

**CONTRACT CHANGE ORDER MEMORANDUM**

TO: Tony Anziano, Program Manager /		FILE: E.A. 04 - 0120F4	
FROM: Darryl Schram, Senior TE		CO-RTE-PM SF-80-13.2/13.9	
CCO#: 312		FED. NO. No	
SUPPLEMENT#: 0	Category Code: CHPT	CONTINGENCY BALANCE (incl. this change) <b>\$46,769,394.62</b>	
COST: \$200,000.00	INCREASE <input checked="" type="checkbox"/> DECREASE <input type="checkbox"/>	HEADQUARTERS APPROVAL REQUIRED? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	
SUPPLEMENTAL FUNDS PROVIDED: \$0.00		IS THIS REQUEST IN ACCORDANCE WITH ENVIRONMENTAL DOCUMENTS? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	
<b>CCO DESCRIPTION:</b> Pier E2 Additional Rods		<b>PROJECT DESCRIPTION:</b> CONSTRUCT SELF-ANCHORED SUSPENSION BRIDGE	
Original Contract Time: <b>2490</b> Day(s)	Time Adj. This Change: <b>DEF</b> Day(s)	Previously Approved CCO Time Adjustments: <b>501</b> Day(s)	Percentage Time Adjusted: (including this change) <b>20</b> %
			Total # of Unreconciled Deferred Time CCO(s): (including this change) <b>9</b>

**THIS CHANGE ORDER PROVIDES FOR:**

As directed by the Engineer, furnishing forty (40) ASTM A354 Grade BD anchor bolt assemblies in accordance with the requirements of Section 10-1.47, "SPHERICAL BUSHING BEARING (PIER E2)" and Section 10-1.50, "SHEAR KEY (PIER E2)" in the Special Provisions and supplementary requirements for hardness, Charpy V impact resistance, and MT inspection for testing and replacement rods in the Pier E2 shear keys and bearings.

Contract Plan Sheets 884R1 "Pier E2 Bearing Details No. 2" and 887R2 "Pier E2 Shear Key Details No. 1" identify the anchor bolts for the Pier E2 Shear Keys and Bearings as 76 mm A354 Grade BD Bolts. These plan sheets require the bolts to be tensioned to 0.70 Fu (70% of their ultimate strength). Special Provisions Sections 10-1.47 "Spherical Bushing Bearing (Pier E2)" and 10-1.50 "Shear Key (Pier E2)" provide the specification requirements for the anchor bolts. Both of these specifications refer you to Special Provisions Section 10-1.59 "Steel Structures" which in turn refers you to various ASTM specifications including ASTMs A123, A153, A143, A354, etc. which provide further specifications for the manufacture and testing of the anchor bolts and hardware. While these references provide for the final mechanical properties and processes for the manufacture of the bolts, they do not specifically require hydrogen embrittlement testing for the anchor bolts.

Within days after tensioning was performed, the anchor bolts in the shear keys directly below the Eastbound and Westbound Orthotropic Box Girder (OBG) structures (known as Shear Keys S1 and S2) began to fail. A total of 32 out of the 96 anchor bolts broke before the Department directed the Contractor to reduce the anchor bolt tension to prevent further failures. A forensic metallurgic examination was jointly performed with both the Contractor's and Materials Engineering and Testing Services' (METS) metallurgical experts. It was determined that while the failed bolts' material properties did meet the contract specifications, the hardness properties were at the upper limit and the ductility and toughness properties were at the lower limit. Taking this high end hardness and low end ductility into account and combining it with a high tensile stress (0.70 Fu) makes this material more susceptible to the effects of hydrogen cracking (also known as hydrogen embrittlement). The metallurgical examination indicated that the bolts were susceptible to hydrogen embrittlement due to a lack of uniformity in the microstructure of the rods.

The anchor bolts at Shear Keys S1 and S2 are uniquely different from the anchor bolts at the remaining shear keys and bearings (known as Shear Keys S3 and S4 and Bearings B1, B2, B3, and B4) in that they were manufactured in 2008 as opposed to the remaining ones in 2010. In addition, due to physical limitations the anchor bolts at Shear Keys S1 and S2 have their anchors fully cast into the Pier E2 cap and are not replaceable, as opposed to the remaining shear keys and bearings which are thru bolted and thus replaceable. As such, Shear Keys S1 and S2 will require an alternate anchorage solution.

Multiple change orders will be issued for the alternate shear key solution including:

- CCO 312 furnish replacements for rods removed for testing,
- CCO 313 procure long lead time materials,
- CCO 314 perform work to remove, replace and test sample rods,
- CCO 319 fabricate saddles,
- CCO 320 shim temporary bearings,
- CCO 325 perform concrete and rebar demolition,
- CCO 326 core drill for through-cap tendons,

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CCO 327 install temporary work platforms, falsework, and saddles,  
 CCO 328 furnish and install reinforcing bars,  
 CCO 329 place shear key concrete,  
 CCO 330 furnish and install post tensioning, and  
 CCO 331 plan sheets  
 CCO 337 furnish, install, and remove temporary rods  
 CCO 338 shim permanent bearings

This change order (CCO 312) will furnish 8 rods to replace rods removed in the Pier E2 shear keys and bearings and 32 rods to be used for additional testing.

The total cost of this change order is \$200,000.00 force account, which can be financed from the contingency fund. A detailed cost analysis is on file.

Consideration of a time adjustment will be deferred until completion of the work specified herein. Determination of a commensurate time adjustment will be made in accordance with Section 10-1.13, "PROGRESS SCHEDULE (CRITICAL PATH METHOD)" and Section 10-1.14, "TIME-RELATED OVERHEAD" of the Special Provisions, as well as Section 8-1.07, "LIQUIDATED DAMAGES", of the Standard Specifications.

The Toll Bridge Project Oversight Committee (TBPOC) initially (April 11, 2013) approved \$4.3 million to continue work on the Shear Key S1 & S2 anchor rod replacement strategy solutions and to procure long lead time materials. The TBPOC revised this approval (May 9, 2013) to include all E2 shear key anchorage work within the approved \$4.3 million funding. At the June 6, 2013 TBPOC meeting the TBPOC revised this approval to \$7.5 million. At the July 10, 2013 TBPOC meeting the TBPOC further revised this approval to \$18 million. CCO's 313, 319, 320, 325, 326, 327, 328, 329, 330, 337, and 338 are specific to this approval.

In addition, for the anchor rods test program TBPOC also approved \$1 million on May 9, 2013, and an additional \$2.7 million on October 3, 2013. CCO's 312 and 314 are specific to this approval.

The SAS risk register carries a risk for the testing of ASTM A354 Grade BD Rods in the range of \$2.05M to \$25M to address testing and remedial actions as necessary. This range is above the \$1.15M that was carried in the change order log dated July 1, 2013. The cost of this change is within the range contemplated for this risk. This change is only a portion of the potential changes addressed by this risk. Any schedule impacts to contract completion related to this issue is covered under a separate risk - "Schedule: Potential delay during construction - Post Seismic Safety Opening (SSO)". This risk carries a range of \$22M to \$44M and is intended to address delays to contract completion for several risk issues and not necessarily this risk alone.

This change order has concurrence from William Casey (Supervising TE), Rich Foley (HQ Oversight), Wenyi Long (Bridge Design), Ken Brown (Maintenance), and Jing Chen (District Design).

CONCURRED BY:			ESTIMATE OF COST		
Construction Engineer:	William Casey, Sup TE	Date 7/9/13	ITEMS	THIS REQUEST	TOTAL TO DATE
Bridge Engineer:	CT Oversight, Wenyi Long, P.E.	Date 7/9/13	FORCE ACCOUNT	\$0.00	\$0.00
Project Engineer:	District Design, Jing Chen	Date 7/10/13	AGREED PRICE	\$200,000.00	\$200,000.00
Project Manager:		Date	ADJUSTMENT	\$0.00	\$0.00
FHWA Rep.:		Date	TOTAL	\$200,000.00	\$200,000.00
Environmental:		Date	FEDERAL PARTICIPATION		
Other (specify):	HQ, Rich Foley	Date 7/9/13	<input type="checkbox"/> PARTICIPATING	<input type="checkbox"/> PARTICIPATING IN PART	<input checked="" type="checkbox"/> NONE
Other (specify):	Struct. Maint, Ken Brown	Date 7/15/13	<input type="checkbox"/> NON-PARTICIPATING (MAINTENANCE) <input type="checkbox"/> NON-PARTICIPATING		
District Prior Approval By:		Date	FEDERAL SEGREGATION (if more than one Funding Source or P.I.P. type)		
HQ (Issue Approve) By:		Date	<input type="checkbox"/> CCO FUNDED PER CONTRACT <input type="checkbox"/> CCO FUNDED AS FOLLOWS		
Resident Engineer's Signature:		Date	FEDERAL FUNDING SOURCE	PERCENT	
		10/9/13	_____		
			_____		
			_____		