifting location was demolished prior to moving the existing bridge due to the unknown condition of the deck.

Figure 11. Temporary Demolition Site

Figure 12. Temporary Demolition Layout

4.0 Lessons Learned

4.1 Contracting Process

The Construction Manager/General Contractor (CMGC) contracting method was used for this project.

Benefits

Benefits of the CMGC contracting process included:

- Early contractor involvement in the project.
- Constant input and coordination on schedule and cost.
- Design focuses on contractor strengths.
- All the answers are not required upfront but can be developed throughout the project.
- Ability to coordinate with the contractor's subcontractors upfront.
- Ability to coordinate with utility companies early in the project.
- Flexibility to provide early action items and early release packages (structural steel procurement and temporary site construction).
- Delivery of project within a tight schedule.

Areas of Improvement

Areas of Improvement include:

- Provide more design time to investigate alternatives, optimize design, and improve constructibility.
- Define clearly the roles and responsibilities of the team regarding the design engineer and the construction engineer.
- Determine a method for improving construction cost estimates early in the design process since the cost of the project is determined as the design progresses.
- Set up the UDOT PDBS system to handle CMGC projects more effectively or provide a different process for CMGC projects.

4.2 Design

Benefits

Benefits of the design process included:

- Designer and contractor working together as one team.
- Ability to visit the site constantly to ensure design requirements are met and design schedule is maintained.
- Early communication and coordination between the designer, contractor, and mover.

Areas of Improvement

Areas of Improvement include:

- Know the design direction for the project upfront with owner defined goals.
- Plan upfront for more design associated with temporary works.
- Obtain the contractor and subcontractors earlier in the process.

Figure 13. Temporary Staging Area

4.3 Construction

Benefits

Benefits of the construction process included:

- Designer and contractor working together as one team.
- Ability to have a contingency plan in place due to unforeseen complications.
- Ability to have multiple pre-event meetings with the entire team to examine every step.

Areas of Improvement

Areas of Improvement include:

- Limit the number of non-project personnel on the job site to limit exposure, risk and liability from the contractor.
- Coordinate more effectively between owner and contractor regarding site access.
- Develop a protocol for site visitation for all individuals.
- Schedule tour times if necessary.
- Investigate cheaper alternatives for temporary work.
- Schedule adequate time for curing requirements of concrete work.
- Plan for adequate space at the staging area for the significant amount of SPMT equipment delivered to the site.
- Develop a checklist for items to evaluate during construction.
- Provide a more detailed plan for the remaining tasks after the bridge move (grading plans, landscaping, staging area, and non-structural items).

Figure 14. Bridge Move Preparation

4.4 SPMT

Benefits

Benefits of the SPMT process included:

- Designer, contractor, and specialty contractor working together as one team.
- UDOT gained experience with the use of SPMTs.
- Ability to construct the new bridge and minimize traffic disruptions.

Areas of Improvement

Areas of Improvement include:

- Provide additional contingency in the conceptual cost estimate when a new technology is being implemented.
- Write specifications to promote accelerated bridge construction and the use of SPMTs.

Figure 15. SPMT Set-up

Figure 16. SPMT Move

Figure 17. SPMT Movement Capability

4.5 Public Involvement

Benefits

Benefits of the public involvement process included:

- Printed information available to the public early in the project.
- Media and public informed throughout the project.

Areas of Improvement

Areas of Improvement include:

- Define clear expectations for the project and the timeline of the bridge move more clearly to the public.
- Provide more information in the public viewing area during the bridge move.
- Provide restroom facilities for all public viewers.

Figure 18. Public Viewing West Area

Figure 19. Public Viewing East Area

5.0 Summary

The project construction cost was approximately $7 million without professional engineer, construction engineer, and utility relocation costs. The department saved over $4 million in user delay costs by using accelerated bridge construction techniques. Overall this project was a huge success for UDOT.