U.S. Department of Transportation
Federal Highway Administration

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November 10, 2009

In Reply Refer To:
HBR-OR
File Code: S003(011)

Mr. Jason Tell
Region 1 Manager
Oregon Department of Transportation
123 NW Flanders St
Portland, OR 97209-4012

Dear Mr. Tell:

Enclosed for your further action are the results of the joint ODOT/FHWA review of the Oregon City Arch Bridge Project (OR43: Willamette River Bridge - Oregon City). The report contains several recommendations that we hope will be beneficial when incorporated into this project.

The Oregon City Arch Bridge has proven to be an extremely complex bridge rehabilitation project due to the unique design of the structure and site constraints. We recognize the high degree of effort that ODOT has put into the development of the project plans and specifications to date.

Please extend our gratitude to the ODOT staff who participated in this review. Their contributions to the review were significant.

If you have any questions or comments regarding the review documentation or require further clarification please contact me at (503) 587-4712 or Timothy Rogers at (503) 587-4706 or timothy.rogers@dot.gov.

Sincerely,

Phillip A. Ditzler
Division Administrator

Enclosure: Oregon City Arch Rehabilitation Project Review Report

cc:
FHWA (Benjamin Beerman, Resource Center, Structural Engineer)
(Claude Napier, Resource Center, Structural Engineer)
ODOT (Christopher Leedham, Technical Services, Structural Engineer)
(Wayne Statler, Region 1, Project Mgr)
(Timothy Smith, Region 1, Asst Project Mgr)

TR/rm

U.S. Department of Transportation

Federal Highway Administration

Project Review

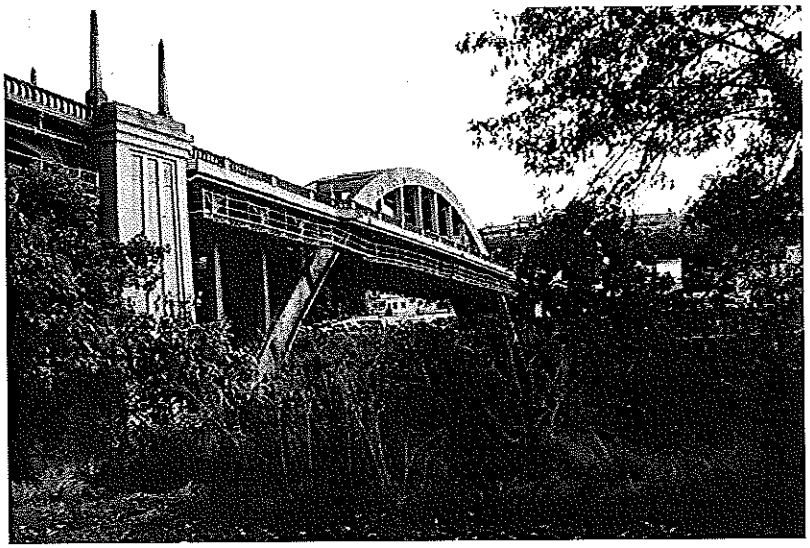
FHWA Oregon Division Office

FHWA Resource Center

Oregon Department of Transportation

Oregon City Arch Rehabilitation (OR43: Willamette River Bridge - Oregon City)

October 22-23, 2009



FINAL REPORT

U.S. Department of Transportation
Federal Highway Administration

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Executive Summary

At the invitation of the Oregon Department of Transportation's (ODOT) Management, members of the Federal Highway Administration's (FHWA) Resource Center, the FHWA Oregon Division Office and ODOT conducted a technical review of the Oregon City Arch Rehabilitation Project (OR43: Willamette River Bridge - Oregon City).

The review team was tasked to evaluate and provide comments on the following items:
Item 1: Have rehabilitation projects, similar in bridge type and scope to this project, occurred in the United States and if so how were they performed?
Item 2: Are there alternate contracting methods which ODOT can employ on this project for the purpose of minimizing the traffic and pedestrian closure periods?
Item 3: Are there alternate construction methods which ODOT can consider on this project for the purpose of minimizing traffic and pedestrian closure periods?

The team conducted the review on October 23-24, 2009. The scope of the review included an inspection of the available project documentation, a site visit, and interviews with the ODOT and consultant project team members.

A summary of the review team's observations and recommendations are as follows:

Observation 1: The review team was unable to identify a bridge rehabilitation project which is similar in bridge type and scope to the Oregon City Arch project.
Recommendation 2: The team recommends that ODOT should continue to make the safety of the public and construction workers the highest priority in development of this project.
Recommendation 3: The team recommends that the ODOT investigate the viability of the attached "above deck work" construction sequence recognizing that this concept is preliminary in nature.
Recommendation 4: The team recommends that ODOT further refine or include additional elements to the proposed A+C+D contracting method so as to promote contractor innovation which specifically addresses lane closures.
Recommendation 5: The team recommends that ODOT take steps to minimize the risks associated with the "unknowns" by performing additional forensic investigations and/or developing detailed mitigation strategies for worse case scenarios that may be encountered during construction.
Recommendation 6: The team recommends that ODOT perform a structural analysis for both traffic and construction loads and rehabilitation sequencing to assure the integrity of the structure will not be compromised during

construction and the degree to which the structure will be able to accommodate legal loads upon completion of the project.

Recommendation 7: The team recommends that ODOT investigate the full removal of the two 35' bays (slab and stringers) between P12/P13 and P4/P3, and use link slabs in lieu of the Asphalt plugs.

Recommendation 8: The team recommends that ODOT review the attached PS&E comments generated by the team and incorporate them into the PS&E package as appropriate.

Background

This review focused on the proposed rehabilitation of the Oregon City Arch Bridge (OR43: Willamette River [Oregon City] Bridge No. 00357). The bridge is located on Oregon Highway 43 and crosses the Willamette River between Oregon City on the south, and West Linn on the north, in northwest Clackamas County.

The Oregon City Arch Bridge was constructed in 1922 and is showing signs of aging. Although routine maintenance of the bridge has been provided, over the years components of the bridge have been deteriorating. The structure is inspected by the Oregon Department of Transportation (ODOT) bridge maintenance crews every 2 years. During these inspections various bridge components are assessed. Recent inspections have found that the existing bridge deck, bridge rails, and deck joints are in poor condition. The bridge deck is the main roadway of the bridge, and the deck joints help protect the concrete from vehicle loads, and they accommodate expansion, contraction, and concrete shrinkage of the deck. Bridge rails provide barriers along the side of the bridge and separate vehicles from the roadway and the Willamette River below.

The proposed project is for rehabilitation activities including repair and improvements to the bridge deck, bridge rails, and deck joints. The structure would be cleaned, the sprayed-on concrete (gunite) exterior would be removed and repaired, the deck would be restored, existing sidewalks and rails would be removed and replaced, and illumination would be repaired and replaced. Approximately 1,600 square feet of pavement would be reconstructed on the Oregon City side of the bridge to repair the existing ramp approach to the bridge.

The proposed rehabilitation project requires a 2 year closure of the bridge would prohibit direct access to Oregon City via Highway 43 and the Oregon City Arch Bridge. Although the direct route across the bridge would not be available during this time, access to Oregon City and the downtown area would be provided via a detour route to I-205 Abernethy Bridge, approximately 1 mile north of the Oregon City Arch Bridge. The detour would add approximately 1.1 miles from the Oregon City Arch bridge, across I-

205, and back to Highway 43. This would add approximately fifteen minutes to trips during peak travel times.

Purpose and Objective

The purpose of this review is to provide the Oregon City Arch project team with a national prospective of the proposed bridge rehabilitation strategy. In particular the team focused on the traffic and pedestrian lane closures during the life of the project.

The objectives of the review were to address the following:

- Have rehabilitation projects, similar in bridge type and scope to this project, occurred in the United States and if so how were they performed?
- Are there alternate contracting methods which ODOT can employ on this project for the purpose of minimizing the traffic and pedestrian closure periods?
- Are there alternate construction methods which ODOT can consider on this project for the purpose of minimizing traffic and pedestrian closure periods?

Scope and Methodology

The scope of the review included a review of the environmental permitting, engineering, and construction activities associated with the Oregon City Arch Bridge project. The methodology used to develop the recommendations included in this report included an on-site visit, a review of the available project documents, and interviews with the design, project development, and construction staff involved with the project.

The project documents included:

- NEPA Documentation (Reevaluation of the Categorical Exclusion Determination
- As-built Drawings
- Roadway and Bridge Plans
- Contract Special Provisions
- Constructability Review Documents
- Incentives/Disincentives Documents
- Construction Sequencing and Scheduling Documents
- Bridge Inspection Documents
- Bridge Load Rating Documents

Interviews were conducted with the following personnel:

Mary Young	ODOT Region 1	Env. Coordinator
John Kalvelage	OBEC Consultants	Proj. Mgr
Dave Place	Consultant	Constr. Engr.
Christopher Leedham	ODOT Technical Services	Structural Engineer

Timothy Smith	ODOT Region 1	Asst Project Mgr
Wayne Statler	ODOT Region 1	Project Mgr

Team Members

Timothy Rogers	FHWA Oregon Division	Bridge Engineer
Benjamin Beerman	FHWA Resource Center	Structural Engineer
Claude Napier	FHWA Resource Center	Structural Engineer
Christopher Leedham	ODOT Technical Services	Structural Engineer
Timothy Smith	ODOT Region 1	Asst Project Mgr
Wayne Statler	ODOT Region 1	Project Mgr

Observations and Recommendations

Observation #1:
The review team was unable to identify a bridge rehabilitation project which is similar in bridge type and scope to the Oregon City Arch project. A search of the National Bridge Inventory data was performed. The search revealed a population of 195 steel through arch bridges. However, there is no national inventory item to designate the type of protective system used on the structural steel of the bridges, and especially with regards to a bridge encased in gunite. Sixty-seven of the bridges in the inventory have been reconstructed since they were built. Typically, the corrosion protection system of choice in the past for steel bridges was a paint system. The gunite used on the Oregon City Arch Bridge is a very unusual and innovative system for its time that has provided a corrosion protection service life (1922 to 2009) that far exceeds the 20 to 25 years of service life for the different typical paint systems.
Recommendation #1:
None

Observation #2:
The team identified this project as "high risk" with regards to safety of both the construction workers and the travelling public. The significant safety issues identified include: limited access to the worksite, significant fall heights, and the occurrence of multiple work operations within a limited work area.
Recommendation #2:
The team recommends that ODOT should continue to make the safety of the public and construction workers the highest priority in development of this project. This would be especially relevant if the use of extended work shifts or night time work is explored as a means minimizing the traffic and pedestrian closure periods.

Observation #3:
The ODOT project team has prepared a thorough and well documented analysis of a vertical construction method which assures that the project is constructible, allows for high quality construction, accommodates for the uncertainties in the scope of the project, promotes a competitive bidding environment, provides for a safe work site, and has a reasonable construction duration.
Recommendation #3:
The team recommends that the ODOT investigate the viability of the attached "above deck work" construction sequence. This scheme is focused on performing a majority of the "above" deck work during the first season with intermittent bridge closures in the second season. While the team considers this scenario to be preliminary in nature, it does have the potential to reduce the length of the bridge closure by several months.

Observation #4:
ODOT has developed the construction duration based on construction practices that are likely to occur on this project and a 6 day – 10 hour shift. The possibility exists that a properly motivated contractor could present a more innovative means of constructing a high quality project while minimizing the lane closures. ODOT is proposing to include a provision for contractor innovation through the use of A+C+D contracting.
Recommendation #4:
The team recommends that ODOT further refine or include additional elements to the proposed A+C+D contracting method so as to promote contractor innovation which specifically addresses lane closures. While the proposed A+C+D scoring criteria does give credit for contractor innovation the team feels that further enhancements to the "D" component or "contractor's approach" could increase the likelihood of receiving innovative bid proposals. Enhancement to the "D" component may include provisions such as; contractor proposed lane closure duration(s), contractor proposed of interim completion dates and associated Incentives/Disincentives, use of partnering agreements, use of multiple or extended construction shifts, or a combination of these items. Additionally, the scoring points assigned to the "contractor innovation" elements should be weighted so their contribution to the total score is effective.

Observation #5:
ODOT has performed on site investigations to determine the extent of the structural repairs necessary to remove the existing structural deficiencies. The project team recognizes that the extent of the rehabilitation required in several key structural elements are unknown at this time. The lack of access to these areas or time needed to perform the investigations has hindered ODOT's ability to positively identify the extent of the needed repair. ODOT has accounted for these "unknown" conditions by including an additional 3 months in the contract duration. The "unknowns" do pose a risk of extending the contract beyond the duration that is currently calculated including the 3 month "unknown" condition allowance.
Recommendation #5:

The team recommends that ODOT take steps to minimize the risks associated with the "unknowns" by performing additional forensic investigations and/or developing detailed mitigation strategies for worse case scenarios that may be encountered during construction. If unknown investigations are included as part of the contract, then the investigations should be addressed at the beginning of the project within specified constraints and appropriate work packages included in the schedule.

Observation #6:
The load rating for the bridge has not been completed nor has an analysis been performed on the structure to verify that the construction sequencing that was used to develop the schedule is structurally feasible.
Recommendation #6:
The team recommends that ODOT perform a structural analysis for both traffic and construction loads and rehabilitation sequencing to assure the integrity of the structure will not be compromised during construction and the degree to which the structure will be able to accommodate legal loads upon completion of the project. Additionally, the information generated through this analysis should be assessed to determine if there is information that would be helpful to a contractor in the preparation of a bid.

Observation #7:
The current rehabilitation scheme includes partial removal of the deck at Piers 12 and 13. The extent of the repairs in this area includes; strengthening of stringer ends, repair of bearing and replacement of joints with asphaltic plugs.
Recommendation #7:
The team recommends that ODOT investigate the full removal of the two 35' bays (slab and stringers) between P12/P13 and P4/P3, and use link slabs in lieu of the Asphalt plugs. This is one of the high risk areas – it is suggested not to "micro the work" in this area. Also, removing the bay will provide access for the underside of the deck for floorbeam repairs and make the bearing replacement easier. Link slabs will keep the areas from future leakage better than the asphalt plugs. Precast panels forms could be considered for ease of construction. Asphalt plugs at P0 and P17 seem to be okay (in lieu of link slabs) because they are away from the arch and some thermal relief is needed.

Observation #8:
The Oregon City Arch is a complicated rehabilitation project to restore a historic steel arch bridge. The State and their consultant are complimented on their rehabilitation efforts. The plans are very extensive and adequately cover all aspect of the restoration except for the three high risk areas discussed during the review. Additionally the review team performed a review of the PS&E package and provided comments.
Recommendation #8:
The team recommends that ODOT review the attached PS&E comments generated by the team and incorporate them into the PS&E package as appropriate.

Attachments

- Attachment 1: Above Deck Work" Construction Sequence
- Attachment 2: PS&E Comments

FHWA/ODOT Review Team PS&E Comments for the Oregon City Arch Rehabilitation Project (OR43: Willamette River Bridge - Oregon City)

The Oregon City Arch is a complicated rehabilitation project to restore a historic steel arch bridge. The State and their consultant are complimented on their rehabilitation efforts. The plans are very extensive and adequately cover all aspect of the restoration except for the three high risk areas discussed during the review.

Major Comment:

Three high risk areas were identified during field review and recommendations included in the bridge review report. The high risk areas for potential unknown deterioration were:

1. Arch ribs passing through the deck at P3-P4 and P12-P13
2. Arch ribs connections to Pier 1 (Oregon City Side) and Pier 2 (West Linn Side)
3. Spandrel Column connections to arch ribs at P1, P2, P14, P15, & P16.

The plans Detail Reference 29 (Dwgs 81814 & 81815) address the repair of column connections to arch ribs by indicating "After shotcrete/concrete removal and cleaning the Engineer will inspect the existing steel to determine the extent of steel repairs." Detail references and a similar note should be added to the plans for the arch ribs passing through the deck and the arch rib connections to Piers 1 and 2 for the engineer to inspect and determine the extent of steel repairs to the arch ribs. In addition a special provision should be written to address the high risk locations and require that the Contractor remove the shotcrete at these locations at the beginning of construction for the engineer's inspection if not done by NDE or destructive methods before advertisement and require that these items be included in the project schedule. Estimated detail requirements and times for review, development of details, shop drawings, fabrication, and installation should be included in the special provision. The Contractor should be required to include these items in his project schedule at the beginning of the project.

General Comments:

1. Since there are details requiring field welding to the existing structural steel, the weldability of the existing steel should be determined.
2. There is no mention of using self consolidating concrete (SCC), however the benefits of the attributes of high performance SCC particularly its flowability should be considered for casting the arch bottom slab replacement (Item 98,

Dwg 8171). In addition, for concrete spalls or delaminated areas, flush repair surfaces can be done easily using SCC.

Plan Comments:

1. Plan and Elevation (Drawing 81811): Item 97 should be shown on the Elevation View at P5 and P11 .
2. Item 5, Repair concrete cracks and spalls, Drawing 81858: Recommend consider making 1" depth saw cut and then requiring that the remaining depth be sloped back into sound concrete at 15 to 20 degree angle to create concrete lock of repair section in the existing concrete to prevent shrinkage popouts particularly for any reinforced repair areas. Type K Cement (Expansive Concrete) is recommended to be used to minimize drying shrinkage of concrete repair and opening of cold joint interface.
3. Item 6, Repair Bearings, and Item 9, Replace Rocker Bearings: What is the tolerance to be allowed in jacking of bridge members to replace bearings? This is not noted in Section 00511 – Shoring of Structures. For Item 6, it is indicated that bearings to be jacked 3/16" to ¼". Based on the way the note is written, it appears that individual jacking of stringers is allowed and simultaneous jacking of stringers is not required.
4. Drawing 81813: Recommend title be changed to Temporary Work Access & Containment Plan.
5. Drawing 81819: Add note: "See Drawing 81866 for Section details."
6. Drawing 81833: Add note: "See Drawing 81832 for location of Section BL-BL." (This may be a detailing practice of not referring back to where sections are taken from.) Section BL-BL: Change reference "New cricket, see Drawing 81871" to "New cricket, see Drawings 81871 and 81873"
7. Drawing 81858: Galvanic Anodes are to be used on any existing steel-concrete materials and bare steel to receive shotcrete (SP Section 00542) Was there consideration on using it on the General Concrete Repairs for corrosion protection?
8. Drawing 81866: Add note: "See Drawing 81819 for location of Sections."
9. Drawing 81867: Consideration should be given to replacing at least half or more of the asphaltic plug joint seals with ductile link slabs to minimize future maintenance of asphaltic plug joint seals. Engineered cementitioujs composites (ECC) for link slabs were developed at Victor Li at University of Michigan. Dr. Celik Ozyildirim at the Virginia Transportation Research Center has also done laboratory tests on high-performance fiber-reinforced composites for link slabs to improve on Virginia's link slabs to replaced joints on simple span bridges. Virginia has used the Utah detail for eliminating joints on bridges on over a hundred bridges. Refer to VTRC website for report on High Performance Fiber-Reinforced Cementitious Composites for Crack Control. http://vtrc.virginiadot.org/PubDetails.aspx?PubNo=08-R12. This study evaluated high-performance fiber-reinforced cementitious composites (HPFRCC), which

are mortar mixtures with synthetic and steel fibers. The feasibility of using HPFRCC technology for transportation applications by the Virginia Department of Transportation, such as link-slabs that can replace joints on decks and in thin overlays for reduced permeability, was explored. HPFRCC has high ductility, is tough, and can exhibit strain-hardening that leads to multiple microcracks at large deformations. Such tight cracks prevent the transport of aggressive solutions and improve durability.

10. Drawing 81870, Anode Installation Notes: Change the reference specifications to install anodes in accordance with "Specification Section 00543.15" to "Specification Section 00542.40"
11. Drawing 81871, Arch Bottom Slab Replacement Details, Drain Detail: Add the designation of "New Cricket" to the chamfer detail since this sheet is referred to for the New Cricket Details.
12. During the site visit, Chris Leedham indicated that the deck drains were going to be extended so that there is no runoff spraying on the bridge beams. No details for deck drain pipe extensions were found on the plans. It is recommended that details be added to extend the deck drain pipes or deck drain holes to below the beams.

Special Provision Comments:

1. Page 12, Section 00220, Subsection 00220.02, 7th bullet: There is a requirement to provide a 5 feet minimum wide temporary pathway with surface meeting the requirements of the Americans Disabilities Act (ADA). Based on review discussions, there are not plans to provide pedestrians and bicyclists access on the bridge after the bridge is closed to traffic for construction. Is this subsection needed in the special provision?
2. Page 15, Subsection 00220.40(f), Limited Duration Road Closure: Not to exceed 20 minutes in duration during erecting and removing temporary bridge girders over the travel lanes. This work is only be permitted between the hours of 11:00 p.m. and 5:00 a.m., Monday through Sunday. Will this require a noise variance since it is outside the 7:00 a.m. to 10:00 p.m. allowed period?
3. Page 19, Section 00254 – Temporary Work Access, Subsection 00254.40, paragraph (b) Contractor-Designed, bullet on proposed construction equipment loads. It is recommended the requirements be modified to adequately address construction sequencing when bridge elements are being rehabilitated for applied construction equipment and material loads.
4. Page 63, Section 00501 – Bridge Removal. Provides a list of items to be removed except for shotcrete which is covered in Section 00543 and the bottom slab of the arch chamber which does not appear to be covered elsewhere. It is recommended that the removal of the bottom slab of the arch chamber be added to the list.
5. Page 64, Section 00501.80: Change "arch cambers" to "arch chambers"

6. Page 66, Section 00511.41a: Recommend revise the wording of "removing existing support of the member undergoing repair or reconstruction" to "removing existing **portion** of the member undergoing repair or reconstruction". Recommend that the phase "where required" be added to the end of the statement "Install shoring under the arch ribs prior to placing construction loads."
7. Page 72, no estimated quantity length is provided for "inject and seal cracks." The estimate has 260 LF.
8. Page 76, Section 00542.10, Galvanic Protection Devices: Only one source is provided and I am not aware of others even though there may be other sources. To use the galvanic protection devices is a good corrosion protection strategy. In order to use a public interest finding should be done or classify as an experimental feature and monitor the installation as an experimental feature project.
9. Page 90, Section 00543.44(a), 5th line: Correct the spelling of "wash water" which is shown as "Use a rust inhibitor in was water."
10. Page 102, Section 00557.04, 3rd bullet: Delete "listed in (2) after production lot numbers since there is no (2) to refer to. There is only the second bullet which refers to the requirement of production lot numbers.
11. Page 126, Section 00593 and subsections referring to polyester topcoat requirements. It is not clear where the polyester topcoat will be applied unless Section 00594.90(b) identifies the specific bridge elements where overcoating will be used.
12. Page 132, Section 00594.90(b) for Pay Item (c) through (g) should have a blank for adding bridge elements where the different surface preparation, coating applications, and coating materials should be used. The estimate is showing bridge members or locations, but is not clear if for full coating replacement or spot repair and overcoating.

Project Estimate Reviewed (Identified as preliminary rough cost estimate)

General Comment: It was very difficult to follow the estimate since quantities were some times included on the plans, or in the special provisions, or no determined source. The estimate needs a good scrubbing with the special provisions and plans to ensure that all pay items are appropriately addressed. There are some specification sections noted on the estimate that do not agree with the special provision sections.

1. Removal of Approach Slab included under both Group 0300 (Roadwork) and Group 0500 (Bridges)
2. Line 0350, Bridge Removal Work: Change Unit from SQFT to LS.
3. Lines 0370 Remove Damaged Shotcrete at Steel Repair), 0380 (Remove Shotcrete from Arch Ribs, below Deck) and 0390 (Remove shotcrete from ribs, above deck) refer to Section 0501 and should be Section 0543 of SP.
4. Line 0420 Reinforcement: Has unit of LB and SP section indicates LS.

5. Line 0440 Deck Concrete Class HPC4000: Has quantity of 8 cuyd. and SP has 18 cuyd.
6. Line 0450 General Structural Concrete, Class 3300: Has quantity of 163 cuyd and SP has 114 cuyd.
7. Line 0505 Retaining Wall, Gabion Concrete Repair. Did not find requirement on plans or SP.
8. Line 0560 (Construct PPC Overlay) and Line 0570 (Furnish polyster polymer concrete) refer to Section 0540 and should be Section 0557.
9. Line 0585 (Retaining Wall, Concrete Sealer) and Line 0590 (Retaining Wall, Concrete Sealer Cement-Based) should be SP Section 0546.
10. Line 0590 (Class 2 Preparation) should be SP Section 0557.
11. Line 0640 (Replace Curb Bumpers): Delete since included in Line 0707 (Replace Curb Bumpers)
12. Line 0705 (Replace Sheer Strakes), Delete "1/2 inch electrical conduit" and replace with "Recycled Plastic Lumber for Structures" in SP Section 0575.
13. Line 0707 (Replace Curb Bumpers): Correct SP Section to Section 0575.
14. Lines 0710 & 0720. Bearing Devices ___ description does not agree with SP description of "Repair Bearing Devices,____."
15. Lines 0740, o750, 0760, 0770. 0780, 0790 (Seismic restraint____) should refer to SP Section 0588 and have unit of EA instead of referring to Section 0582 and having unit of LS.
16. Lines 0800 and 0810 should refer to Sec 0582 Bridge Bearings instead of Miscellaneous.
17. Lines 0960, 0970, 0980, 0990, 1000, 1010, 1020, 1030, 1040, 1050 should have descriptions reworded to agree with SP Section 0594 so that it is clear when Surface Preparation is for full coating replacement or spot repair and overcoating and coating application is for full coating replacement or spot repair and overcoating.