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**Date**        **September 14, 2009**

**To**           Trent Prall / Jim Shanks

**From**        Jeff Mehle

**Subject**      29 Road and I-70B Life Cycle Cost Evaluation

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This memorandum documents the process and evaluation for the structure type selection, including consideration of the life cycle cost, for the 29 Road and I-70B bridge structures.

### **Project Description**

The proposed 29 Road and I-70B Interchange is intended to provide a safe and efficient transportation connection along 29 Road between D Road and North Avenue, including a new interchange with I-70B and a grade-separated crossing of the Union Pacific Railroad (UPRR). The new bridge structure design is centered on the existing 29 Road alignment to carry 29 Road over the UPRR tracks and I-70B. A second bridge structure is proposed to provide ramp access from I-70B to 29 Road.

### **Structure Type Selection Report**

A Structure Type Selection Report and Preliminary Design submittal, dated July 2006, was prepared for the City of Grand Junction. This report summarizes the preliminary design, evaluation and recommended structure type selection for the proposed bridge structures for the 29 Road and I-70B interchange.

### **Structure Types**

Multiple structure types were considered and evaluated for the interchange structure. The structure is broken into four separate units, separated by expansion joints. Since each unit has different span lengths, widths and constraints, each structure unit was evaluated independently and as a whole for the project. Structure alternatives evaluated include the following:

- Prestressed concrete girders (multiple girder depths)
- Spliced prestressed concrete girders (where applicable)
- Steel girders (multiple girder depths)
- Cast-in-place concrete box girders (multiple structure depths, variable widths)

### **Evaluation Criteria**

The proposed alternatives vary in structure cost, method of construction, and future maintenance. Each structure type was evaluated based on the following criteria:

- Economy
- Constructability
- UPRR Constraints / Requirements

The economy of the bridge includes the construction cost as well as future maintenance costs for the structure types to evaluate the life cycle cost of the structure.

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A summary of the structure cost from the July 2006 Structure Type Selection Report for the South unit of the 29 Road Bridge over the UPRR is provided on the following page for reference. These costs are based on the conceptual design and unit costs from 2006.

## South Unit Structure Type Cost Analysis (Three-span crossing of UPRR tracks)

Structure Type	Cost	Cost Sq Ft	Advantages	Disadvantages
BT72	\$5,220,000	\$106	Shallow depth-to-span ratio, efficient and conventional construction.	Span requires close girder spacing, (16 girder lines) adding to the structure cost.
BT84	\$4,890,000	\$99	Girder has more capacity, wider spacing than BT72s, requiring fewer girders (12 girder lines); less expensive.	Deeper section impacts clearance and results in heavier girders for erection.
Spliced	\$5,030,000	\$102	Use BT72 girders made continuous on-site with PT requires fewer girder lines, (10) and efficient structure type.	Requires installation and stressing of post-tensioning on-site.
Steel Girder	\$5,260,000	\$106	Shallower depth, wider spacing, efficient and conventional construction.	Previous volatile steel prices, has driven structure cost up, future maintenance with painting.
CIP Box Girder	\$5,400,000	\$109	Shallow 6' structure depth. Can accommodate variable structure width and longer spans.	Requires falsework over UPRR tracks. More expensive.

The Center, North and Ramp A units have comparable unit costs.

## Future Maintenance Cost

The maintenance costs for the four alternatives are calculated based on a 75-year service life. The following assumptions are assumed in evaluating the maintenance and life cycle costs for the steel alternatives:

- Painting exposed structural steel: Required in years 20, 40, and 60
- Deck wearing surface overlay: Replace at 5 to 10 year intervals
- Replacing bearings: Required at years 40
- Replacing expansion joints: Required at years 15, 30, 45 and 60

The following assumptions are assumed in evaluating the maintenance and life cycle costs for the concrete alternatives:

- Deck wearing surface overlay: Replace at 5 to 10 year intervals
- Replacing bearings: Required at years 40.
- Replacing expansion joints: Required at years 15, 30, 45 and 60

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The anticipated future maintenance and resulting life cycle cost are consistent for each of the four structure types evaluated, with the exception of the painting of the structural steel associated with the steel girder alternative. Not only is this an additional expense, but a significant maintenance cost over the active UPRR tracks and I-70B. The steel girder structure alternate was not selected for this project based on the initial construction cost as well as the future maintenance and resulting life cycle cost.

## Type Selection

The evaluation of total cost (initial and future) indicated that prestressed girders are the most economic structure type for this project. The use of spliced prestressed girders for longer spans over the UPRR tracks offer additional savings in structure depth that reduced the associated costs of retaining walls, fill and substructure cost. The recommended structure type for the 29 Road and I-70B Interchange is prestressed girders for the Center, North and Ramp A units and spliced prestressed girders for the South Unit. Reference to the July 2006 Structure Type Selection Report is recommended for additional information regarding the evaluation and selection.

## Design Details for Life Cycle Cost

The design of the 29 Road and I-70B bridge structures includes additional details that are intended to reduce future maintenance and life cycle cost. These details include the following:

- The bridge structure was divided into four separate units (South, Center, North and Ramp A) to control the bridge movement and wear on expansion joints. Other configurations would have resulted in expansion joints being subjected to longitudinal and lateral movements, (twisting) resulting in premature wear and replacement of the joints. The division of the bridge into four units results in additional expansion joints and initial construction cost, but will reduce future maintenance and reduces the life cycle cost for the structure. The unit layout was driven by reducing the expansion joint wear and future replacement.
- The use of high-strength concrete ( $f_c' = 8,500$  psi) with prestressing and post-tensioning provides a very durable construction material that will meet or exceed the anticipate 75-year life for the structure. Prestressed, high-strength concrete is less susceptible to cracking and possible corrosion due to exposure to moisture. By keeping the concrete in compression, the structural elements will have a longer service life with less maintenance.

## Summary

The structure type selection and final design details for the 29 Road and I-70B Interchange Bridge addresses the initial construction cost as well as the future maintenance and life cycle cost for the project. For additional information regarding the review, evaluation and design, please reference the Structure Type Selection Report and Preliminary Submittal dated July 2006 and FOR or Final Design Plans for the 29 Road and I-70B.

Should you have any questions or would like to discuss this in more detail, do not hesitate in contacting me.