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Inaugural Load Test of the Charles W. Cullen Bridge at Indian River Inlet

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August, 2013

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Executive Summary

This following is a summary of the findings from the controlled load test that was conducted on the new Charles W. Cullen Bridge at the Indian River Inlet on April 30, 2012, shortly before the bridge was dedicated and opened to full traffic. The load test was conducted using the permanent structural monitoring system on the bridge and four test vehicles with a combined weight of 254 kips. The results of this test serve as a baseline for the new bridge response against which future test results can be compared.

The Charles W. Cullen Bridge at the Indian River Inlet, also commonly referred to as the Indian River Inlet Bridge (IRIB), is a 1,750-foot long cable stayed bridge with a 950-foot main span and two 400-foot back spans. The bridge has an out-to-out with of 106 feet, 2 inches and carries four lanes of traffic, two shoulders, and a 12-foot wide pedestrian walkway. The walkway is located on the east side of the bridge. Steel was precluded by the owner as a material option because of the bridge's close proximity to the Atlantic Ocean and the heavy presence of chlorides. Another constraint imposed on the design was that the horizontal clearance was to be 900 feet, to allow for possible future widening of the inlet channel.

Construction of the bridge began in 2009 with the driving of the piles for the pylons. The bridge was opened to limited traffic in the winter of 2011 and was completed and open to full traffic in May of 2012.

The SHM system includes 7 different types of sensors, with a total of 146 installed on the bridge. The different sensors are designed to measure the structural response of the bridge under various environmental loads and live load conditions. Because strain is the primary focus of the controlled load test, these sensors are described in the most detail, and the resulting data from these sensors will be the primary focus of the evaluation.

The load test started at approximately 10:00 pm and lasted until approximately 1:30 am. Maintenance of traffic was provided by DelDOT crews and the state police: traffic was prohibited from crossing the bridge while data was being collected. The test was conducted at night to minimize traffic disruption and to minimize the effects of thermal variations and radiant heating of the bridge due to the sun was minimized.

Four fully loaded 10-wheel dump trucks were used as a controlled live load for the test. The truck axles were weighed by DelDOT offsite and confirmed onsite using portable truck scales. The average truck weight was 63.5 kips.

Two different types of load passes were made for the test: slow, semi-static passes (approximately 10 mph) and fast, dynamic passes (approximately 55 mph). There were 17 total load passes overall, fifteen slow semi-static passes and two dynamic passes.

The following is a list of significant findings from the load test.

- Based on the load test the bridge was found to be behaving as expected.

- Based on the repeatability of the recorded data, and the fact that the recorded time history response of the bridge is consistent with the expected bridge response, the structural health monitoring system is deemed to be functioning properly.

- For the edge girder (which happens to be the element that, in most cases, governs the load rating of the bridge for the strength limit state), the maximum strain recorded during any of the load passes was 102.1 $\mu\varepsilon$ at gauge S_W22 during pass 4a (four tucks side-by side, one in each travel lane). This gauge is located at the bottom of the western edge girder between pylon 6W and pier 7 (within 4 feet of the controlling location for the load rating). The strain of 102.1 $\mu\varepsilon$ corresponds to a live-load tensile stress in the rebar of 2.96 ksi and a live-load tensile stress in the concrete of 527 psi.

- The minimum edge girder strain recorded during any of the load passes was -44.9 $\mu\varepsilon$ at gauge S_W21 during pass 4a (four trucks side-by side, one in each travel lane). This gauge is located at the same location as gauge S_W22 (the controlling location), but is in the top of the western edge girder. This strain corresponds to a live-load compression stress of 1.30 ksi in the rebar and a live-load compression stress in the concrete of 232 psi.

- The maximum and minimum pylon strains recorded during any of the load passes were 27.6 $\mu\varepsilon$ and -37.5 $\mu\varepsilon$ at gauge S_W24S during pass 4f and 4g respectively. Gauge S_W24S is located at pylon 6W above the deck.

- The maximum and minimum displacements recorded during any of the load passes were 0.294 inches and -0.327 inches at gauge D_E2 during pass 4e and 4c respectively. Gauge D_E2 is located at pylon 5E.

- The maximum and minimum deck tilts recorded during any of the load passes were 0.129 radians and -0.16 radians at gauge T_E1 during pass 4f and 4g respectively. Gauge T_E1 is located at pier 4.

- A single truck weighing 63,500 lbs and crossing in the slow lane would be expected to cause peak strains in the edge girders at the controlling location and at midspan on the order of 30 $\mu\varepsilon$. This corresponds to a live-load tensile strain in the rebar of 0.87 ksi and a live-load tensile stress in the concrete of 155 psi.

- A long permit vehicle (on the order of 65 feet long) and weighing 127,000 lbs and crossing in the slow lane would be expected to cause peak strains at the controlling location and at midspan on the order of 50 $\mu\varepsilon$. This corresponds to a live-load tensile strain in the rebar of 1.45 ksi and a live-load tensile stress in the concrete of 258 psi.

- When a truck is in the western most lane (southbound slow lane), 69.3% of the truck load goes to the western edge girder. When a truck is in the eastern most lane (northbound slow lane), 63.4% of the truck load goes to the eastern edge girder.

- When loaded with four trucks across the bridge (one in each travel lane), 53.4% of the total load goes to the western edge girder.

- The computed one-lane, two-lane, and four-lane distribution factors are found to be 0.695, 1.32, and 2.21 respectively.

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- University of Delaware – for help during the load test; Pablo Marquez.

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1. Introduction

The University of Delaware Center for Innovative Bridge Engineering conducted a controlled load test of the new Charles W. Cullen Bridge at the Indian River Inlet on April 30, 2012, shortly before the bridge was dedicated and opened to full traffic. The load test was conducted using the permanent structural monitoring system on the bridge and four test vehicles with a combined weight of 254 kips. The results of this test establish a baseline for the new bridge response against which future test results can be compared. Presented in this report is a description of the bridge, a description of the monitoring system, the test procedure, results, and conclusions.

2. Description of the bridge

The new Charles W. Cullen Bridge at the Indian River Inlet, also commonly referred to as the Indian River Inlet Bridge (IRIB), is a 1,750-foot long cable stayed bridge with a 950-foot main span and two 400-foot back spans. The bridge has an out-to-out with of 106 feet 2 inches and carries four lanes of traffic, two shoulders, and a 12-foot wide pedestrian walkway. The walkway is located on the east side of the bridge. Steel was precluded by the owner as a material option because of the bridge's close proximity to the Atlantic Ocean and the heavy presence of chlorides. Another constraint imposed on the design was that the horizontal clearance was to be 900 feet, to allow for possible future widening of the inlet channel.

The bridge was designed using a combination of precast and cast-in-place reinforced concrete. There are two twin pylons which each reach a height of 248 feet above the ground. The pylons have a hollow box shape that is uniform below the deck level and then tapers to the top of the pylon. Only a grade beam connects the twin pylons at their base – designers were able to eliminate the conventional cross-strut typically seen in bridges of this type through the use of an aerodynamically efficient cross-section and by minimizing the eccentricity of the stay plane with respect to the centroid of the cross-section. The pylons were cast-in-place using slip-form construction. The pylons are supported on a 10-foot thick spread footing that is supported by 42 prestressed concrete piles. The deck consists of two edge girders, transverse floor beams spaced at 12 feet on center, and a cast-in-place deck. The portions of the deck over land, approximately 66%, were constructed on falsework, which was faster and more economical. In this region the floorbeams were precast pretensioned I sections that tapered in depth from the center to their ends. The edge girders, which are roughly rectangular in shape and are 6 feet deep and 5 feet wide, are continuous and were cast-in-place. The regions over water were constructed using a form traveller in sections of length of 24 feet. Post-tensioning was used in the deck, edge girders, and the connection of the precast floorbeams to the edge girders. There are a total of 152 stays, 38 per pylon; 19 stays emanate from each side of the pylons and are anchored to the edge girder on 24-foot centers. The stay cables are seven wire strands in bundles of 19 to 61. The strands are waxed and encapsulated in high-density polyethylene sheathing. The stays are enclosed in an HDPE pipe with a raised helical strake to minimize the potential for wind-rain induced vibrations. The bridge is fixed at the northern pylon and is free to expand at the south pylon and abutments. A more detailed description of the bridge design and construction can be found in Nelson (2011).

Construction of the bridge began in 2009 with the driving of the piles for the pylons. The bridge was opened to limited traffic in the winter of 2011 and was completed and open to full traffic in May of 2012.

3. Description of the monitoring system

The SHM system includes 7 different types of sensors, with a total of 146 installed on the bridge. The different sensors are designed to measure the structural response of the bridge under various environmental loads and live load conditions. Because strain is the primary focus of the controlled load test, these sensors are described in the most detail, and the resulting data from these sensors will be the primary focus of the evaluation.

A general layout sketch that shows the locations of the strain and displacement sensors on the bridge is shown in Figure 1. To aid in describing the SHM system and sensor layout, a three dimensional Cartesian coordinate system is thought to be placed on the bridge. The X direction is along the length of the bridge, positive pointing north. The Y direction is perpendicular to X, in the plane of the road, positive pointing west. The Z direction is perpendicular to X and Y, positive pointing up.

Each sensor has two designations, the "CMS" designation which is shorter and was setup primarily for the convenience of displaying and referencing within the SHM monitoring system, and the "UD" designation, which is somewhat longer but more descriptive, and therefore is convenient for quick recognition and reporting purposes, particularly for those who do not work with the system on a regular basis. The CMS designation is 4 to 6 characters. The first character denotes the type of measurement ("A" for acceleration, "S" for strain, etc). This is followed by a "dash." For strains, displacements, and tilts, the third character refers to the sensor cardinal location on the bridge (i.e., "E" for "east", "W" for "West", etc). For strains in the pylons this is followed by another directional designator to denote the pylon cardinal face in which the sensor is located. For accelerations the third character denotes the measurement direction ("X", "Y", or "Z"), the fourth character is the directional designation of the pylon in which it is located, and this is followed by a numeric designation. Examples of the CMS designation are presented in Table 1. The UD designation is a 6 to 10 character designation. The first character denotes the type of measurement, similar to the CMS first character (chloride sensors are defined by their first two characters). The next one or two characters denote the member, i.e., "D" for deck, "S" for stay, "P5" for pylon 5, or "P6" for pylon 6. The next character denotes the sensor cardinal location on the bridge (i.e., "E" for "east", "W" for "West"). This is followed by an "underscore" character "_". The remaining characters define the location of the sensor on the bridge and if needed, the sensory direction. For example, "108B" refers to section 108 and bottom of the edge girder; "TOPX" refers to the top of a pylon measuring in the X direction. Examples of the UD designation are also shown in Table 1.

Strain is measured at 70 locations throughout the bridge, including in the edge girders, pylons, and deck. All of the strain measurements are made using Micron Optics os3600 strain sensors. The sensors have a gage length of 9.8 inches, a range of +/- 2500 $\mu\varepsilon$, and a sensitivity of 1.2 pm/$\mu\varepsilon$.

Strain is measured in the pylons at 24 different locations. The pylon sensors are placed in groups of 4 at different elevations, measuring the vertical (Z direction) strain in each wall of the pylon. In pylon 5 East the strains are measured at the B1 level (elevation 18') and at lift T4 (elevation 115.5"). In pylons 6 East and 6 West the strains are measured at lift T1 (elevation ~52 ft) and T4 (elevation 115.5'). Cross-sections of the pylons which show the locations of the strain sensors are shown in Figures 2 through 4.

Strain is measured in the edge girders at 44 different locations, at 11 different longitudinal positions of the bridge. The longitudinal positions correspond to approximately 1/8 points on the main span and back spans. At each position the strain is measured in both the top and bottom of both the east and west edge girders (i.e., 4 unique strain measurements at each longitudinal position). In all cases the strain in the edge girder is measured in the longitudinal (X) direction. At any given edge girder location the strain is measured in the top of the edge girder, approximately 6 inches from the top of the girder, and in the bottom of the edge girder, approximately 4 inches from the bottom of the girder. The strains are measured at the approximate center of the cross section. A cross-section of the edge girder that shows general location of the strain sensors in the girder is shown in Figure 5.

Strain is measured at 2 locations in the deck. In both cases the strain is measured in the Y direction (transverse to the travel direction). These sensors are located 6" up from the bottom face of the deck and are anchored to the side of the upper mat of rebar. The deck strain sensor locations are shown in Figure 1.

Displacement at each of the two expansion joints and at the bearing on pylon 5 East are measured using a Cleveland Electric Labs model ATG-FOLS-7126-20 displacement transducer. The transducers have a range of 20 in and a resolution of 0.05 inches. In all cases the transducer is positioned on the east side of the bridge and measures the longitudinal movement, in the direction of traffic, i.e., the X direction. The location of the displacement transducers are shown in Figure 1.

The heart of the fiber-optic system is a pair of Micro Optics SM130 Interrogators. Each of the 4-channel interrogators can scan at a maximum rate of 1 kHz. A 16 channel multiplexer is connected to each which increases the effective number of main fibers for the system to 32. Interrogator "A" runs at a rate of 125 Hz and handles all of the sensors except the accelerometers and a few strain sensors. Interrogator B runs at a rate of 250 Hz and handles all of the accelerometers and the few remaining strain sensors. The back end control software for the system is Micro Optic's "Enlight" software. This is where all of the fundamental control parameters for the system are set and the sensor parameters are stored. On the front end is running Chandler Monitoring Systems, "Intellioptics" software. This is a GUI program that provides overall control and database management of the SHM system.

4. Test procedure

The test was conducted on the night of April 30, 2012. By conducting the test at night traffic disruption was minimized, as were the effects of thermal variations and radiant heating of the bridge due to the sun was minimized. The test started at approximately 10:00 pm and lasted until approximately 1:30 am. Maintenance of traffic was provided by DelDOT crews and the state police: traffic was prohibited from crossing the bridge while data was being collected.

Four, fully loaded 10-wheel dump trucks were used as a controlled live load for the test. The truck axles were weighed by DelDOT offsite and confirmed onsite using portable truck scales. The trucks, identified by their 4 digit number, and their gross weights are listed in Table 1. The average truck weight is 63.5 kips. Figure 6 shows the wheel spacing's and wheel loads of each truck.

Two different types of load passes (load cases) were made for the test: slow passes (approximately 10 mph) and dynamic (approximately 55 mph). There were 17 total load passes overall, fifteen slow crawl passes and two dynamic passes. The first four passes were single truck by the same truck in each of the four lanes. Next, six passes were made with two trucks in specified formations. Lastly, five passes were conducted in which all four trucks were used in different formations. The pass number, pass identifier, and the truck formations for the slow passes are shown in Table 2. The formations are shown in Figure 7 through Figure 9.

The dynamic, or high speed tests, were conducted with the trucks traveling at approximately 55 mph with approximately 100 foot intervals between the trucks. The dynamic passes are shown in Figure 10.

In all cases for the slow passes the trucks were staged a short distance from the beginning of the cable supported spans. The signal was given to start the data collection then the signal was given for the truck to proceed across the span. Data collection was stopped once the vehicle was off the cable supported spans. Data was collected at a rate of 125 samples-per-second on interrogator A and 250 samples-per-second on interrogator B, for the slow passes.

For the high speed passes the trucks were staged approximately ¼ mile from the start of the cable supported spans. The signal was given to start the data collection and then the signal was given for the trucks to approach the bridge. The trucks were instructed to cross the bridge at the posted speed limit (55 mph) or the maximum speed they could reach. Data collection stopped once the last truck was off the cable supported spans. Data was collected at the same rates as for the slow passes.

Two data files were created for each load pass, one from interrogator A and one from interrogator B. The files were given a common pre-fix name and the date and time when the file was created is appended to the file name.

5. Results

The following sections present the significant findings from the load test.

Peak Response

The absolute maximum and minimum strains, displacements, and tilts recorded during any of the 17 load passes are presented in Table 3. In terms of strains, a positive value indicates tension while a negative value indicates compression. That means that maximum strains indicate the largest live-load tensile strain recorded and minimum strains indicate the largest live-load compression strain recorded. As would be expected, all of the maximum and minimum values occurred during load passes involving 4 trucks.

For the edge girder (which happens to be the element that, in most cases, governs the load rating of the bridge for the strength limit state), the maximum strain recorded during any of the load passes was 102.1 $\mu\varepsilon$ at gauge S_W22 during pass 4a (four tucks side-by side, one in each travel lane). This gauge is located at the bottom of the western edge girder between pylon 6W and pier 7 (within 4 feet of the governing location for the load rating). Hereafter, this location will be referred to as the “controlling location.” The strain of 102.1 $\mu\varepsilon$ corresponds to a live load tensile stress of 2.96 ksi in the rebar (based on a Young’s modulus of 29,000 ksi) and a live load tensile stress in the concrete of 527 psi (based on a Young’s modulus of 5,164,000 psi which was computed based on an average compressive strength of 8,240 psi from the cylinder tests). Note that a live load tensile stress does not mean that the element is in a state of net tension as it has a large dead load compression component. The west girder is expected to have higher maximum strains than the east girder because the pedestrian walkway on the east side of the bridge causes the centroid of the traffic lanes to be closer to the western edge girder.

The minimum edge girder strain recorded during any of the load passes was -44.9 $\mu\varepsilon$ at gauge S_W21 during pass 4a (four trucks side-by side, one in each travel lane). This gauge is located at the same location as gauge S_W22 (the controlling location), but is in the top of the western edge girder. This strain corresponds to a live load compression stress of 1.30 ksi in the rebar and a live load compression stress in the concrete of 232 psi.

The maximum and minimum pylon strains recorded during any of the load passes were 27.6 $\mu\varepsilon$ and -37.5 $\mu\varepsilon$ at gauge S_W24S during pass 4f and 4g respectively. Gauge S_W24S is located at pylon 6W above the deck.

The maximum and minimum displacements recorded during any of the load passes were 0.294 inches and -0.327 inches at gauge D_E2 during pass 4e and 4c respectively. Gauge D-E2 is located at pylon 5E.

The maximum and minimum deck tilts recorded during any of the load passes were 0.129 radians and -0.16 radians at gauge T_E1 during pass 4f and 4g respectively. Gauge T-E1 is located at pier 4.

While Table 3 presents the single maximum and minimum response for the various sensors and bridge components for all load passes, Tables A.1 to A.20 (found in Appendix A) present the maximum and minimum values for each sensor during each load pass, and also present the absolute maximum and minimum value for each sensor for all slow speed passes and for all high speed passes. Note that data for the accelerometers, which are not the focus of the load tests, are not presented in the tables. Within these tables are the maximum and minimum bearing displacements (Tables A.1 to A.2), the maximum and minimum deck tilts (Tables A.3 to A.4), the maximum and minimum pylon strains in pylons 5E, 6E, and 6W (Tables A.5 to A.10), the maximum and minimum east girder strains (Tables A.11 to A.14), the maximum and minimum west girder strains (Tables A.15 to A.18), and the maximum and minimum deck strains (Tables A.19 to A.20).

Response Due to Single Trucks and Two-Truck Trains

In order to predict future response due to permit vehicles or other heavy trucks, it is useful to investigate the response due to single trucks (Passes 1a, 1b, 1c, and 1d) and due to the two-truck trains (Passes 2b, 2c, 2e, and 2f). Based on the data from single truck loadings, the maximum western edge girder strain recorded at the governing location was 32.1 $\mu\varepsilon$ (see Table A.17, sensor S_W22, Pass 1a – truck in southbound slow lane), while the maximum eastern edge girder strain recorded at the governing location was 30.3 $\mu\varepsilon$ (see Table A.13, sensor S_W22, Pass 1d – truck in northbound slow lane). The data also shows that for single truck loadings, the maximum western edge girder strain recorded at midspan was 36.1 $\mu\varepsilon$ (see Table A.17, sensor S_W8, Pass 1a – truck in southbound slow lane), while the maximum eastern edge girder strain recorded at midspan was 30.9 $\mu\varepsilon$ (see Table A.13, sensor S_W8, Pass 1d – truck in northbound slow lane). Based on this data a single truck weighing 63,500 lbs and crossing in the slow lane (which produces the greatest edge girder strains) would be expected to cause peak strains in the edge girders on the order of 30 $\mu\varepsilon$. This corresponds to a live-load tensile strain in the rebar of 0.87 ksi and a live-load tensile stress in the concrete of 155 psi.

Presented in Appendix Tables A.13 and A.17 are the maximum western edge girder strains due to a two-truck train in the southbound slow lane (Pass 2b) and the maximum eastern edge girder strains due to a two-truck train in the northbound slow lane (Pass 2f). The two-truck train in this case weighs approximately 127,000 lbs and has a length on the order of 65 feet which is similar to some long permit vehicles. The data shows that the maximum strain in the western edge girder at the controlling location due to a two-truck train in the southbound slow lane was 52.6 $\mu\varepsilon$, while the maximum strain in the eastern edge girder at the controlling location due to a two-truck train in the northbound slow lane was 48.8 $\mu\varepsilon$. Similarly, the data shows that the maximum strain in the western edge girder at midspan due to a two-truck train in the southbound slow lane was 56.7 $\mu\varepsilon$, while the maximum strain in the eastern edge girder at midspan due to a two-truck train in the northbound slow lane was 52.9 $\mu\varepsilon$. Therefore, permit vehicles weighing 127,000 lbs can be expected to produce peak strains at the controlling location and at midspan on the order of 50 $\mu\varepsilon$. This corresponds to a live-load tensile strain in the rebar of 1.45 ksi and a live-load tensile stress in the concrete of 258 psi.

Time History Response

Since the maximum effects occurred when four trucks crossed the bridge, we will focus on the time history plots that correspond to Pass 4a (four tucks side-by side traveling southbound with one in each travel lane). Time history plots of strain, displacement, and tilt for all sensors can be found in Appendix B. The strain time histories for gauges in the edge girders have two curves per plot (Figures B.1 to B.23), one corresponding to the top gauge and one corresponding to the bottom gauge, both at the same section along the girder. The pylon strain plots show the response recorded by the four gauges all at the same pylon cross-section (Figures B.24 to B.29). The displacement time history plots at the bearings and the deck tilt time history plots both have a single curve per plot (Figures B.30 to B.32, and B.33 to B.41, respectively).

All plots have time on the x-axis. It is useful to note that based on the time-history plots it is evident that the trucks move onto the north backspan at about 20 seconds, reach the north pylon (Pylon 6) at about 55 seconds, reach midspan of the main span at about 85 seconds, reach the south pylon (Pylon 5) at about 113 seconds, and finally leave the end of the south backspan at about 138 seconds.

Edge Girder Strain Time History

Figure 11 shows the stain time history of gauges in the western edge girder at the controlling location that includes the maximum peak response of 102.1 $\mu\varepsilon$ given in Table 3. Another edge girder strain time history of interest is the one corresponding to gauges at midspan (see Figure 12). In both plots the peak response occurs when the trucks are at the location of the plotted gauge (t=30 seconds and t=85 seconds respectively). Note also in both plots the reflected nature of the upper and lower gauges, and that the strains go to zero when the trucks are at the ends of the backspans (t=20 seconds and t=138 seconds) as well as when the trucks are at the pylons (t=55 seconds and t=113 seconds). The fact that the magnitude of the lower gauge is considerably higher that the magnitude of the upper gauge shows that the neutral axis location of the section is, as expected, much closer to the top face of the girder. The response also shows how the girder experiences positive bending when the trucks are in the span above the gauge, but the girder experiences negative bending when the trucks are in an adjacent span(s).

Pylon Strain Time History

Figure 13 shows a typical stain time history for the four gauges in a pylon at a given lift location (in this case Pylon 6 west, lift T1). As one would expect, as the trucks approach the north pylons from 20 to 55 seconds (Pylon 6), the top of the pylon is pulled by the stays to the north, causing the north face gauge (S-E31N) to go into compression (negative strain), and the south face gauge (S-E32S) to go into a reflected tensile state (positive strain). As the trucks cross the pylon at 55 seconds, the strains go to zero. Next, as the trucks cross the main span from 55 to 113 seconds, the stays pull the pylon to the south, and the north and south face gauges respond exactly opposite as when the trucks were on the backspan. Also as expected, there is very little out of plane bending of the pylon and therefore little strain in either the east or west face gauges.

Deck Strain Time History

Figure 14 shows a typical stain time history for the strain gauges in the deck at Section 210. The deck strain gauges are in the roadway, and their response is, as expected, quite localized (the deck strain occurs when the truck is between adjacent stays). The strains recorded by gauges S-C1 and S-C2 at Section 210 are of similar magnitude as would be expected, peaking around -35 to -40 $\mu\varepsilon$ when the trucks are above the gauges. This magnitude of strain corresponds to compression stresses in the concrete on the order of 180 to 205 psi.

Bearing Displacement Time History
Figure 15 shows a typical bearing displacement time history for the bearing at Pylon 5. The movements recorded under the live load are quite small, as would be expected, ranging in this case from +/- 0.25 inches. There is movement at the bearing with the primary response occurring after the trucks reach midspan at 85 seconds, and then reaching -0.25 inches when the truck approaches Pylon 5, and then reaching +0.25 inches when the truck moves across the backspan.

Deck Tilt Time History
Figure 16 shows a typical deck tilt time history for the tilt gauge on the deck at midspan. As expected, the deck tilts in one direction as the trucks move from Pylon 6 (at 55 seconds) and approaches midspan (at 85 seconds), peaking at about -0.5 radians right before the trucks get to midspan (at about 80 seconds). When the trucks are at midspan (at 85 seconds), the deflection at midspan will be a maximum and the tilt goes to zero. As the trucks continue away from midspan, the tilt reaches a peak of about +0.5 radians (at about 90 seconds) and then gradually returns to zero as the truck approaches Pylon 5 (at 113 seconds). The fact that the positive and negative peaks are equal is as expected and indicate that the tilt sensor are working effectively.

Load Distribution
Utilizing the various load passes, load distribution to the two edge girders can be evaluated. Since the controlling location for the edge girder is within 4 feet of the longitudinal location of gauges S_W22 and S_E22, response recorded at those gauges is used to evaluate the load distribution.

Figure 17 shows the peak stain recorded by gauge S_W22 (bottom of west edge girder) due to a single truck in one of the four travel lanes (Passes 1a, 1b, 1c, and 1d), while Figure 18 shows the peak stain recorded by gauge S_E22 (bottom of east edge girder) due to a single truck in one of the four travel lanes. These plots give initial indications as to how the load distributes between the two edge girders. Summing the two peak edge girder strains for a single pass (the peaks occur at the same time) yields the total strain caused by a single truck (or two wheel lines – needed later to compute distribution factors). This sum is plotted in Figure 19. Considering each of the four passes, the average total strain for one truck is 46.2 $\mu\varepsilon$. Figures 20 and 21 show the percentage of the total strain going to the west and east girder respectively when a single truck is in each of the four travel lanes. When a truck is in the western most lane (southbound slow lane), 69.3% of the truck load goes to the western edge girder; when a truck is in the eastern most lane (northbound slow lane), 63.4% of the truck load goes to the eastern edge girder. The eastern girder takes a smaller percentage because of the pedestrian walkway that is located on the eastern side of the bridge. When all four trucks are on the bridge (one in each of the four travel lanes – Pass 4a), the total strain (sum of the peak strain in the west and east girder) is 191 $\mu\varepsilon$. This value is very close to the sum of the strain in the east and west girder found by summing the peak strains for the four individual truck passes (Passes 1a, 1b, 1c, and 1d). That sum is 185 $\mu\varepsilon$. One would expect some variation in the two summations due to the fact that the same truck was used for all single truck passes, but four different rucks (with slightly different weight) were used for the four truck pass. Furthermore, the four individual passes did not use each truck once, and the location of the trucks within the travel lanes would not have been identical. However, the excellent agreement (difference of 3%), indicates that the structural health monitoring system is giving repeatable results. This repeatability will be further investigated in future load tests. Note that based on the Pass 4a results, 53.4% of the total load resulting from four trucks across the bridge (one in each travel lane) goes to the western edge girder (102.1 $\mu\varepsilon$/ 191 $\mu\varepsilon$ = 0.534).

Distribution Factors

Using the peak strain recorded for Passes 1a (one truck), 2a (two trucks), and 4a (four trucks), and dividing that strain by the strain caused by one truck (46.2 $\mu\varepsilon$), the one-lane, two-lane, and four-lane distribution factors have been calculated:

- single-lane distribution factor = 0.695 (32.1 $\mu\varepsilon$/46.2 $\mu\varepsilon$)
- two-lane distribution factor = 1.32 (60.8 $\mu\varepsilon$/46.2 $\mu\varepsilon$)
- four-lane distribution factor = 2.21 (102.1 $\mu\varepsilon$/46.2 $\mu\varepsilon$).

Note that for a two-girder system, the maximum values for one-lane, two-lane, and four-lane distribution factors are 1, 2, and 4 respectively (that assumes one girder carries the entire load).

6. Summary

This following is a summary of the findings from the controlled load test that was conducted on the new Charles W. Cullen Bridge at the Indian River Inlet on April 30, 2012, shortly before the bridge was dedicated and opened to full traffic. The load test was conducted using the permanent structural monitoring system on the bridge and four test vehicles with a combined weight of 254 kips. The results of this test serve as a baseline for the new bridge response against which future test results can be compared.

- Based on the load test the bridge was found to be behaving as expected.

- Based on the repeatability of the recorded data, and the fact that the recorded time history response of the bridge is consistent with the expected bridge response, the structural health monitoring system is deemed to be functioning properly.

- For the edge girder (which happens to be the element that, in most cases, governs the load rating of the bridge for the strength limit state), the maximum strain recorded during any of the load passes was 102.1 $\mu\varepsilon$ at gauge S_W22 during pass 4a (four tucks side-by side, one in each travel lane). This gauge is located at the bottom of the western edge girder between pylon 6W and pier 7 (within 4 feet of the controlling location for the load rating). The strain of 102.1 $\mu\varepsilon$ corresponds to a live-load tensile stress in the rebar of 2.96 ksi and a live-load tensile stress in the concrete of 527 psi.

- The minimum edge girder strain recorded during any of the load passes was -44.9 $\mu\varepsilon$ at gauge S_W21 during pass 4a (four trucks side-by side, one in each travel lane). This gauge is located at the same location as gauge S_W22 (the controlling location), but is in the top of the western edge girder. This strain corresponds to a live-load compression stress of 1.30 ksi in the rebar and a live-load compression stress in the concrete of 232 psi.

- The maximum and minimum pylon strains recorded during any of the load passes were 27.6 $\mu\varepsilon$ and -37.5 $\mu\varepsilon$ at gauge S_W24S during pass 4f and 4g respectively. Gauge S_W24S is located at pylon 6W above the deck.

- The maximum and minimum displacements recorded during any of the load passes were 0.294 inches and -0.327 inches at gauge D_E2 during pass 4e and 4c respectively. Gauge D_E2 is located at pylon 5E.

- The maximum and minimum deck tilts recorded during any of the load passes were 0.129 radians and -0.16 radians at gauge T_E1 during pass 4f and 4g respectively. Gauge T_E1 is located at pier 4.

- A single truck weighing 63,500 lbs and crossing in the slow lane would be expected to cause peak strains in the edge girders at the controlling location and at midspan on the order of 30 $\mu\varepsilon$. This corresponds to a live-load tensile strain in the rebar of 0.87 ksi and a live-load tensile stress in the concrete of 155 psi.

- A long permit vehicle (on the order of 65 feet long) and weighing 127,000 lbs and crossing in the slow lane would be expected to cause peak strains at the controlling location and at midspan on the order of 50 $\mu\varepsilon$. This corresponds to a live-load tensile strain in the rebar of 1.45 ksi and a live-load tensile stress in the concrete of 258 psi.

- When a truck is in the western most lane (southbound slow lane), 69.3% of the truck load goes to the western edge girder. When a truck is in the eastern most lane (northbound slow lane), 63.4% of the truck load goes to the eastern edge girder.

- When loaded with four trucks across the bridge (one in each travel lane), 53.4% of the total load goes to the western edge girder.

- The computed one-lane, two-lane, and four-lane distribution factors are found to be 0.695, 1.32, and 2.21 respectively.

References

Nelson, E. T. (2012), “Indian River Inlet Bridge – Surviving the storms,” *ASPIRE The Concrete Bridge Magazine*, Precast/Prestressed Concrete Institute, Chicago, IL, Vol. 6, No. 1, 2012.

Table 1. CMS/UD sensor designation nomenclature

Sensor	CMS Nomenclature		UD Nomenclature	
	Example	Description	Example	Description
Pylon acceleration	A-XE3	Acceleration, X-direction, east pylon, number 3	APE6E_TOPX	Acceleration, pylon 6 east, east side, top, x direction
Stay acceleration	A-ZW5	Acceleration, Z-direction, west side, number 5	ASW_310Z	Acceleration, stay, west side, section 310, z direction
Deck acceleration	A-ZW1	Acceleration, Z-direction, west side, number 1	ADW_108Z	Acceleration, deck, west side, section 108, z direction
Displacement	D-E3	Displacement, east, number 3	DDE_415	Displacement, deck, east side, section 415
Tilt	T-E7	Tilt, east, number 7	IDE_301	Inclination, deck, east side, section 301
Edge girder strain	S-W4	Strain, edge girder west, number 4	SDW_108B	Strain, deck, west side, section 108, bottom
Pylon strain	S-W23N	Strain, pylon, number 23, north face	SP6W_T1N	Strain, pylon 6, west side, lift T1, north face

Table 2. Trucks and truck weights

Truck #	Gross Weight (kips)
2829	63.2
2677	63.7
2784	63.4
2904	63.6
Average	63.5

Table 3. Truck passes

Pass	Identifier	Description
One truck		
1	1a	southbound slow-lane
2	1d	northbound slow-lane
3	1b	southbound fast-lane
4	1c	northbound fast-lane
Two trucks		
5	2a	side by side, southbound, one fast-lane, one slow-lane
6	2d	side by side, northbound, one fast-lane, one slow-lane
7	2b	2 truck train, southbound, slow-lane
8	2f	2 truck train, northbound, slow-lane
9	2c	2 truck train, southbound, fast-lane
10	2e	2 truck train, northbound, fast-lane
Four trucks		
11	4a	side by side, southbound, one in each lane
12	4c	all trucks traveling northbound in square formation
13	4b	all trucks traveling southbound in square formation
14	4e	4 truck train, northbound, all in slow-lane
15	4d	4 truck train, southbound, all in slow-lane
Four truck high speed passes		
16	4f	4 truck train, ~100 ft spacing, northbound, slow-lane
17	4g	4 truck train, ~100 ft spacing, southbound, slow-lane

Table 4. Absolute maximum and minimum strains, displacements, and tilts

Member	Sensor	Location	Max	Min	Pass
Edge girder	S_W21	Top, west edge girder, between pylon 6W and pier 7		-44.9 $\mu\varepsilon$	4a
	S_W22	Bottom, west edge girder, between pylon 6W and pier 7	102.1 $\mu\varepsilon$		4a
Pylon	S_W24S	6W (above deck)	27.6 $\mu\varepsilon$		4b
	S_W24S			-37.5 $\mu\varepsilon$	4d
Displacement	D_E2	Pylon 5E	0.294 in		4e
	D_E2			-.327 in	4c
Tilt	T_E1	Pier 4	0.129 rad		4f
	T_E1			-0.16 rad	4g

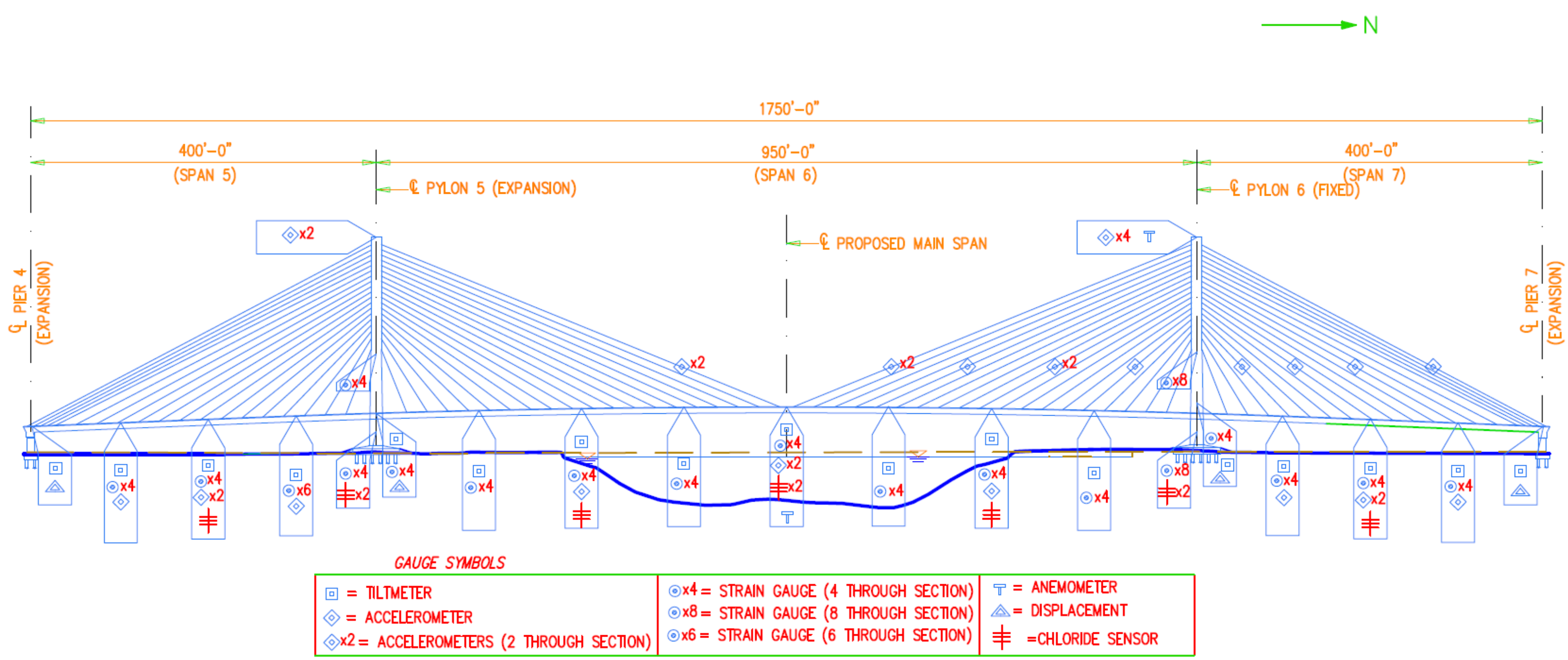

Figure 1. General elevation view showing sensor layout on the bridge

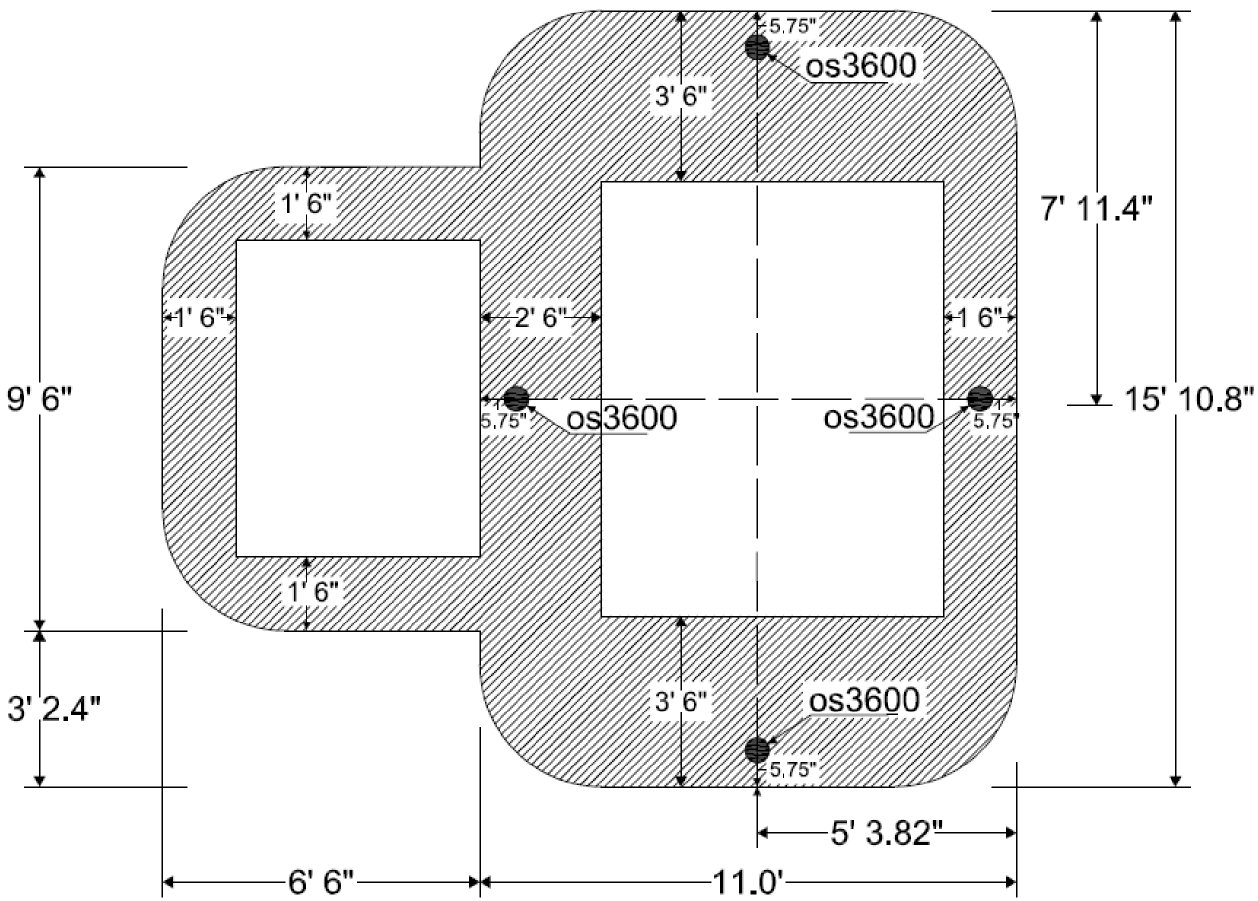

Figure 2. Cross-section of pylon 5 East showing location of strain sensors at lift B1 (elevation 18')

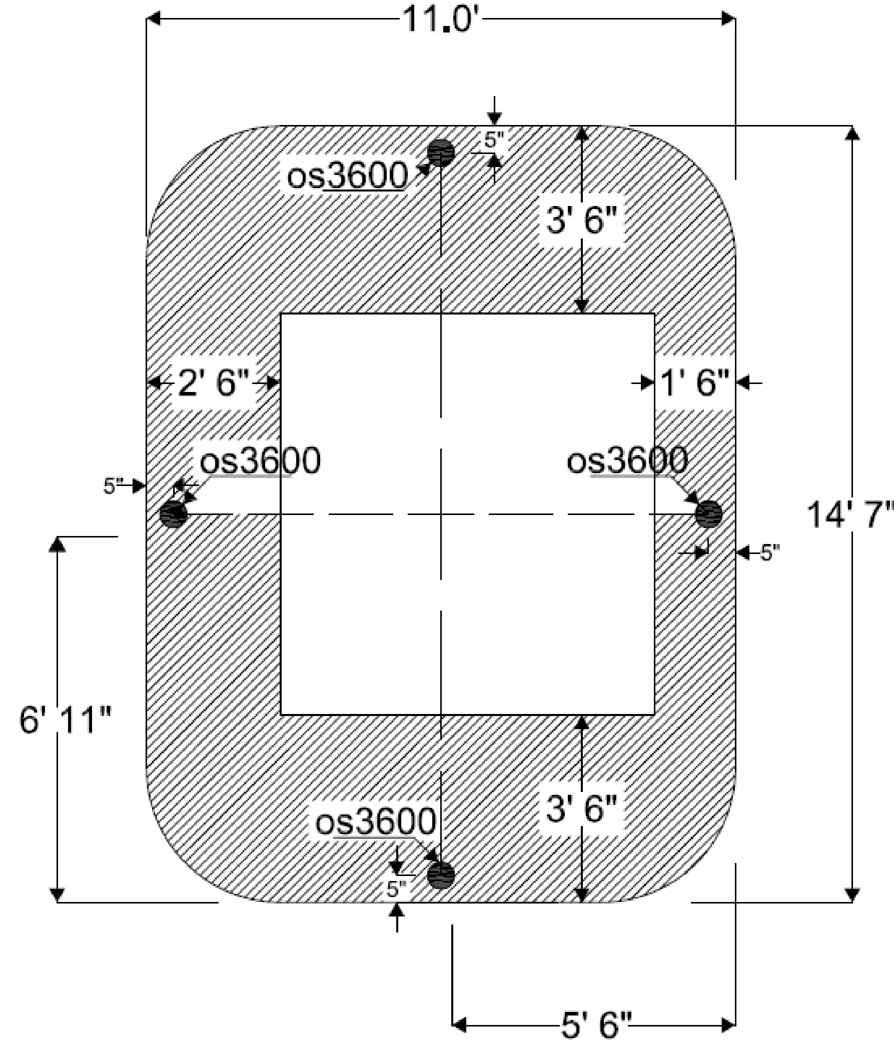

Figure 3. Cross-section of pylons 6 East and 6 West showing location of strain sensors at lift T1 (elevation 52')

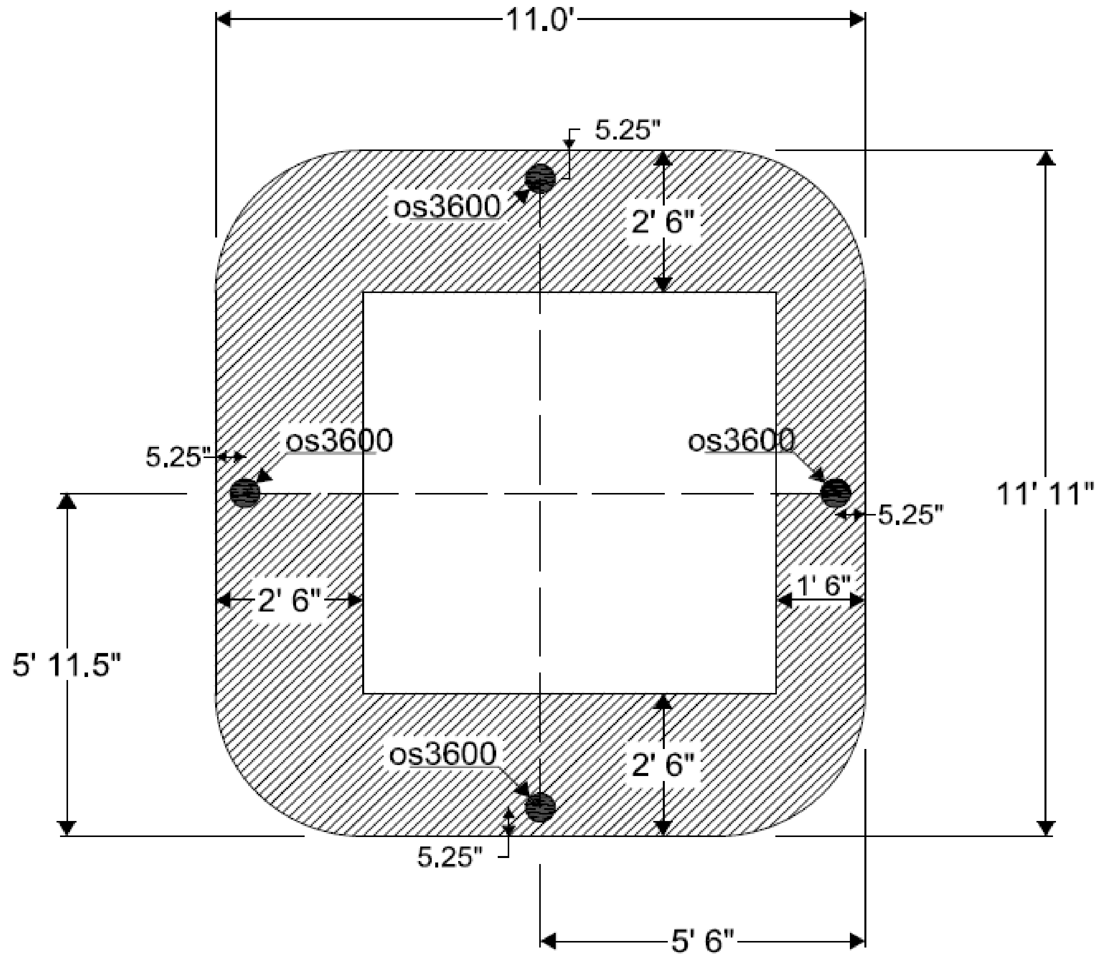

Figure 4. Cross-section of pylons 6 East and 6 West showing location of strain sensors at lift T4 (elevation 115.5')

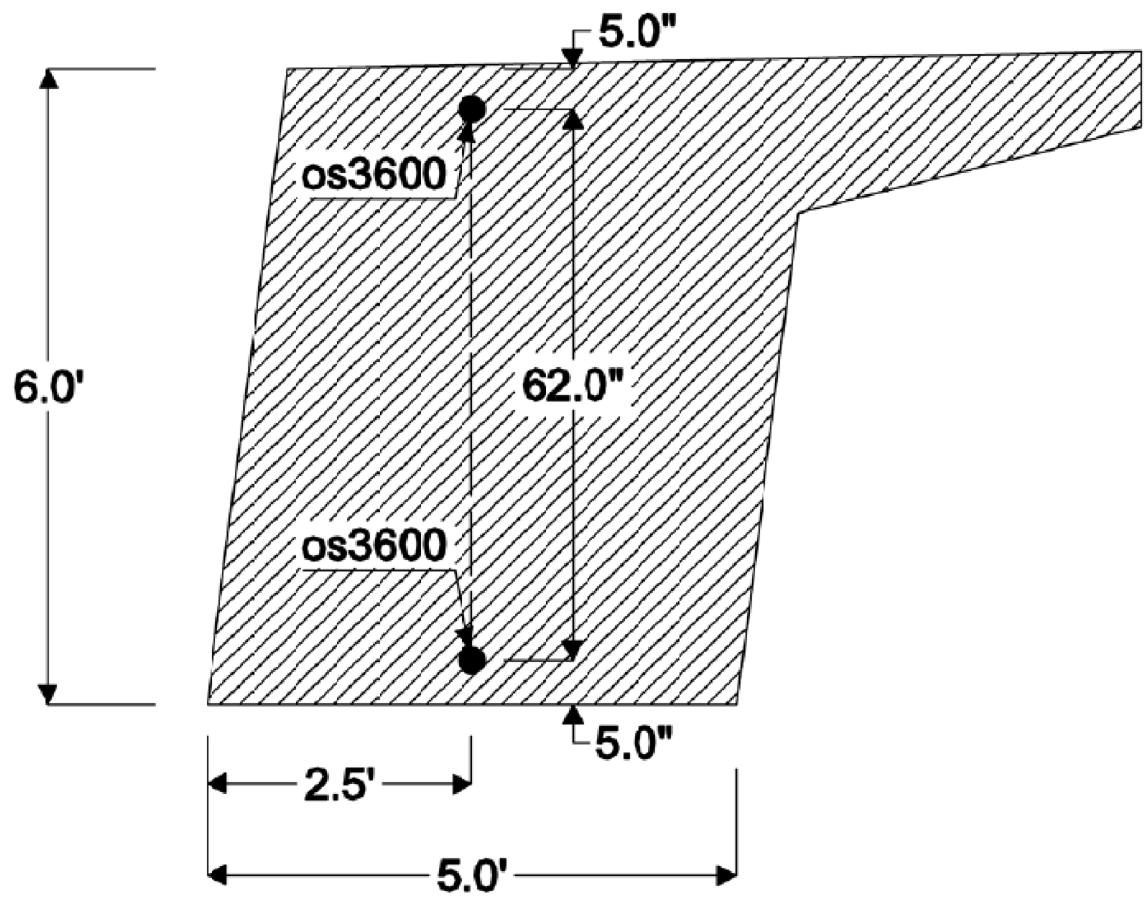

Figure 5. Cross-section of edge girder showing location of strain sensors

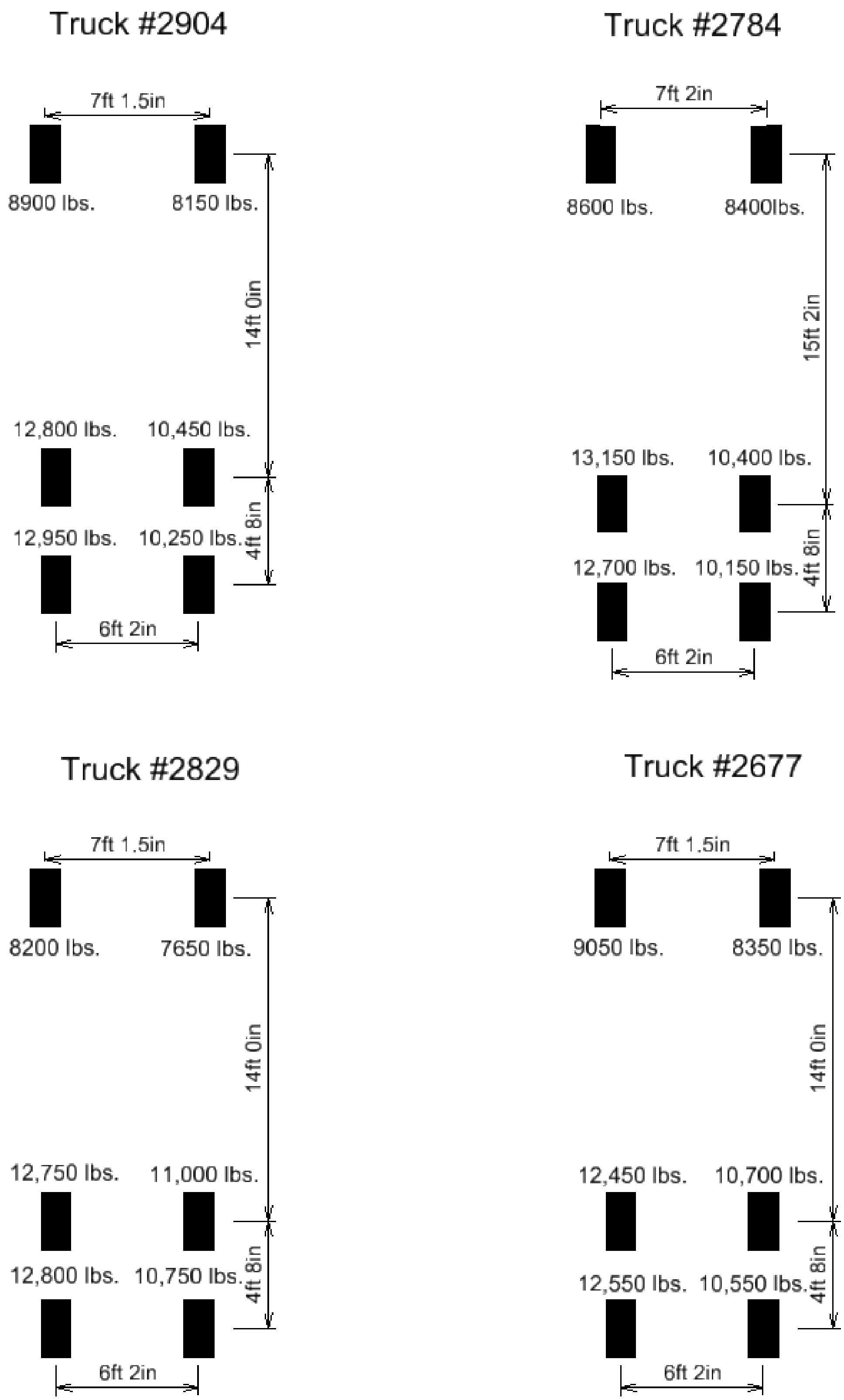

Figure 6. Vehicle layouts showing wheel weights

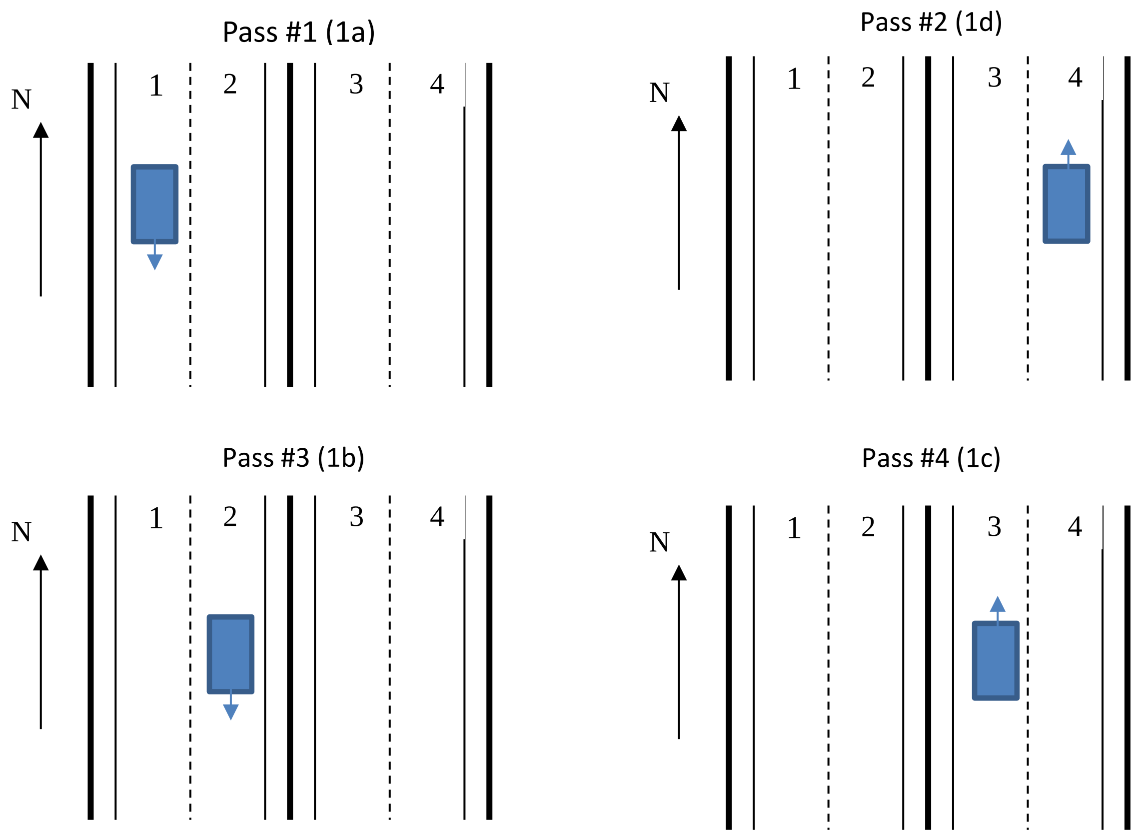

Figure 7. Single truck slow speed passes (All Truck #2829)

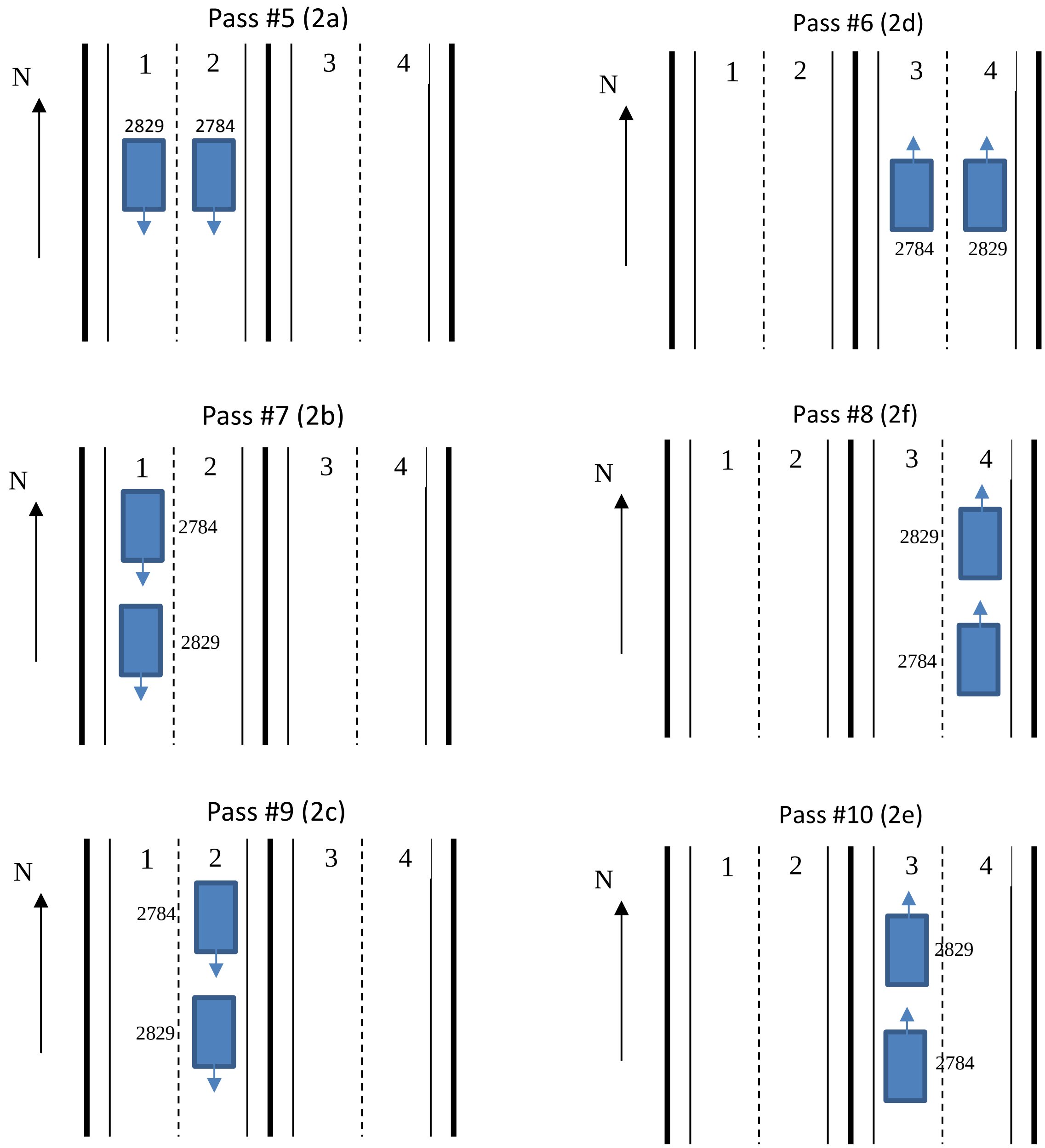

Figure 8. Dual truck slow speed passes

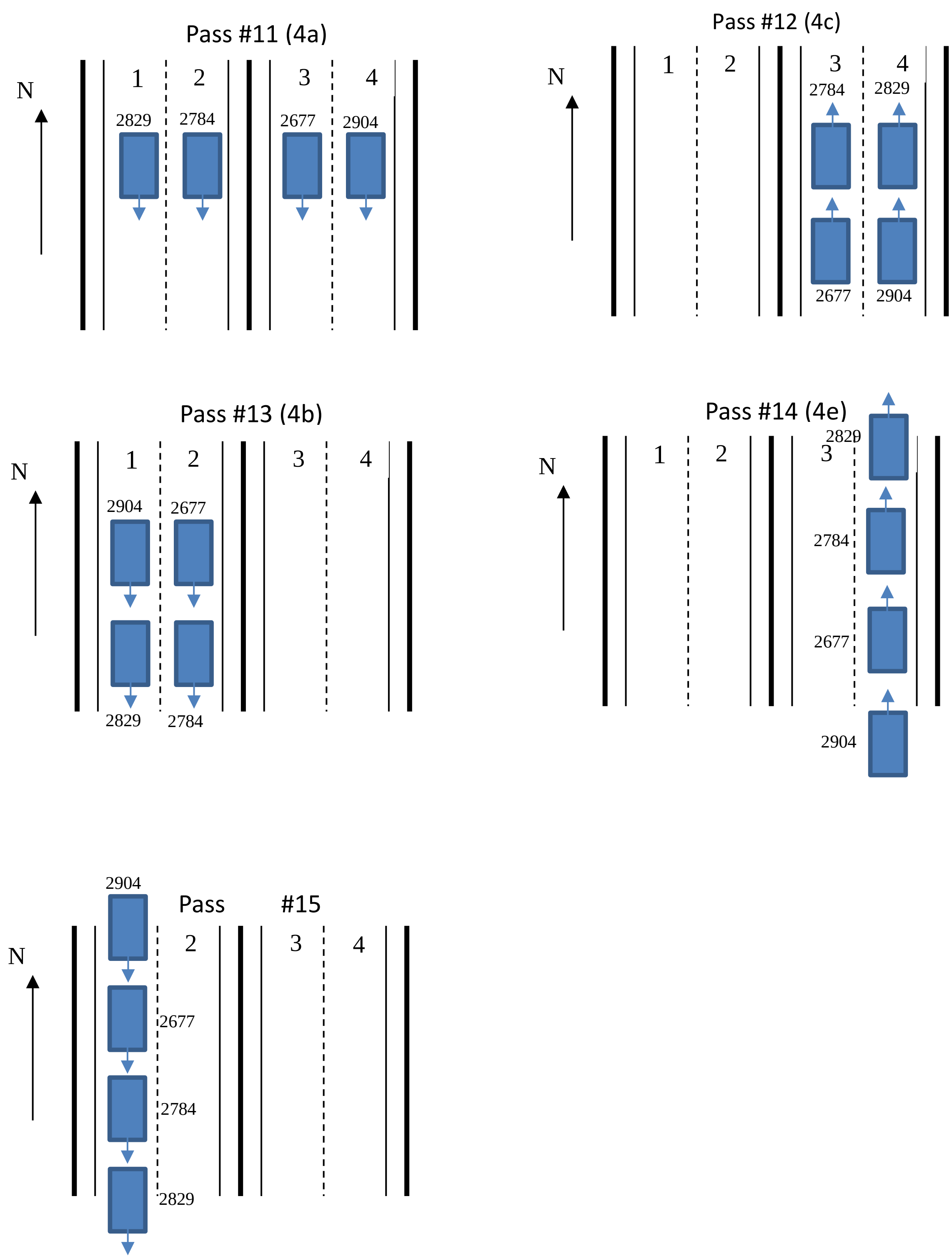

Figure 9. Four truck slow speed passes

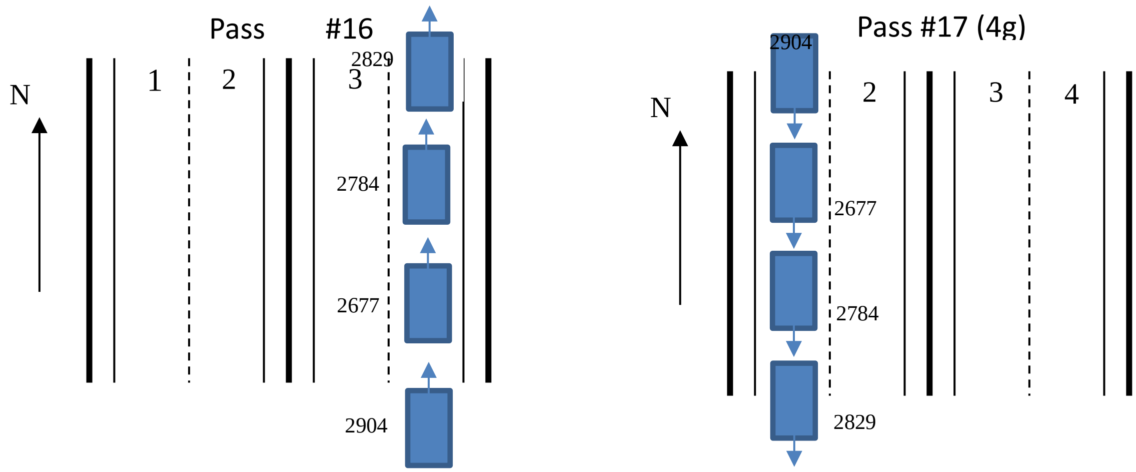

Figure 10. Four truck dynamic passes

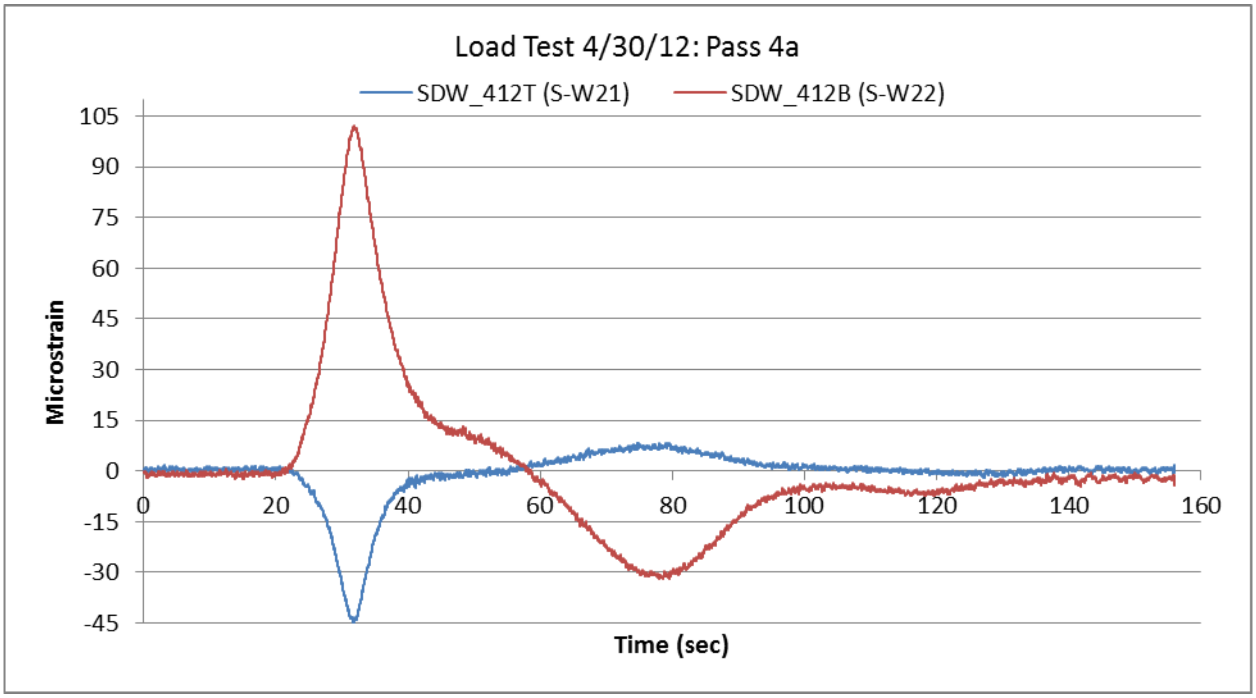

Figure 11. Edge girder strain time history - section 412

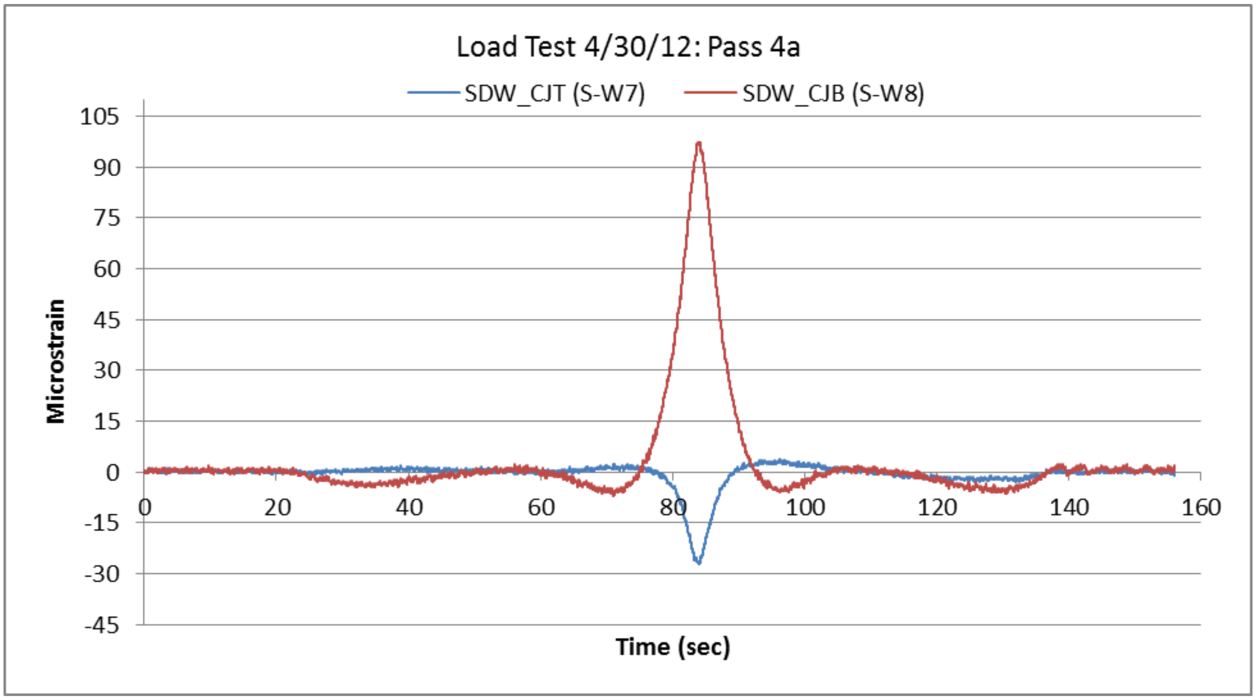

Figure 12. West edge girder strain time history - closure joint

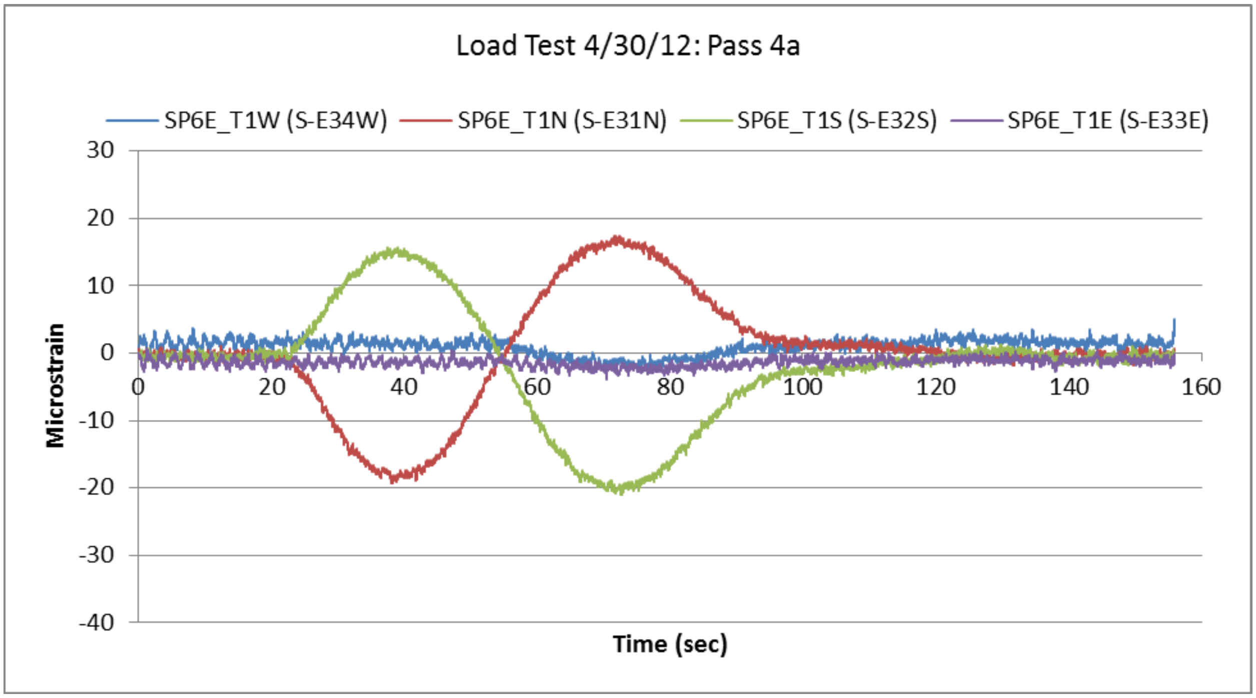

Figure 13. Pylon 6 east strain time history - lift T1

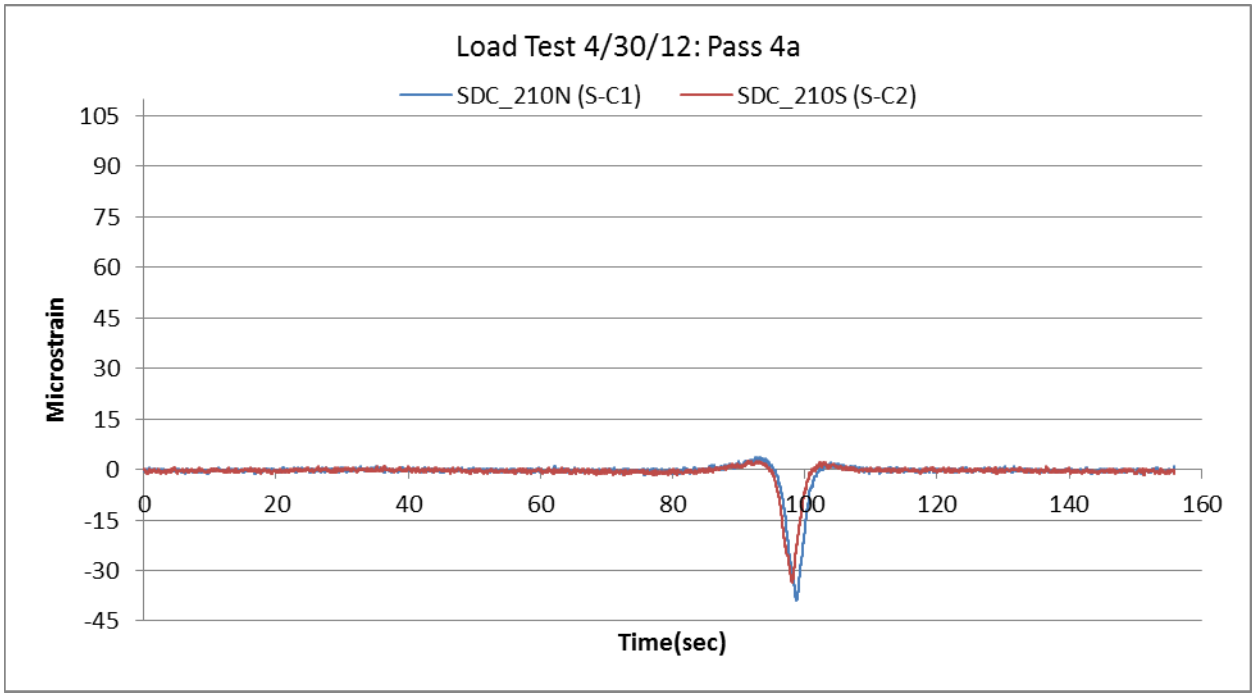

Figure 14. Deck strain time history - Section 210

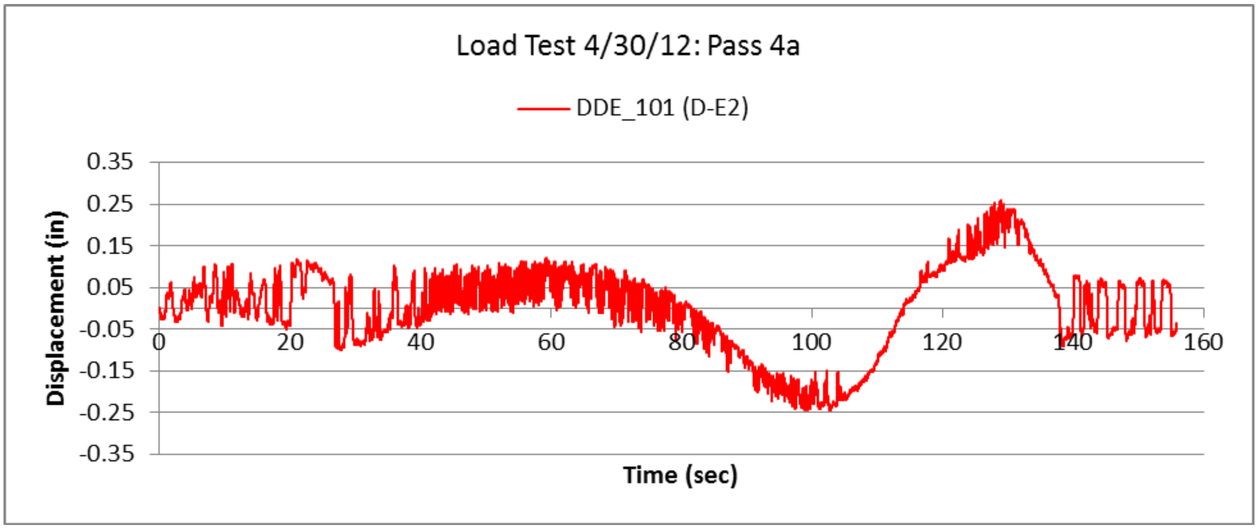

Figure 15. Bearing displacement time history – Pylon 5

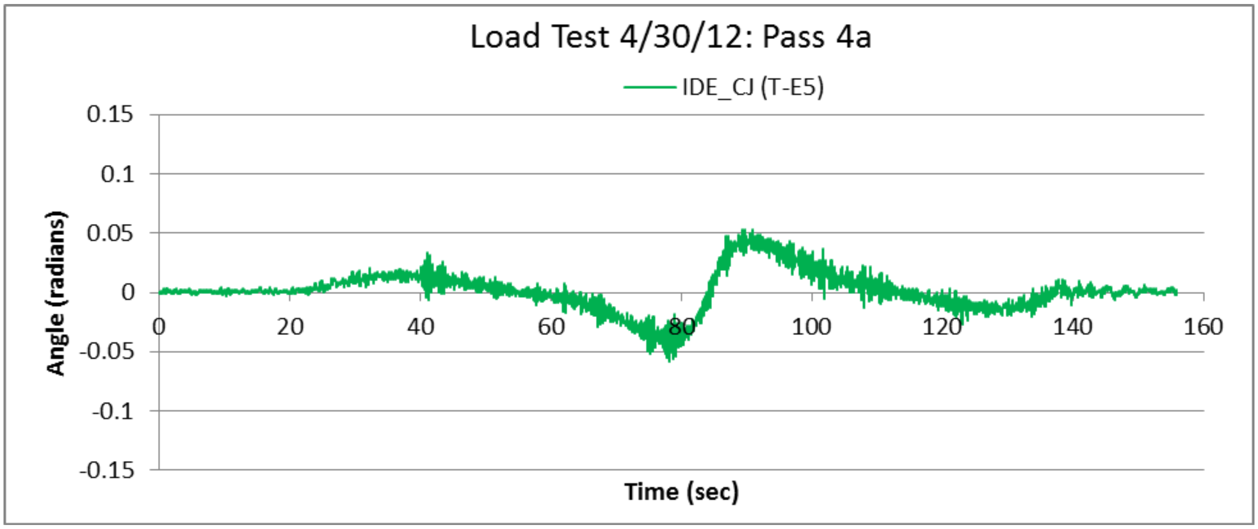

Figure 16. Deck tilt time history - Section Closure Joint

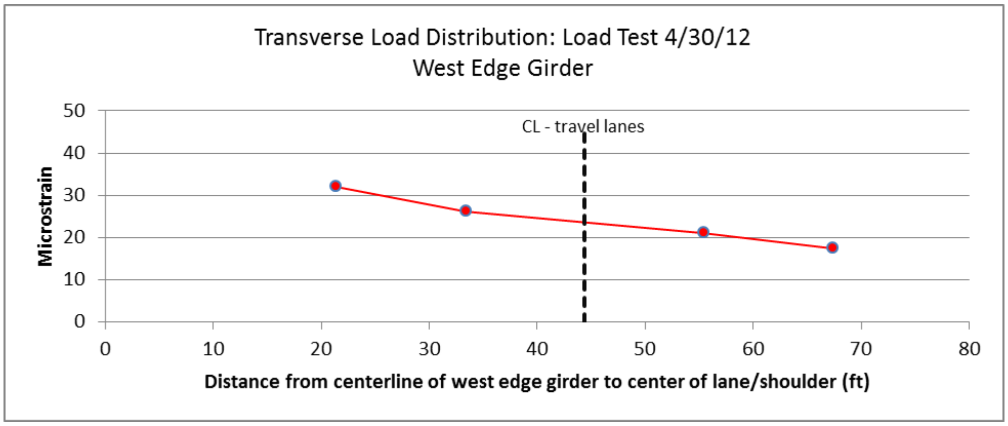

Figure 17. Transverse load distribution - west edge girder

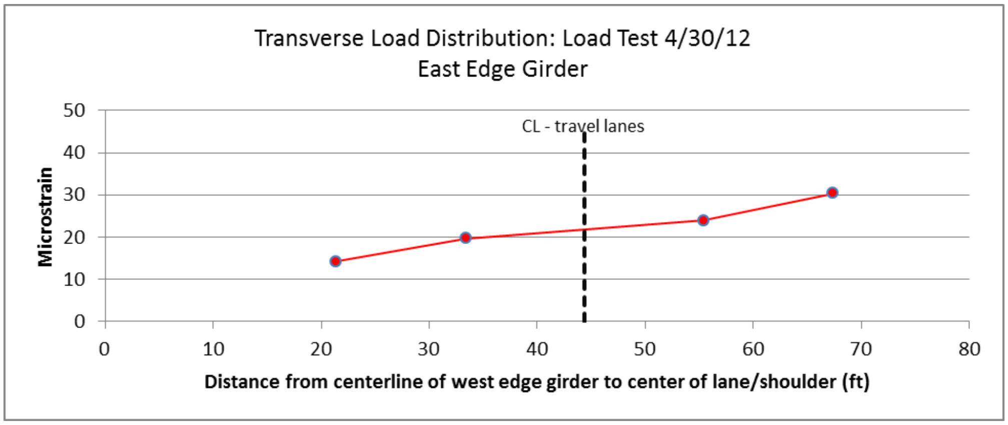

Figure 18. Transverse load distribution - east edge girder

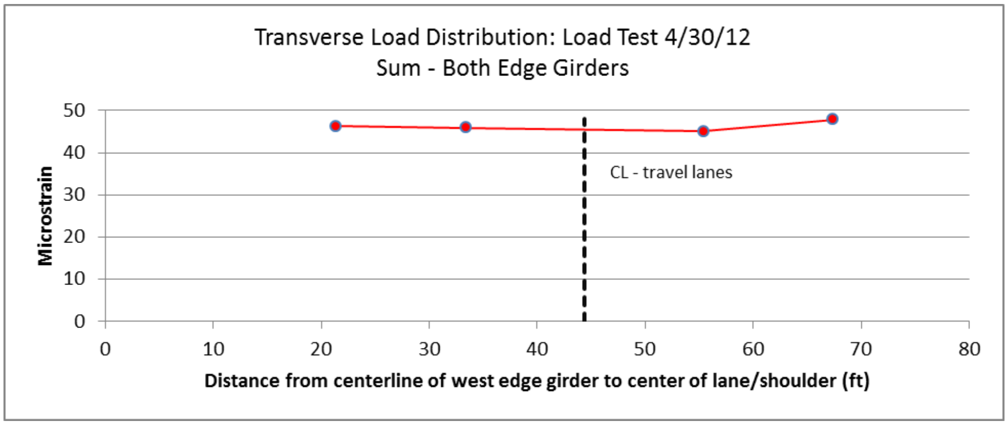

Figure 19. Transverse load distribution – sum both girders

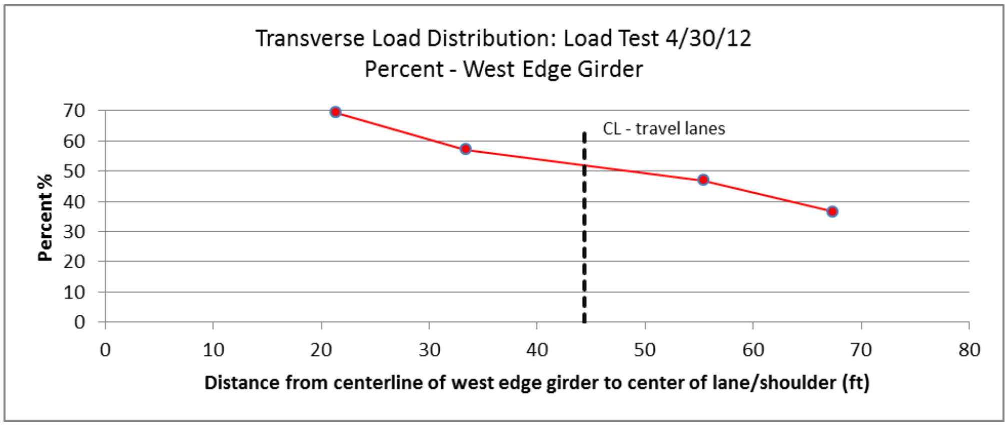

Figure 20. Transverse load distribution as a percent – west edge girder

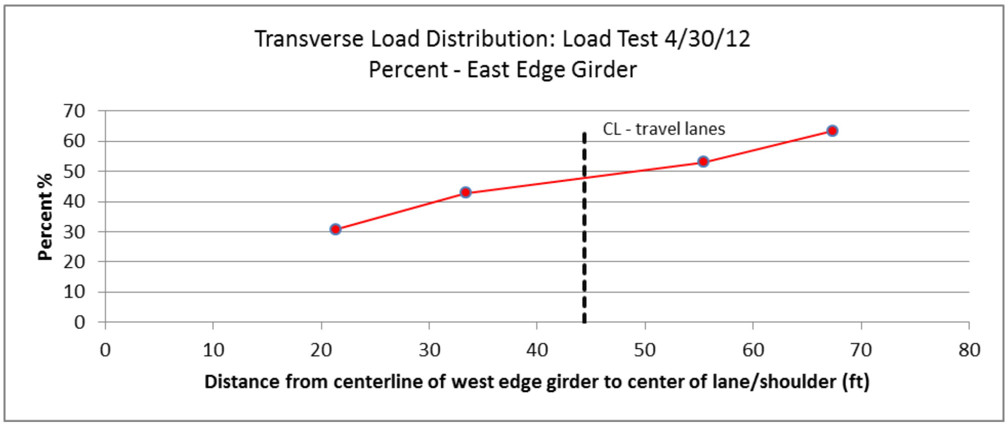

Figure 21. Transverse load distribution as a percent – east edge girder

Appendix A. Tables of results for Load Test 1 (4/30/12)

Table A.1 Bearing Displacement: Maximums

No. trucks	Pass	Displacement (in)	
		DDE_101 D-E2	DDE_415 D-E3
Slow speed passes			
1	1a	0.1	0.034
	1b	0.129	0.021
	1c	0.171	0.023
	1d	0.141	0.026
2	2a	0.197	0.046
	2b	0.089	0.031
	2c	0.133	0.055
	2d	0.126	0.056
	2e	0.108	0.043
	2f	0.171	0.033
4	4a	0.259	0.105
	4b	0.198	0.094
	4c	0.191	0.142
	4d	0.191	0.063
	4e	0.294	0.113
Maximum		0.294	0.142

High speed passes			
4	4f	0.218	0.056
	4g	0.089	0.021
Maximum		0.218	0.056

Table A.2 Bearing Displacement: Minimums

No. of trucks	Pass	Displacement (in) DDE_101 D-E2	Displacement (in) DDE_415 D-E3
Slow speed passes			
1	1a	-0.146	-0.011
	1b	-0.108	-0.022
	1c	-0.086	-0.022
	1d	-0.115	-0.022
2	2a	-0.109	-0.015
	2b	-0.238	-0.034
	2c	-0.184	-0.01
	2d	-0.242	-0.021
	2e	-0.237	-0.027
	2f	-0.191	-0.047
4	4a	-0.245	-0.124
	4b	-0.243	-0.116
	4c	-0.327	-0.069
	4d	-0.223	-0.109
	4e	-0.201	-0.081
Minimum		-0.327	-0.124

High speed passes			
4	4f	-0.175	-0.018
	4g	-0.251	-0.04
Minimum		-0.251	-0.04

Table A.3 Deck Tilt: Maximums

No. of trucks	Pass	Tilt sensor (rad.) IDE_115 T-E1	IDE_108 T-E2	IDE_101 T-E3	IDE_210 T-E4	IDE_CJ T-E5	IDE_310 T-E6	IDE_301 T-E7	IDE_408 T-E8	IDE_415 T-E9
Slow speed passes										
1	1a	0.041	0.025	0.014	0.008	0.015	0.016	0.024	0.022	0.039
	1b	0.036	0.016	0.02	0.007	0.017	0.019	0.016	0.032	0.048
	1c	0.05	0.025	0.028	0.005	0.024	0.026	0.024	0.028	0.074
	1d	0.034	0.02	0.029	0.006	0.023	0.026	0.017	0.034	0.081
2	2a	0.045	0.018	0.015	0.007	0.024	0.025	0.014	0.028	0.047
	2b	0.033	0.02	0.02	0.008	0.024	0.022	0.011	0.022	0.047
	2c	0.043	0.028	0.024	0.008	0.028	0.024	0.022	0.021	0.048
	2d	0.053	0.033	0.028	0.009	0.039	0.048	0.019	0.031	0.088
	2e	0.059	0.027	0.042	0.007	0.033	0.042	0.027	0.032	0.096
	2f	0.047	0.029	0.038	0.006	0.043	0.045	0.032	0.026	0.072
4	4a	0.072	0.045	0.04	0.014	0.053	0.067	0.027	0.039	0.091
	4b	0.086	0.036	0.032	0.009	0.039	0.05	0.024	0.026	0.087
	4c	0.096	0.052	0.058	0.011	0.065	0.07	0.033	0.038	0.116
	4d	0.056	0.028	0.034	0.01	0.036	0.035	0.022	0.026	0.079
	4e	0.076	0.047	0.06	0.009	0.066	0.066	0.035	0.032	0.133
Maximum		0.096	0.052	0.06	0.014	0.066	0.07	0.035	0.039	0.133

High speed passes										
4	4f	0.129	0.079	0.091	0.06	0.085	0.076	0.069	0.079	0.179
	4g	0.098	0.049	0.079	0.04	0.061	0.057	0.054	0.066	0.089
Maximum		0.129	.079	0.091	0.06	0.085	0.076	0.069	0.079	0.179

Table A.4 Deck Tilt: Minimums

No. of trucks	Pass	Tilt sensor (rad.) IDE_115 T-E1	IDE_108 T-E2	IDE_101 T-E3	IDE_210 T-E4	IDE_CJ T-E5	IDE_310 T-E6	IDE_301 T-E7	IDE_408 T-E8	IDE_415 T-E9
Slow speed passes										
1	1a	-0.064	-0.02	-0.018	-0.006	-0.015	-0.014	-0.019	-0.019	-0.032
	1b	-0.042	-0.014	-0.021	-0.007	-0.018	-0.017	-0.018	-0.021	-0.045
	1c	-0.059	-0.023	-0.029	-0.01	-0.026	-0.02	-0.023	-0.04	-0.053
	1d	-0.04	-0.016	-0.024	-0.009	-0.021	-0.015	-0.021	-0.027	-0.064
2	2a	-0.051	-0.018	-0.03	-0.009	-0.026	-0.016	-0.021	-0.024	-0.029
	2b	-0.077	-0.014	-0.02	-0.007	-0.023	-0.021	-0.02	-0.024	-0.03
	2c	-0.069	-0.015	-0.029	-0.01	-0.026	-0.028	-0.018	-0.021	-0.048
	2d	-0.061	-0.016	-0.033	-0.013	-0.031	-0.02	-0.029	-0.044	-0.052
	2e	-0.056	-0.03	-0.03	-0.014	-0.039	-0.019	-0.038	-0.059	-0.068
	2f	-0.056	-0.02	-0.027	-0.015	-0.042	-0.022	-0.021	-0.036	-0.051
4	4a	-0.116	-0.024	-0.031	-0.018	-0.058	-0.031	-0.041	-0.054	-0.058
	4b	-0.103	-0.024	-0.037	-0.015	-0.04	-0.027	-0.026	-0.04	-0.059
	4c	-0.102	-0.033	-0.042	-0.023	-0.066	-0.026	-0.038	-0.056	-0.071
	4d	-0.083	-0.02	-0.02	-0.011	-0.031	-0.016	-0.02	-0.033	-0.062
	4e	-0.109	-0.025	-0.037	-0.026	-0.067	-0.027	-0.035	-0.053	-0.066
Minimum		-0.116	-0.033	-0.042	-0.026	-0.067	-0.031	-0.041	-0.059	-0.071
High speed passes										
4	4f	-0.104	-0.06	-0.082	-0.053	-0.082	-0.069	-0.062	-0.094	-0.139
	4g	-0.16	-0.055	-0.075	-0.036	-0.048	-0.078	-0.06	-0.053	-0.087
Minimum		-0.16	-0.06	-0.082	-0.053	-0.082	-0.078	-0.062	-0.094	-0.139

Table A.5 Plyon 5E Strain: Maximums

No. of trucks	Pass	Strain sensor (με) (Below Deck – Level B1)				Strain sensor (με) (Above Deck – Level T4)			
		SP5E_B1W S-E26W	SP5E_B1N S-E23N	SP5E_B1E S-E25E	SP5E_B1S S-E24S	SP5E_T4W S-E30W	SP5E_T4N S-E27N	SP5E_T4E S-E29E	SP5E_T4S S-E28S
Slow speed passes									
1	1a	3.7	1	1.8	3.6	1.4	1.7	1.2	1.5
	1b	3.1	1.7	2	4.7	2.1	2.3	1.5	2
	1c	2.6	0.8	2.7	5.1	0.8	2.2	2	2.8
	1d	1.9	1.6	1.1	5.4	2	1.5	1.8	4.8
2	2a	1.8	1.9	1.2	6.7	1.8	1.7	1.5	4
	2b	1.5	0.8	2.1	6.3	1.3	1.4	1.7	2.9
	2c	0.9	2.6	1.2	7.5	1.1	2.1	1.3	5.2
	2d	2.5	2.3	1.8	10.7	1.2	3.2	2.6	5.9
	2e	2.4	1.5	1.9	10.1	0.5	2.1	2.4	5.1
	2f	1.4	1.9	1.5	11.5	2.1	2.9	1.4	5.4
4	4a	2.8	1.8	2.1	18	1.1	3	1.1	9
	4b	1.8	2.4	1.6	12.8	1.2	3.5	1.7	5.7
	4c	2.3	2.5	2.1	19.4	2.2	3	1.5	10.3
	4d	1.9	1.4	1.3	11	1.8	2	1.5	4.6
	4e	2.2	3.6	1.5	21.4	1.2	2.6	1.4	11.4
Maximum		3.7	3.6	2.7	21.4	2.2	3.5	2.6	11.4

High speed passes									
4	4f	1.7	2.3	1.3	15.7	1.1	2	1.6	6.1
	4g	3	2.2	4.2	8.2	0.6	1.6	1.7	4.7
Maximum		3	2.3	4.2	15.7	1.1	1.6	1.7	4.7

Table A.6 Plyon 5E Strain: Minimums

No. of trucks	Pass	Strain sensor (με)(Below Deck – Level B1)				Strain sensor (με) (Above Deck – Level T4)			
		SP5E_B1W S-E26W	SP5E_B1N S-E23N	SP5E_B1E S-E25E	SP5E_B1S S-E24S	SP5E_T4W S-E30W	SP5E_T4N S-E27N	SP5E_T4E S-E29E	SP5E_T4S S-E28S
Slow speed passes									
1	1a	-1	-2	-1	-3.4	-1.7	-3.3	-1.6	-2.1
	1b	-1.7	-2.6	-1.3	-4.8	-2.3	-2.9	-1.4	-2.7
	1c	-1	-2.4	-1.3	-6.6	-2.8	-4.3	-1.6	-2.4
	1d	-1.8	-1.8	-2.1	-7.9	-2.7	-5.1	-1.5	-1.8
2	2a	-2	-2.3	-2.5	-7.2	-2.2	-5	-1.9	-2.2
	2b	-1.7	-2.3	-1.3	-6.2	-2	-4	-2.3	-4.5
	2c	-3.2	-1.3	-1.9	-7.8	-2.7	-4.9	-1.9	-1.9
	2d	-1.4	-2.4	-2.4	-12.4	-3.8	-7.4	-2	-4.3
	2e	-1.7	-3.3	-1.9	-10.2	-5.8	-7.5	-1.6	-4
	2f	-2.1	-2.4	-1.5	-13.2	-2.9	-7.7	-2.3	-5.4
4	4a	-1.7	-2.6	-2	-17.9	-5	-12	-2.3	-5.9
	4b	-2.3	-3.7	-1.9	-13.5	-3.4	-7.1	-1.8	-4.4
	4c	-2.5	-3	-3.1	-25	-4.6	-15.1	-3.4	-7.8
	4d	-2.1	-3.2	-2.1	-10.5	-2.7	-6.2	-2.2	-4
	4e	-2.3	-3.1	-2.8	-23.6	-5.8	-15.6	-2.7	-6
Minimum		-3.2	-3.7	-3.1	-25	-5.8	-15.6	-3.4	-7.8

High speed passes									
4	4f	-2.6	-6.7	-2.3	-14.1	-4.9	-10.4	-2.7	-5.1
	4g	-1.8	-1.4	-1.8	-6.7	-2.9	-4.5	-2	-1
Minimum		-2.6	-6.7	-2.3	-14.1	-4.9	-10.4	-2.7	-5.1

Table A.7 Plyon 6E Strain: Maximums

No. of trucks	Pass	Strain sensor (με) (Above Deck – Level T1)				Strain sensor (με) (Above Deck – Level T4)			
		SP6E_T1W S-E34W	SP6E_T1N-E31N	SP6E_T1E S-E33E	SP6E_T1S S-E32S	SP6E_T4W S-E38W	SP6E_T4N S-E35N	SP6E_T4E S-E37E	SP6E_T4S S-E36S
Slow speed passes									
1	1a	4.6	3.3	2	3.3	2.4	3.6	3	2.1
	1b	3.9	4.4	4.1	2.9	2.5	2.7	2.2	1.4
	1c	1.5	5.3	1	4.1	1.8	3.2	1.3	2.1
	1d	2	6.4	1.4	5.2	1.2	3.6	1.9	1.8
2	2a	2.5	5.8	4	6	2	4.3	2.5	2.8
	2b	3.4	5.9	1	5.1	2.2	4.3	1.4	1.9
	2c	0.7	7	4.5	6.5	1.4	4	4	1.5
	2d	2.2	11.4	3	9.3	2.9	6.4	1.4	4.5
	2e	2	9.6	1.7	8.2	2.4	5.9	1.8	1.8
	2f	4	12.2	3	10	1.5	7.8	1.9	2.7
4	4a	5	17.4	0.7	15.6	3.8	10.8	0.8	4.4
	4b	2	13.9	1.9	12	2.2	8	1.8	3.3
	4c	2.1	21	1.9	17.3	1.5	13.4	1.2	3.1
	4d	1.2	11.6	4.4	9.3	4.3	6.2	2.2	2.2
	4e	2.3	23.2	4.3	17.5	2.5	13.6	2	3.4
Maximum		5	23.2	4.5	17.5	4.3	13.6	4	4.5
High speed passes									
4	4f	4.8	16.4	1.9	9.3	2.3	9.2	2.6	2.3
	4g	2.1	8.1	2.5	6.2	1.6	4.2	2.4	2
Maximum		4.8	16.4	2.5	9.3	2.3	9.2	2.6	2.3

Table A.8 Plyon 6E Strain: Minimums

No. of trucks	Pass	Strain sensor (με) (Above Deck – Level T1)				Strain sensor (με) (Above Deck – Level T4)			
		SP6E_T1W S-E34W	SP6E_T1N-E31N	SP6E_T1E S-E33E	SP6E_T1S S-E32S	SP6E_T4W S-E38W	SP6E_T4N S-E35N	SP6E_T4E S-E37E	SP6E_T4S S-E36S
Slow speed passes									
1	1a	-0.9	-3.9	-3.2	-3.4	-2.2	-1.4	-1.1	-2.3
	1b	-2.6	-4.6	-6	-6.1	-3.9	-2.9	-1.4	-3.8
	1c	-2.7	-5.5	-2.3	-6.7	-1.6	-3.8	-1.6	-4.1
	1d	-2	-6.4	-2.3	-7.2	-2.8	-3	-1.4	-5.1
2	2a	-2.3	-7.9	-3.2	-7.8	-2.9	-2.5	-1.5	-4.8
	2b	-4.1	-6.1	-2.8	-6.5	-4.1	-1.7	-2.7	-4.6
	2c	-4	-8.3	-1.9	-8.3	-3	-3.2	-0.8	-6.6
	2d	-3.1	-10.8	-2.9	-13.2	-1.7	-4.4	-2	-9.5
	2e	-2.9	-9.9	-2.1	-11.4	-1.5	-3.4	-1.2	-8.9
	2f	-3.4	-12	-1.8	-14.1	-2.2	-3.8	-1.7	-10.2
4	4a	-2.6	-19.3	-3.9	-21	-1.7	-6	-3.2	-14.2
	4b	-3.4	-13.1	-1.7	-14.8	-1.9	-4.5	-2.2	-9.9
	4c	-5.3	-21.8	-2.9	-26.4	-2	-5.9	-2.4	-18.6
	4d	-3.6	-10.7	-2.2	-12.5	-1.4	-3.6	-3.7	-7.5
	4e	-6.4	-21	-2.3	-28	-3.1	-5.7	-2.3	-18.4
Minimum		-6.4	-21.8	-6	-28	-4.1	-6	-3.7	-18.6

High speed passes									
4	4f	-4.1	-11.1	-3.5	-19.9	-2.7	-4.8	-2.1	-12.6
	4g	-2.3	-6.8	-1.9	-9.9	-2.7	-1.7	-1.1	-5.4
Minimum		-4.1	-11.1	-3.5	-19.9	-2.7	-4.8	-2.1	-12.6

Table A.9 Pylon 6W Strain: Maximums

No. of trucks	Pass	Strain sensor (με) (Above Deck – Level T1)				Strain sensor (με) (Above Deck – Level T4)			
		SP6W_T1W S-W26W	SP6W_T1N S-W23N	SP6W_T1E S-W25E	SP6W_T1S S-W24S	SP6W_T4W S-W30W	SP6W_T4E S-W29E	SP6W_T4S S-W28S	SP6W_T4N S-W27N
Slow speed passes									
1	1a	1.3	3.2	2.1	8.1	0.3	1.1	4	5.8
	1b	0.2	1.2	2.1	8.2	2.2	1.3	2.5	5.1
	1c	1.9	2.3	0.6	4.9	1.2	1.6	1.5	4
	1d	1.3	2	2.3	5.4	2.5	2.1	2.3	3.5
2	2a	1.3	2.8	2.2	14.2	5.2	1.4	3.5	9.4
	2b	2.8	2.2	2	14.9	1.8	2.4	3.1	10.4
	2c	2	1.9	2.3	12.3	3	1.6	3.9	9.5
	2d	1.8	2	1.5	9.4	2.1	2.5	4.1	6.8
	2e	1	1.4	2.8	10.8	2.1	2.2	3	7.6
	2f	3.7	1.5	1.3	8.3	2.9	1.4	2.6	5.6
4	4a	2.9	3	2.4	24.9	1.9	1.3	6.6	16
	4b	1.7	3.6	2.7	27.6	3.2	1.8	6.8	18.5
	4c	1.3	2.4	2	19.5	2.5	1.7	4.6	12.1
	4d	0.8	3.4	1.8	26.6	1.6	1.4	5.8	17.6
	4e	2.2	2	1.4	17.7	1.3	2	4.3	9.5
Maximum		3.7	3.6	2.8	27.6	5.2	2.5	6.8	18.5

High speed passes									
4	4f	1.9	2	1.6	10.1	1.4	2.4	3.3	6.9
	4g	2.1	2.2	2.2	16.5	1.3	1.7	2.8	12.2
Maximum		2.1	2.2	2.2	16.5	1.4	2.4	3.3	12.2

Table A.10 Pylon 6W Strain: Minimums

No. of trucks	Pass	Strain sensor (με) (Above Deck – Level T1)				Strain sensor (με) (Above Deck – Level T4)			
		SP6W_T1W S-W26W	SP6W_T1N S-W23N	SP6W_T1E S-W25E	SP6W_T1S S-W24S	SP6W_T4W S-W30W	SP6W_T4E S-W29E	SP6W_T4S S-W28S	SP6W_T4N S-W27N
Slow speed passes									
1	1a	-3.5	-1.8	-2.7	-10	-3.7	-3	-8	-2.9
	1b	-3.2	-4	-2.1	-8.1	-2.7	-2.2	-5.9	-2.9
	1c	-1.1	-1.3	-2.5	-8	-2.2	-1.3	-5.5	-2.3
	1d	-2.3	-0.9	-1.6	-5.4	-1.6	-1.6	-4.3	-2
2	2a	-3.3	-2.5	-2.8	-18.7	-3.3	-3	-13.6	-5.4
	2b	-2.1	-2.8	-3.6	-20.4	-4.6	-2.2	-14.9	-5
	2c	-1.8	-2.4	-3	-18.1	-3	-4.1	-11.9	-4.8
	2d	-2.2	-2.2	-2.3	-12.6	-2.7	-2.5	-9.1	-3.8
	2e	-3	-2.4	-1.6	-14.3	-2.6	-2.9	-9.9	-3.9
	2f	-1.3	-4.2	-3	-11.4	-2	-2.2	-8	-4.3
4	4a	-2.6	-2.8	-3.8	-30.3	-5.4	-3	-21.1	-8.8
	4b	-3	-2.9	-4.3	-37.1	-4.6	-3.7	-24.8	-9.5
	4c	-3.1	-3.3	-3.3	-23.1	-3.8	-2.5	-16	-7.8
	4d	-3.1	-3.2	-5.8	-37.5	-6.4	-3.5	-25	-9.3
	4e	-1.7	-3	-3.8	-18.9	-3.8	-2.8	-13.1	-5.9
Minimum		-3.5	-4.2	-5.8	-37.5	-6.4	-4.1	-25	-9.5
High speed passes									
4	4f	-2.1	-4.8	-3.7	-15.4	-3.6	-1.9	-9.1	-3.9
	4g	-2.8	-3.5	-4.1	-30.9	-5	-3.6	-18.4	-5.1
Minimum		-2.8	-4.8	-4.1	-30.9	-5	-3.6	-18.4	-5.1

Table A.11 East Edge Girder – Top Strain: Maximums

No. of trucks	Pass	Strain sensor (με)										
		SDE_108T S-E1	SDE_101T S-E3	SDE_210T S-E5	SDE_CJT S-E7	SDE_315T S-E9	SDE_310T S-E11	SDE_305T S-E13	SDE_301T S-E15	SDE_404T S-E17	SDE_408T S-E19	SDE_412T S-E21
Slow speed passes												
1	1a	2.1	1.6	2	2.1	1	1.8	2.7	2.6	1.8	2.2	2.4
	1b	1.4	1.8	2.5	2.3	2	0.8	1.2	4.2	2.2	1.4	2.1
	1c	4.7	1.6	1.1	2.1	1.2	1.7	4.4	5.8	2.6	2	1.6
	1d	1.9	1.8	3.2	1.8	1.9	1.7	3.4	7	2	2.7	2.9
2	2a	1.4	2.3	2.8	1.9	1.7	2.8	2.3	5.1	1.3	3.2	2.8
	2b	1.5	1.6	2	2	1.8	1.9	2	2.9	1.3	1.8	2.3
	2c	5	1.7	1.2	1.6	2.2	2.3	3.2	5.8	1.9	1.1	4
	2d	1.6	1.8	4	3.4	2.4	2.1	4.3	12.6	3.8	2.4	4
	2e	2.4	1.3	2.6	2.8	3.4	2.8	3.4	9.3	3.5	1.8	3.9
	2f	2.1	1.9	2.8	4	3.8	2.3	4	11.9	4.2	1.3	3.7
4	4a	2.2	0.9	3.5	2.8	4.2	2.7	4.4	16.9	6.2	3.7	5.9
	4b	2.8	2.4	2.5	1.9	1.9	4.8	2.1	8.4	2.1	2.1	6
	4c	2.2	1.5	4.3	4.3	5.6	2.1	3.9	21.3	6.1	2.2	7.5
	4d	2.7	2.3	1.8	1.5	2	3.1	2.3	5	2.1	1.8	4.7
	4e	4.9	1	4.4	5.3	6	2.5	3.9	20.9	4.7	1.4	6.1
Maximum		5	2.4	4.4	5.3	6	4.8	4.4	21.3	6.2	3.7	7.5

High speed passes												
4	4f	2.8	3.5	3.4	2.3	3.5	2.9	3.8	9.6	3.3	2.6	5.2
	4g	2.1	3	2.4	2.9	2.8	1.8	2.2	3.3	1.9	1.9	3.7
Maximum		2.8	3.5	3.4	2.9	3.5	2.9	3.8	9.6	3.3	2.6	5.2

Table A.12 East Edge Girder – Top Strain: Minimums

No. of trucks	Pass	Strain sensor (με)										
		SDE_108T S-E1	SDE_101T S-E3	SDE_210T S-E5	SDE_CJT S-E7	SDE_315T S-E9	SDE_310T S-E11	SDE_305T S-E13	SDE_301T S-E15	SDE_404T S-E17	SDE_408T S-E19	SDE_412T S-E21
Slow speed passes												
1	1a	-1.8	-3.8	-1.9	-1.3	-1.8	-1.5	-1.4	-1.9	-0.9	-1	-3.2
	1b	-3.2	-5.1	-3.3	-3.7	-3.5	-3.4	-4.9	-1.9	-3	-3.6	-6.2
	1c	-4.2	-8.2	-7.6	-7.3	-7.9	-5.8	-7.9	-3.4	-5.4	-5.1	-10.7
	1d	-7.6	-9.5	-8.9	-11.5	-11.1	-9	-10.7	-3.2	-9.1	-8	-14.5
2	2a	-2.7	-7.5	-2.1	-3.8	-3	-1.8	-4.4	-2.9	-3.6	-2.5	-9.2
	2b	-1.7	-6.4	-2.6	-5.3	-2.1	-2.4	-2.7	-3.2	-1.6	-2.3	-7.1
	2c	-3.3	-9	-4.6	-5.9	-4.3	-3.6	-5.6	-2.6	-3.6	-4.1	-9.4
	2d	-12.2	-16.5	-15.7	-18.6	-18.7	-14.5	-17.6	-3.6	-14.8	-13.5	-24
	2e	-6.9	-14.1	-8.5	-11.7	-10.2	-8.3	-10.6	-3.5	-7	-8.1	-16.3
	2f	-10.8	-17.6	-12.7	-16.2	-16.3	-12.7	-13.8	-4.2	-11.6	-11.9	-21.7
4	4a	-15.3	-25.3	-17.3	-22.3	-20.4	-17.3	-21.8	-4.7	-15.5	-14.7	-33.3
	4b	-1.2	-13.9	-3.3	-5.2	-4.1	-3.3	-4.3	-4.3	-2.9	-3	-12.6
	4c	-11.9	-29.4	-15.6	-21.1	-20.7	-16.2	-17.5	-5.6	-14.2	-12.9	-27.2
	4d	-1.2	-10.1	-3.9	-4.6	-3.3	-2	-3	-3.7	-2.8	-3.3	-8
	4e	-9.6	-31.3	-10.5	-15.5	-16	-12.4	-12.3	-6.2	-11.4	-11.2	-23.2
Minimum		-15.3	-31.3	-17.3	-22.3	-20.7	-17.3	-21.8	-6.2	-15.5	-14.7	-33.3
High speed passes												
4	4f	-6.8	-21.2	-9.5	-12	-12.3	-10	-12	-5	-10.3	-9.4	-15.4
	4g	-1.6	-9	-2.3	-2.4	-3	-2.7	-2.7	-3	-2.3	-2.1	-4.8
Minimum		-6.8	-21.2	-9.5	-12	-12.3	-10	-12	-5	-10.3	-9.4	-15.4

Table A.13 East Edge Girder – Bottom Strain: Maximums

No. of trucks	Pass	Strain sensor (με)										
		SDE_108B S-E2	SDE_101B S-E4	SDE_210B S-E6	SDE_CJB S-E8	SDE_315B S-E10	SDE_E310B S-E12	SDE_305B S-E14	SDE_301B S-E16	SDE_404B S-E18	SDE_408B S-E20	SDE_412B S-E22
Slow speed passes												
1	1a	8.4	2.3	11.1	12.3	10.4	7.2	6.2	2.5	5.8	9.6	14.2
	1b	11.5	3.9	11.9	18.3	16.5	10.6	9.4	2.5	8.9	13.2	19.7
	1c	16.5	5.2	20.8	24.9	21.6	15.2	14.5	2	12.8	20.2	23.9
	1d	21.2	7.2	25.5	30.9	27.2	20.4	18.6	1.7	18.5	25.8	30.3
2	2a	18.5	5.1	25.5	27.9	24.5	17.6	14.6	2.3	13.5	22.1	34.1
	2b	12.3	3.3	16.8	22.5	19.2	11.6	10.5	2.3	8.8	15.9	26.8
	2c	20.2	5.4	24.4	30	27	18.3	16.7	2.5	13.3	22.8	34.1
	2d	38.6	11.8	45	56.5	48.2	35.4	31.4	1.3	30.4	44.1	52
	2e	27.6	8.4	32.2	43.7	36.2	26	22.6	3.4	19.2	33	42.3
	2f	34.9	11.8	38.4	52.9	45.1	32	25.5	1.5	25.6	40.5	48.8
4	4a	58.3	14.8	64.4	85.5	72.9	54	45.9	2.2	40.5	65.4	89.1
	4b	26.8	6.9	30.1	45.6	40	23.6	18.3	2.9	13.4	30.3	54.1
	4c	44.5	22	53.1	77.8	63.2	42.7	33.5	2.1	33.1	52.4	72.5
	4d	17.3	4.6	14.6	27	25.2	13.2	10.8	3.5	7	17.6	38.5
	4e	35.1	20.4	43	61.3	47	24.5	21.1	2.8	23	40.1	61.1
Maximum		58.3	22	64.4	85.5	72.9	54	45.9	3.5	40.5	65.4	89.1

High speed passes												
4	4f	25.4	10.7	29.3	44.5	31.7	16.2	16.8	3.5	17.2	29.5	32
	4g	11.4	3.1	9.4	15.9	15.2	7.5	5.2	3.4	4	9.8	20.5
Maximum		25.4	10.7	29.3	44.5	31.7	16.2	16.8	3.5	17.2	29.5	32

Table A.14 East Edge Girder – Bottom Strain: Minimums

No. of trucks	Pass	Strain sensor (με) SDE_108B S-E2	SDE_101B S-E4	SDE_210B S-E6	SDE_CJB S-E8	SDE_315B S-E10	SDE_E310B S-E12	SDE_305B S-E14	SDE_301B S-E16	SDE_404B S-E18	SDE_408B S-E20	SDE_412B S-E22
Slow speed passes												
1	1a	-3.1	-2.3	-4.6	-2.2	-3.9	-3.3	-4.1	-3.1	-4.1	-3.8	-5.9
	1b	-5.1	-1.8	-8.6	-1.6	-4.8	-5.5	-5.6	-4.3	-5.3	-4.9	-6.3
	1c	-5.5	-2.6	-6.7	-2.3	-5.9	-7.3	-7.2	-7.5	-7.4	-5.2	-7.7
	1d	-6.5	-2.8	-8.7	-3.2	-6.5	-7.4	-7.5	-9.1	-7.7	-6.3	-8.1
2	2a	-6.1	-2.6	-7.3	-3.9	-7.6	-7	-8.3	-8.3	-9.1	-6.2	-9.5
	2b	-6	-2.9	-7.6	-2.7	-6.6	-7	-6.7	-5.7	-7.3	-5.4	-10.7
	2c	-6.5	-3.4	-8.6	-3.8	-7.1	-7	-8.1	-8.1	-10	-6.9	-11.2
	2d	-10	-4.1	-13.8	-3.8	-10.8	-12.7	-15.8	-15	-13.8	-10.1	-15.4
	2e	-8	-3.8	-11.7	-3.3	-10.7	-11.6	-13.2	-11.3	-13.2	-9.5	-15
	2f	-9.9	-4.3	-15.7	-4.5	-11.9	-12.9	-17	-16.3	-15.3	-10.1	-16.7
4	4a	-15.7	-5.6	-21.7	-6.2	-17.5	-19.6	-22.7	-21	-21.5	-14.7	-28.3
	4b	-11.4	-4.2	-16.1	-6.4	-12.3	-13.2	-15.5	-12.8	-16.3	-10	-27
	4c	-19	-6.7	-25.9	-7.3	-21.5	-23.5	-29.1	-24.2	-24.2	-18.4	-32.5
	4d	-8.8	-3.9	-13	-5	-8.9	-8.8	-10.4	-8.4	-11.5	-8.4	-22.4
	4e	-19.2	-7.7	-24.7	-6.4	-21.2	-23.2	-28.5	-26	-22.3	-19	-32.6
Minimum		-19.2	-7.7	-25.9	-7.3	-21.5	-23.5	-29.1	-26	-24.2	-19	-32.6
High speed passes												
4	4f	-14.7	-5.2	-14.5	-8.8	-15.6	-18.2	-18.3	-17.2	-18.1	-14.6	-22.5
	4g	-7	-2.8	-8.7	-7.1	-7.2	-6.3	-5.7	-7.6	-6.1	-7.9	-15.9
Minimum		-14.7	-5.2	-14.5	-8.8	-15.6	-18.2	-18.3	-17.2	-18.1	-14.6	-22.5

Table A.15 West Edge Girder – Top Strain: Maximums

No. of trucks	Pass	Strain sensor (με) SDW_108T S-W1	SDW_101T S-W3	SDW_210T S-W5	SDW_CJT S-W7	SDW_315T S-W9	SDW_310T S-W11	SDW_305T S-W13	SDW_301T S-W15	SDW_404T S-W17	SDW_408T S-W19	SDW_412T S-W21
Slow speed passes												
1	1a	1.4	7.6	3.8	0.6	2.2	1	2.9	7.6	3.1	1.2	3.1
	1b	1.6	7.2	2.7	1.2	4.3	1.2	1.6	6.9	2.5	0.9	2.1
	1c	0.7	4.8	2.2	1.1	2.9	3.3	0.8	5.2	1.2	2.2	2.4
	1d	1.2	3	1.5	3.3	3.1	1.8	1.8	4	2.1	2.7	2.4
2	2a	2.2	12.6	2.9	3.3	5.6	1.8	3.9	13.1	4.1	2.7	4.4
	2b	1.7	13.1	3.2	3.3	4.8	2.5	3.1	12.8	4	2.4	5.4
	2c	2.2	10.2	2.3	3	5.1	4.4	3.4	11.2	3.1	1.9	4.3
	2d	1.6	6.7	2.4	1.3	7.2	2.1	2.7	7.3	1.7	2.1	4.4
	2e	2	7.6	1.5	2.2	2.2	2.2	2.2	8.1	1.4	3.1	4.6
	2f	2.2	5.3	2.4	1.9	2.9	2	2.3	6.1	0.9	1.5	2.9
4	4a	2.3	17.7	4.2	3.7	5	2.6	3.9	20.5	5.7	3.6	8.2
	4b	1.8	22.1	4	4.1	5.7	4	4.9	26.8	6.9	2	8.7
	4c	1.8	13.1	2.3	2.8	3.5	2.4	2.4	12.6	1.5	1.6	7.1
	4d	1.3	21.4	3.5	3.7	7.3	3.2	3.2	23.3	4.9	2.5	8
	4e	1.2	7.9	1.8	2.1	4.6	2.9	1.7	8.7	1.9	2.5	5.8
Maximum		2.3	22.1	4.2	4.1	7.3	4.4	4.9	26.8	6.9	3.6	8.7

High speed passes												
4	4f	1.1	4.6	2.1	2.7	2.7	2	3	5.9	2.6	1.8	6.2
	4g	2.1	11.2	3	2.5	4.5	3.5	2.1	14.1	3.2	2	6.5
Maximum		2.1	11.2	3	2.7	4.5	3.5	3	14.1	3.2	2	6.5

Table A.16 West Edge Girder – Top Strain: Minimums

No. of trucks	Pass	Strain sensor (με)										
		SDW_108T S-W1	SDW_101T S-W3	SDW_210T S-W5	SDW_CJT S-W7	SDW_315T S-W9	SDW_310T S-W11	SDW_305T S-W13	SDW_301T S-W15	SDW_404T S-W17	SDW_408T S-W19	SDW_412T S-W21
Slow speed passes												
1	1a	-10.7	-3	-10.8	-14.3	-12.9	-12.7	-11.5	-2.7	-9.1	-9.9	-17.9
	1b	-6.9	-2.9	-8.2	-9.5	-8.8	-9.4	-9.9	-3.1	-7	-7.6	-15.2
	1c	-4.9	-2.4	-4.4	-5.5	-8.2	-4.6	-6.3	-1.8	-4.4	-4.1	-10.2
	1d	-2.6	-3.5	-2.7	-2.4	-2.6	-2.1	-2.9	-1.4	-2.1	-2.4	-7.2
2	2a	-17.1	-5.5	-19.2	-21.4	-19.7	-20	-20.2	-4.1	-16.8	-15.7	-32.2
	2b	-13.8	-6.5	-15.8	-17.8	-18	-15	-16.3	-3.8	-11.8	-12.2	-25.6
	2c	-10.4	-5.5	-11.8	-13.8	-12.1	-11.6	-11.5	-4.7	-9.3	-10.2	-22.4
	2d	-5.5	-3	-5.7	-7.5	-5.5	-6.7	-8	-3.6	-5.6	-5.1	-15.7
	2e	-5.5	-3	-7.1	-8	-8.6	-7.5	-7.7	-2.4	-5.9	-5.8	-15.7
	2f	-2.4	-2.7	-3.2	-3.9	-2.8	-3.1	-4.4	-2.7	-3.1	-3.6	-11.1
4	4a	-20.6	-7.5	-24.2	-27	-25.6	-24.2	-27.7	-5.5	-20.5	-20.1	-44.9
	4b	-18.2	-9.9	-21.2	-26.5	-27	-21.6	-20.8	-6.7	-16	-17.3	-38.1
	4c	-5	-4.8	-5.9	-8.4	-7.7	-7.2	-8.6	-3.4	-6.5	-6.1	-19.7
	4d	-12.6	-10	-14	-18	-17.8	-14	-14.2	-7.1	-9.6	-11.8	-29.5
	4e	-3.5	-5	-3.9	-4	-5.8	-4	-5.7	-3.4	-3.6	-2.8	-15
Minimum		-20.6	-10	-24.2	-27	-27	-24.2	-27.7	-7.1	-20.5	-20.1	-44.9

High speed passes												
4	4f	-2.4	-2.2	-2.9	-2.9	-4.1	-3	-3.9	-4.1	-4.5	-3.6	-8.1
	4g	-9.3	-6.5	-11.2	-11.8	-11.4	-10.1	-11.4	-4.4	-10	-9.7	-19.9
Minimum		-9.3	-6.5	-11.2	-11.8	-11.4	-10.1	-11.4	-4.4	-10	-9.7	-19.9

Table A.17 West Edge Girder – Bottom Strain: Maximums

No. of trucks	Pass	Strain sensor (με)									
		SDW_108B S-W2	SDW_101B S-W4	SDW_210B S-W6	SDW_CJB S-W8	SDW_315B S-W10	SDW_310B S-W12	SDW_305B S-W14	SDW_404B S-W18	SDW_408B S-W20	SDW_412B S-W22
Slow speed passes											
1	1a	33.1	3.3	32.4	36.1	31.1	24.3	19.7	16.9	30.8	32.1
	1b	25.2	3.3	29.1	29.7	26.2	18.8	16	13.6	25.1	26.2
	1c	18.6	1	19	21.5	19.7	15	13.1	10.1	18.5	21.1
	1d	13.5	2.2	14.1	16.7	14.5	10.2	8.3	7.1	12.6	17.5
2	2a	55.8	1.4	57.1	64.5	57	43.6	35.9	30.5	54.3	60.8
	2b	50	1.6	47.7	56.7	54	37.4	29.7	22.9	46	52.6
	2c	42.2	2.3	40	48.5	44.1	31.4	24.8	20.7	39.1	46
	2d	30.5	1	33.4	36.4	32.7	25	20.3	15.9	29.6	38.1
	2e	30.7	1.7	30.4	38.1	34.3	24	18.8	14.7	29.6	39.2
	2f	23.1	2.8	23	29.3	25.6	18.3	15	11	21.5	30
4	4a	85.4	1.9	87.3	97.4	90.3	67.9	54.7	44.7	84.3	102.1
	4b	70.9	1.7	67.3	89	81.9	53.1	40.2	32.1	65.2	87.8
	4c	37.8	5.3	41.1	52.8	46.8	29.2	23.7	19.4	36.9	60.7
	4d	51.8	1.2	38.1	64.8	57.1	33	27	16.9	45.7	66.9
	4e	24.5	2	28.2	36.6	30	16.1	11	11.2	23.3	44.3
Maximum		85.4	5.3	87.3	97.4	90.3	67.9	54.7	44.7	84.3	102.1

High speed passes											
4	4f	17.1	3	19.8	26.2	18.9	10.5	8.8	10.3	16.2	24
	4g	33	2.2	24.4	36.5	32.9	23	17.6	14.4	28.6	38.6
Maximum		17.1	3	24.4	36.5	32.9	23	17.6	14.4	28.6	38.6

Table A.18 West Edge Girder – Bottom Strain: Minimums

No. of trucks	Pass	Strain sensor (με)									
		SDW_108B S-W2	SDW_101B S-W4	SDW_210B S-W6	SDW_CJB S-W8	SDW_315B S-W10	SDW_310B S-W12	SDW_305B S-W14	SDW_404B S-W18	SDW_408B S-W20	SDW_412B S-W22
Slow speed passes											
1	1a	-7.4	-9.1	-9.1	-2.8	-8.3	-9.3	-10.6	-8.1	-5.7	-8.2
	1b	-6.9	-6.6	-6.7	-2.7	-7.1	-8.5	-9.1	-7.1	-6	-9.4
	1c	-6	-7.3	-7.6	-3.3	-5.4	-6.5	-6.7	-5.9	-4.2	-7.8
	1d	-5.5	-3.8	-5.9	-2.2	-4.8	-5	-6.1	-4.5	-3.8	-6
2	2a	-14.2	-17.1	-17.2	-5.2	-14.3	-16	-17.7	-14.6	-10	-13.6
	2b	-14.7	-16.7	-18.1	-6.1	-13.2	-16.3	-17.9	-15.8	-11	-15.3
	2c	-13.3	-14.4	-17.2	-4.9	-12.1	-13.8	-15.5	-13.3	-10	-14.1
	2d	-10.1	-10.7	-10.9	-5	-9.6	-9.4	-10.8	-10.6	-7.2	-12.3
	2e	-10.5	-11.3	-12.7	-4.1	-9.3	-10.8	-11.9	-11.3	-8.3	-12.4
	2f	-7.9	-7.2	-9.4	-3.1	-7.9	-8.2	-8.2	-8.1	-6.3	-11.5
4	4a	-23.3	-26.4	-26.5	-7	-21.3	-24.2	-27.7	-24.4	-17.2	-32
	4b	-26.5	-28.9	-32.2	-7.7	-24.5	-29.5	-33.5	-27.7	-20.3	-37.9
	4c	-17.5	-16.6	-19.5	-6.4	-16.5	-17.2	-19.5	-17.7	-12.9	-24.5
	4d	-28	-31	-30.5	-5.9	-22.1	-26.8	-29.7	-24.6	-20.9	-35
	4e	-15.7	-14.1	-16	-5.9	-13.3	-14.7	-16.3	-13.6	-11.5	-22.5
Minimum		-28	-31	-32.2	-7.7	-24.5	-29.5	-33.5	-27.7	-20.9	-37.9

High speed passes											
4	4f	-13.1	-12.5	-10.8	-7.9	-11.9	-11.9	-10.4	-10.2	-9	-16
	4g	-21.6	-21.6	-21.6	-6.1	-13.9	-17.7	-19.1	-11.7	-17.4	-23.9
Minimum		-21.6	-21.6	-21.6	-7.9	-13.9	-17.7	-19.1	-11.7	-17.4	-23.9

Table A.19 Deck Strain: Maximums

No. of trucks	Pass	Strain sensor (με)	
		SDC_210N S-C1	SDC_210S S-C2
Slow speed passes			
1	1a	1.8	1.4
	1b	2	1.8
	1c	2.3	1.2
	1d	1.3	1.4
2	2a	2.5	2.1
	2b	2.7	1.9
	2c	2.4	2.8
	2d	2.2	2.2
	2e	2.1	2.1
	2f	3	2
4	4a	3.7	2.6
	4b	2.9	3.2
	4c	3.1	3.3
	4d	2.7	2.6
	4e	1.8	2.1
Maximum		3.7	3.3

High speed passes			
4	4f	1.7	1.8
	4g	1.8	1.4
Maximum		1.8	1.8

Table A.20 Deck Strain: Minimums

No. of trucks	Pass	Strain sensor (με)	
		SDC_210N S-C1	SDC_210S S-C2
Slow speed passes			
1	1a	-6.5	-4.6
	1b	-9.6	-8.4
	1c	-16.9	-15.6
	1d	-9.5	-7.7
2	2a	-14.8	-12.9
	2b	-7.4	-6.4
	2c	-12.1	-9.1
	2d	-27.4	-25.1
	2e	-20.2	-18.3
	2f	-10.8	-9.4
4	4a	-38.9	-33.5
	4b	-14.8	-11.9
	4c	-26.5	-22.8
	4d	-5.8	-4.3
	4e	-11.1	-8.5
Minimum		-38.9	-33.5

High speed passes			
4	4f	-9.4	-7.5
	4g	-5.4	-4.9
Minimum		-9.4	-7.5

Appendix B. Strain, displacement, and tilt plots for Load Test 1 (4/30/12), Pass 4a

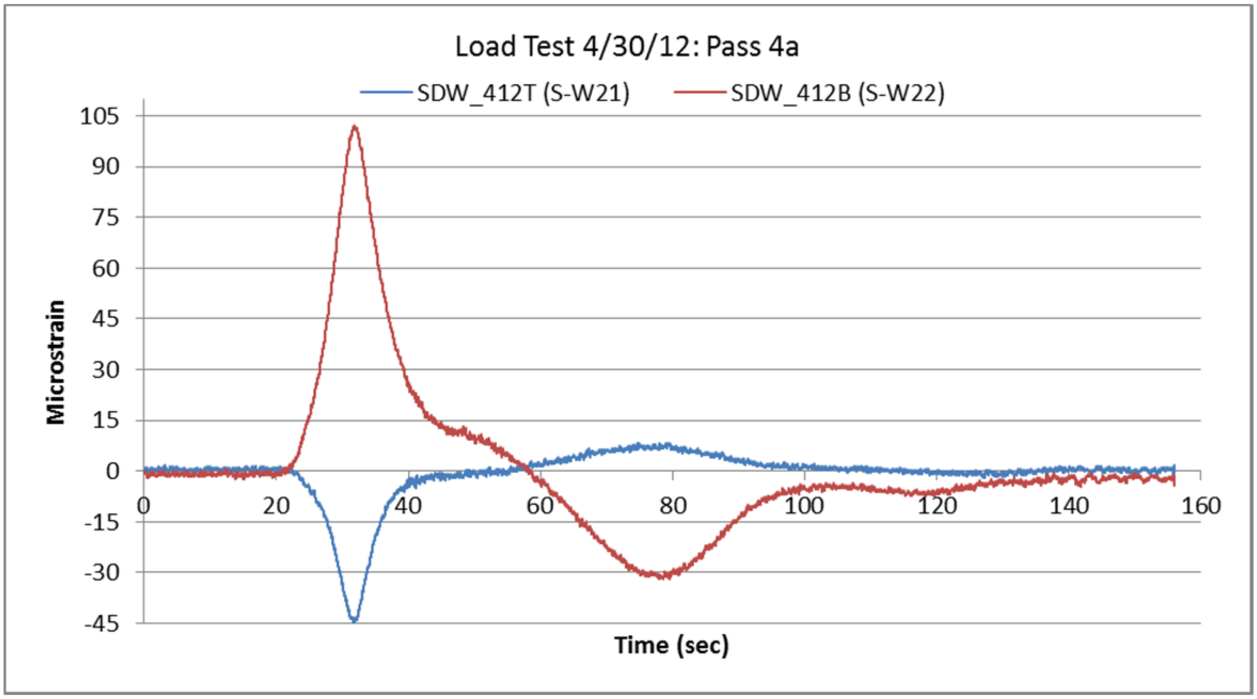

Figure B.1 Edge girder strain time history - section 412

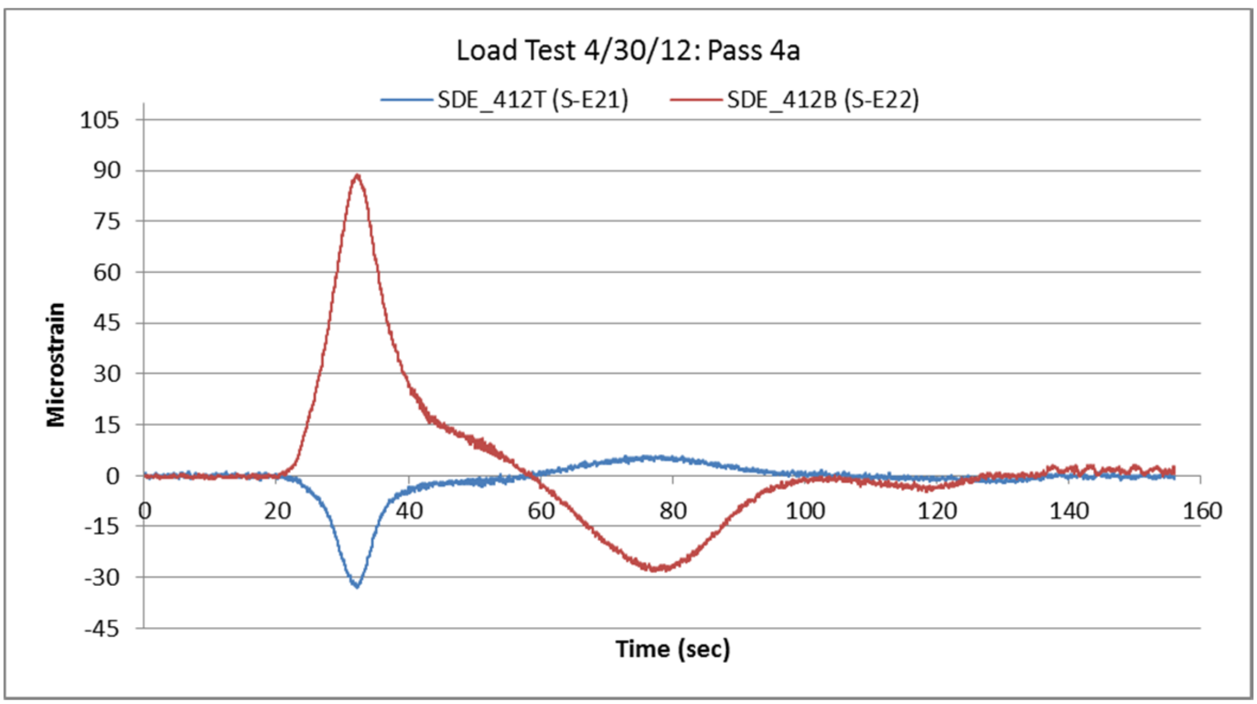

Figure B.2 Edge girder strain time history - section 412

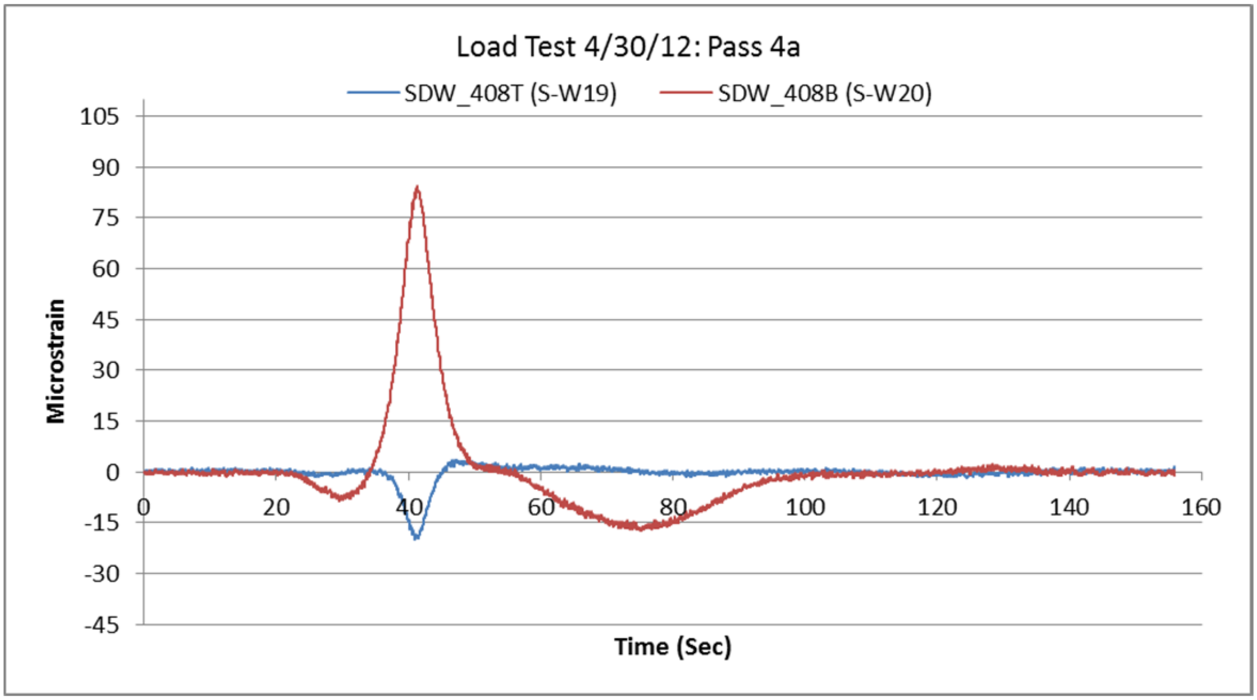

Figure B.3 West edge girder strain time history - section 408

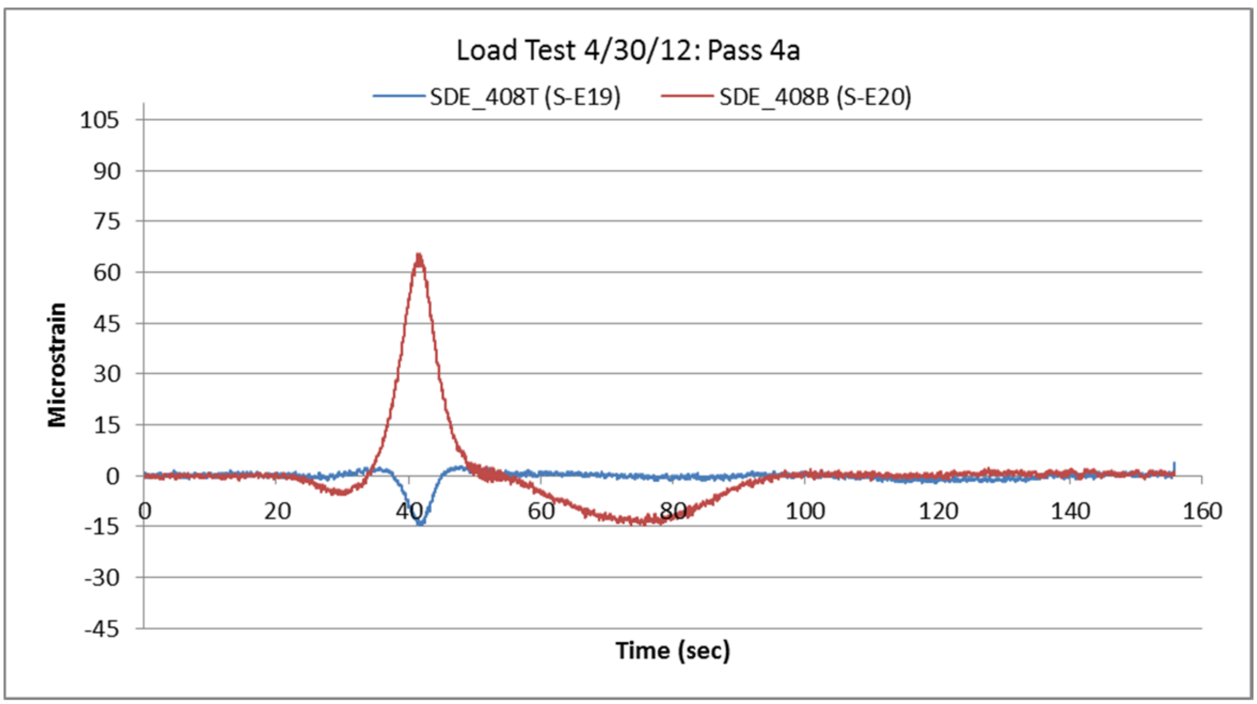

Figure B.4 East edge girder strain time history - section 408

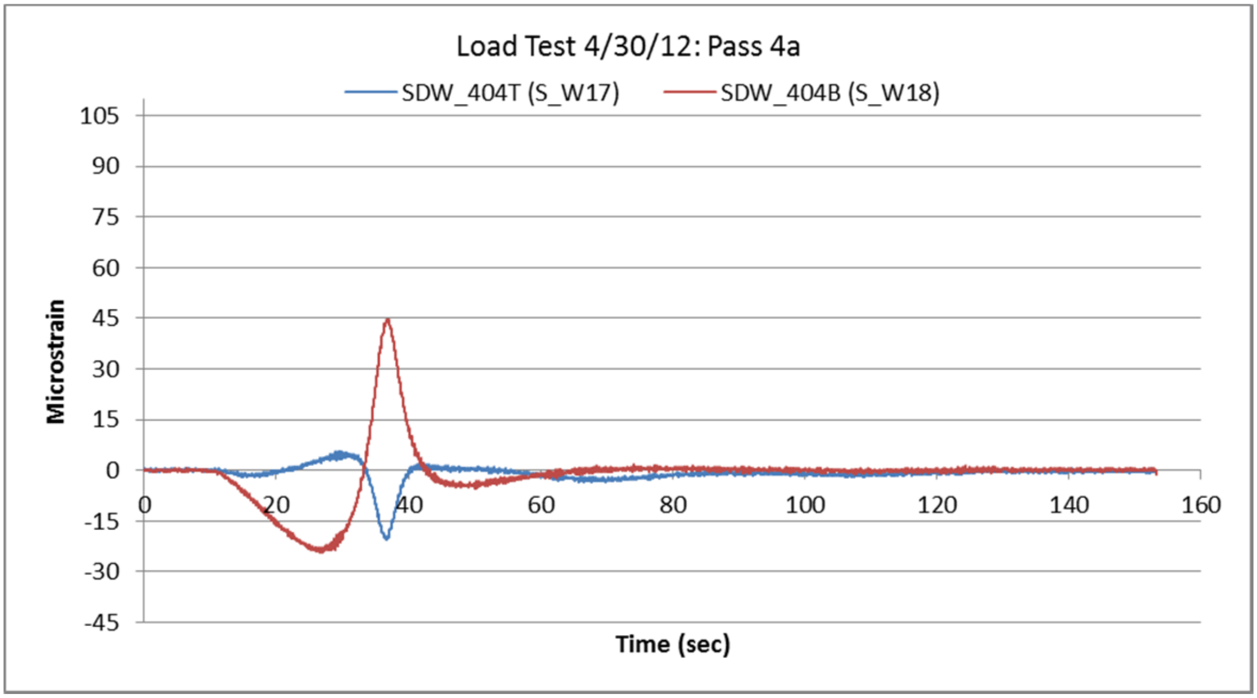

Figure B.5 West edge girder strain time history - section 404

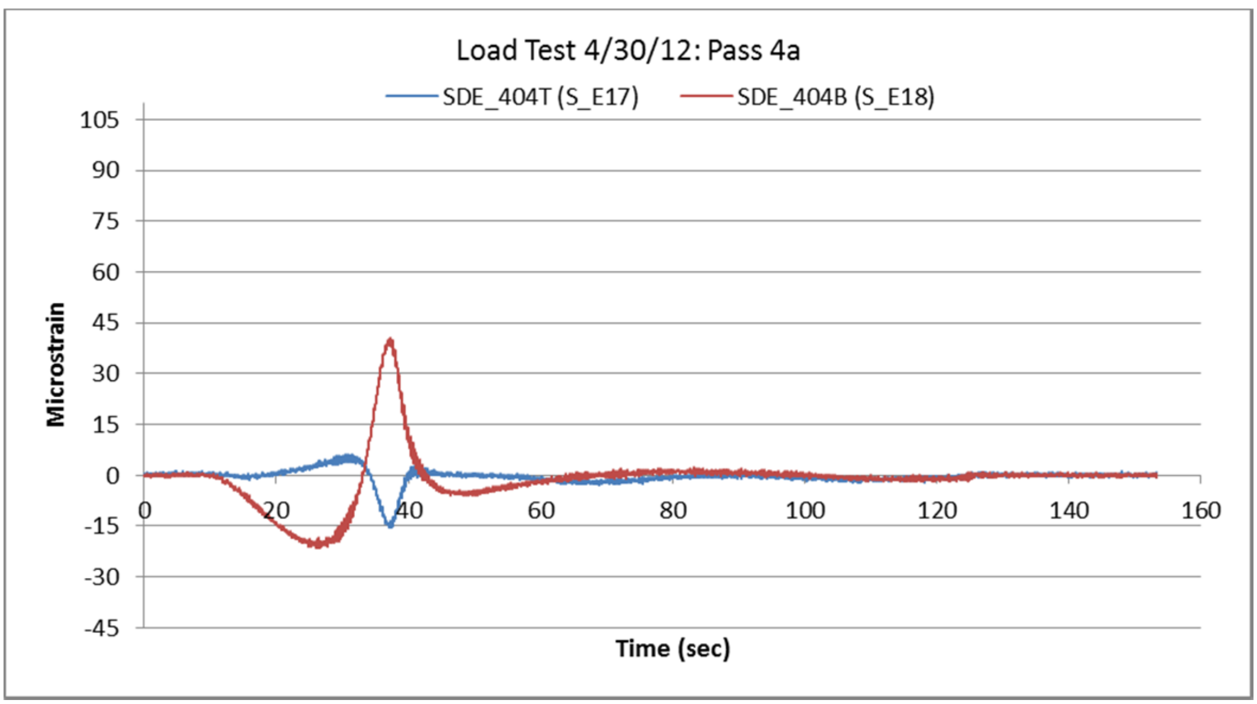

Figure B.6 East edge girder strain time history - section 404

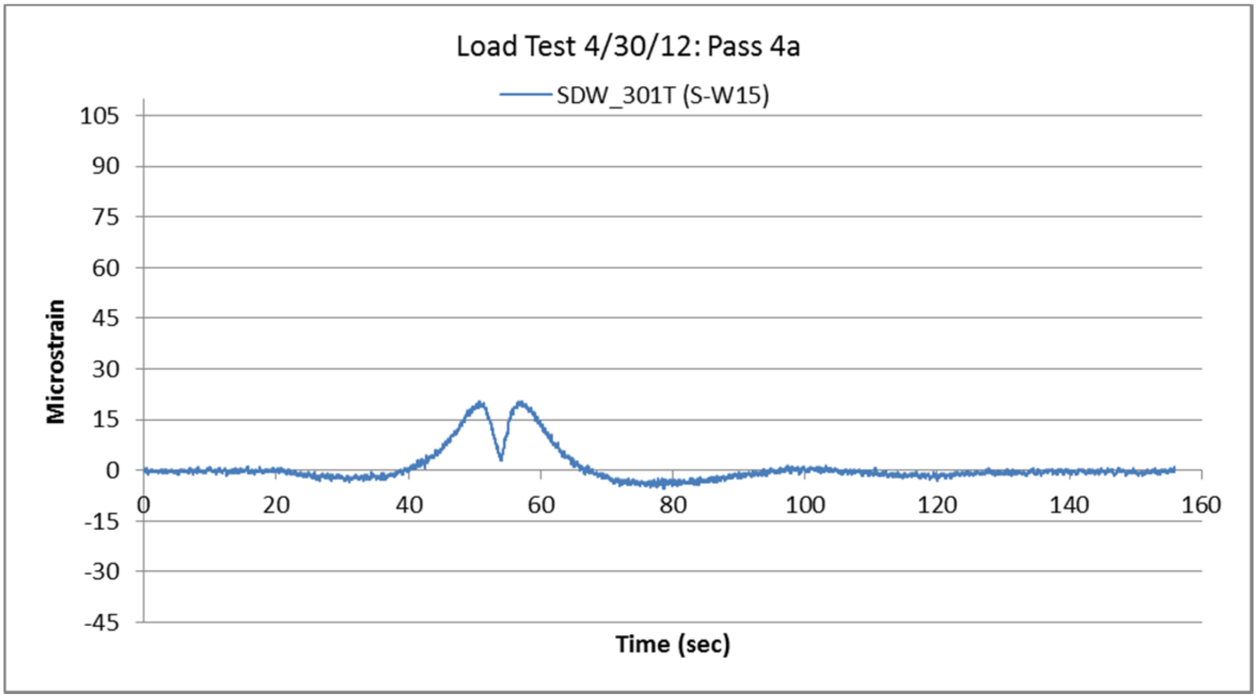

Figure B.7 West edge girder strain time history - section 301

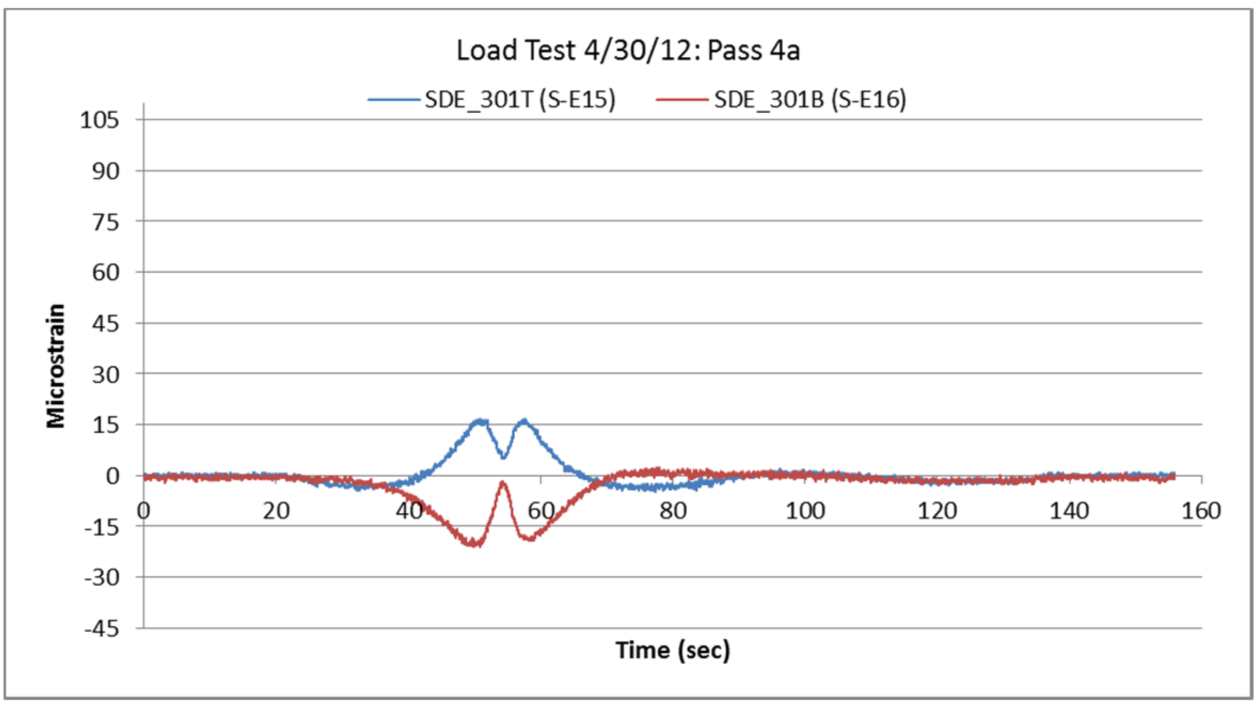

Figure B.8 East edge girder strain time history - section 301

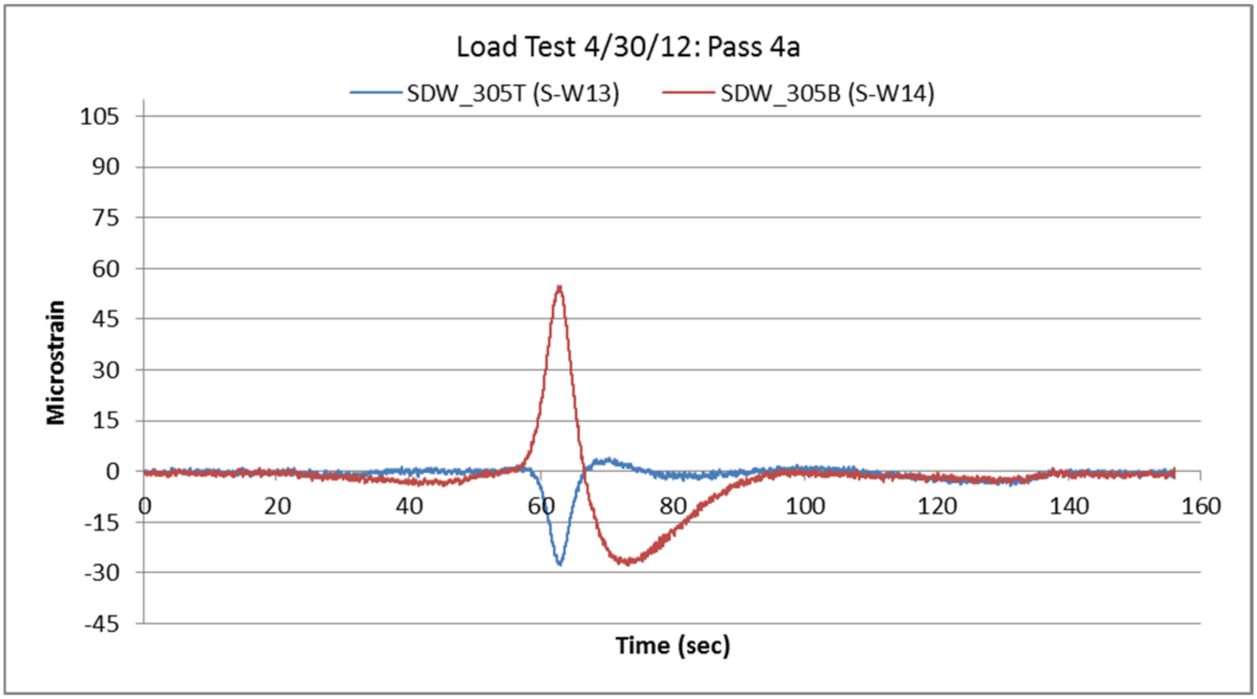

Figure B.9 West edge girder strain time history - section 305

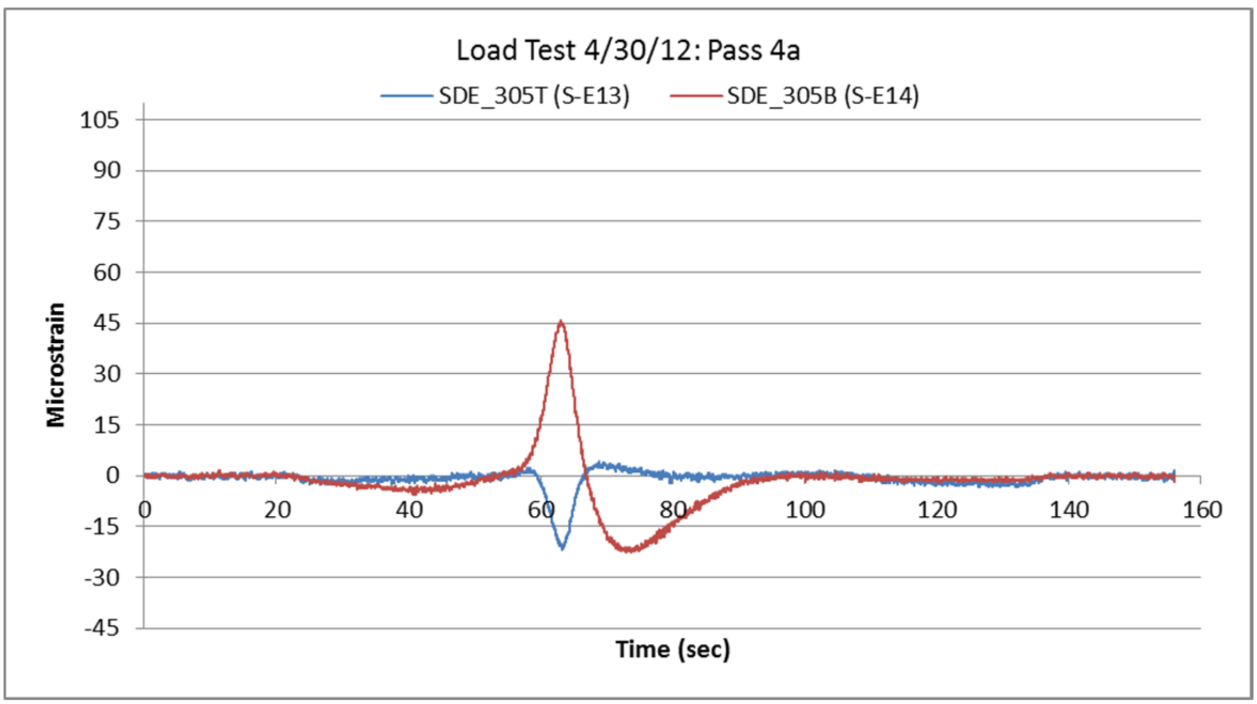

Figure B.10 East edge girder strain time history - section 305

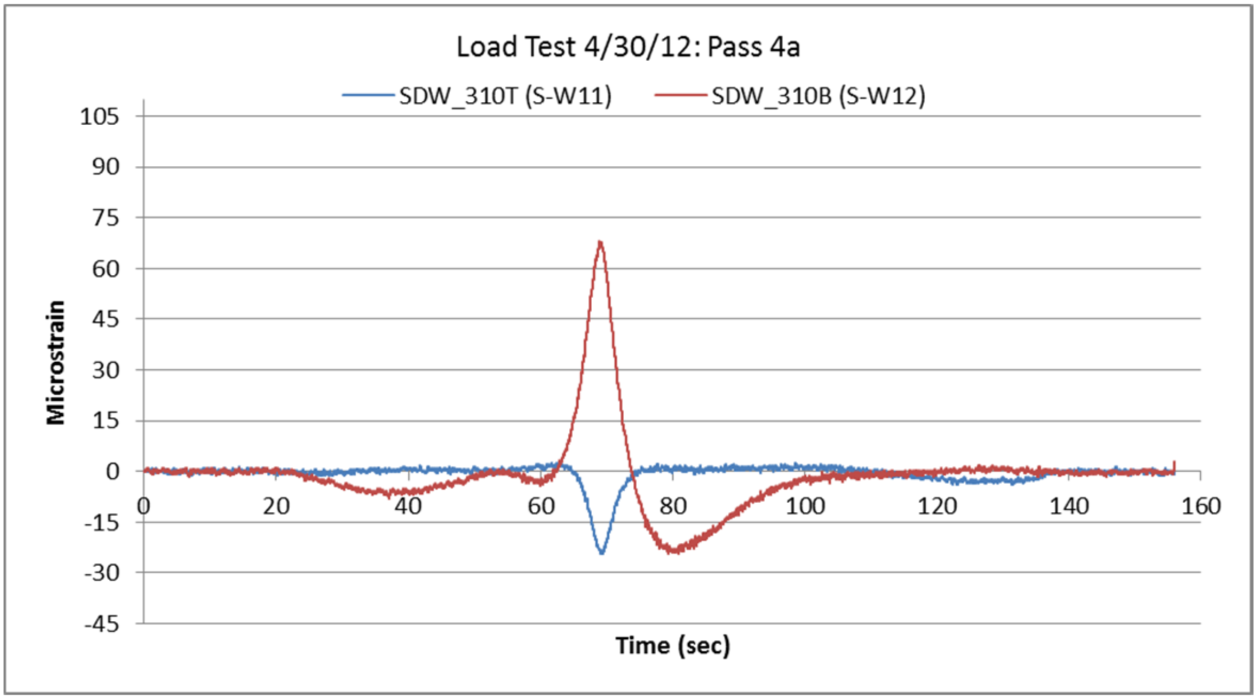

Figure B.11 West edge girder strain time history - section 310

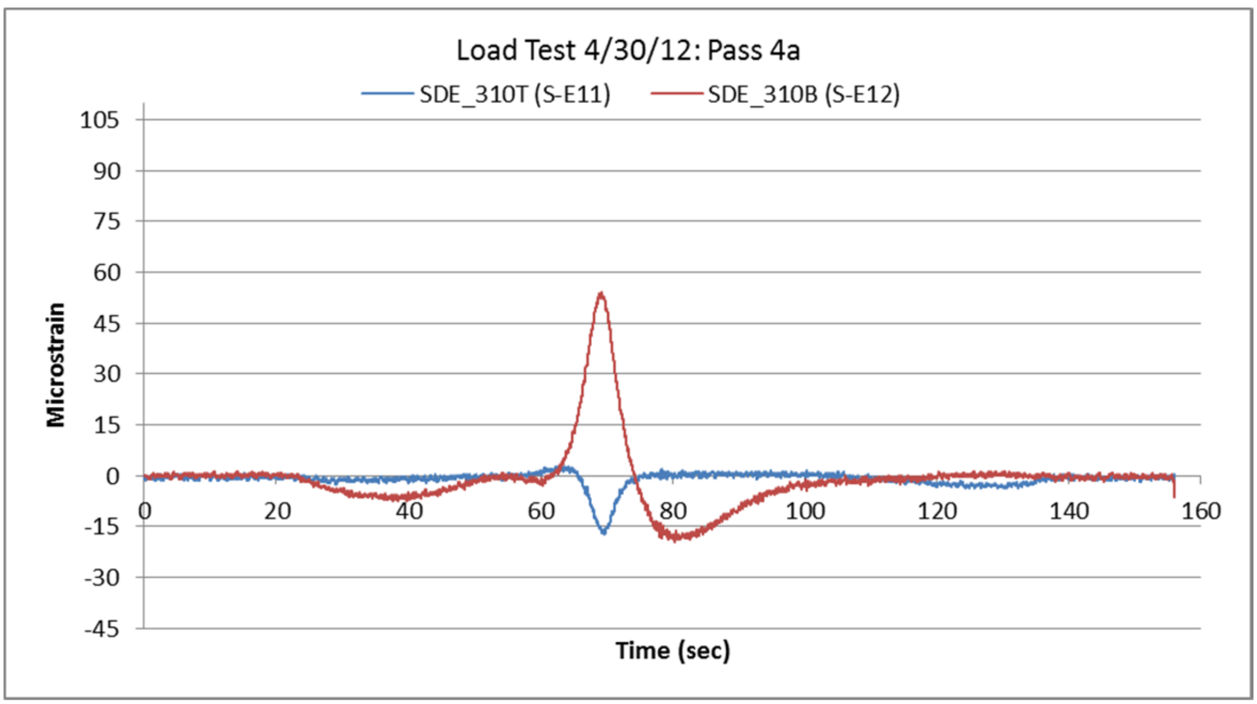

Figure B.12 East edge girder strain time history - section 310

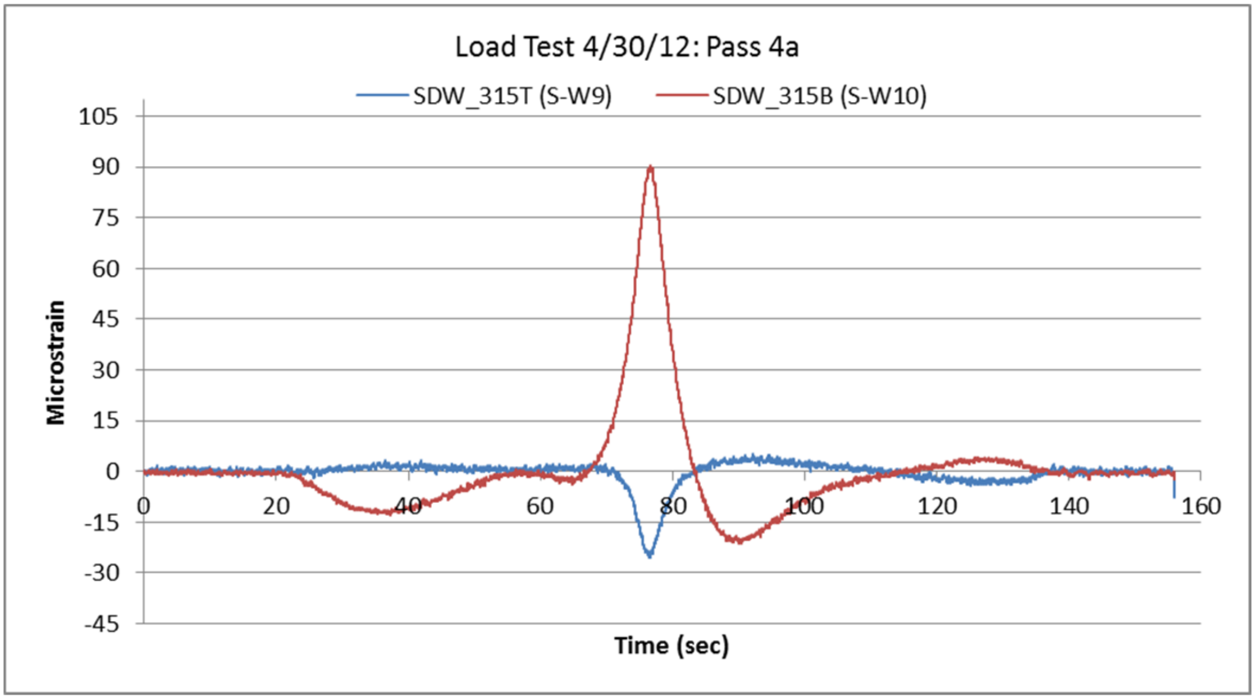

Figure B.13 West edge girder strain time history - section 315

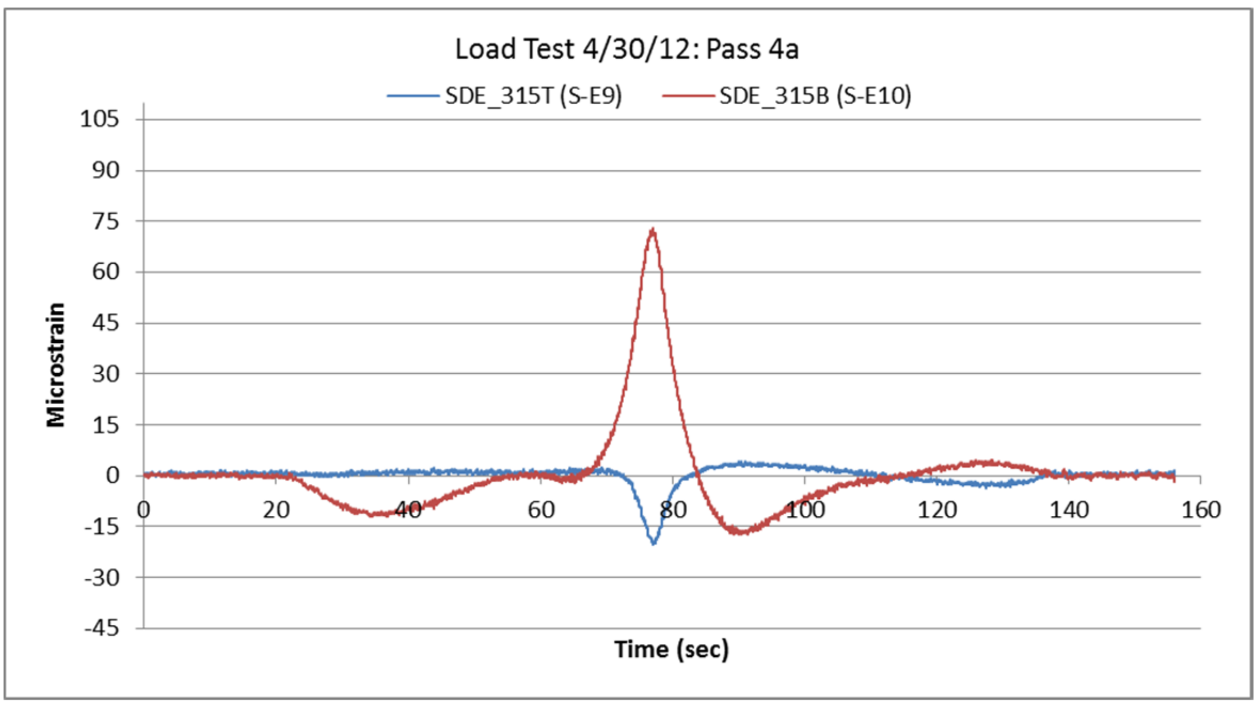

Figure B.14 East edge girder strain time history - section 315

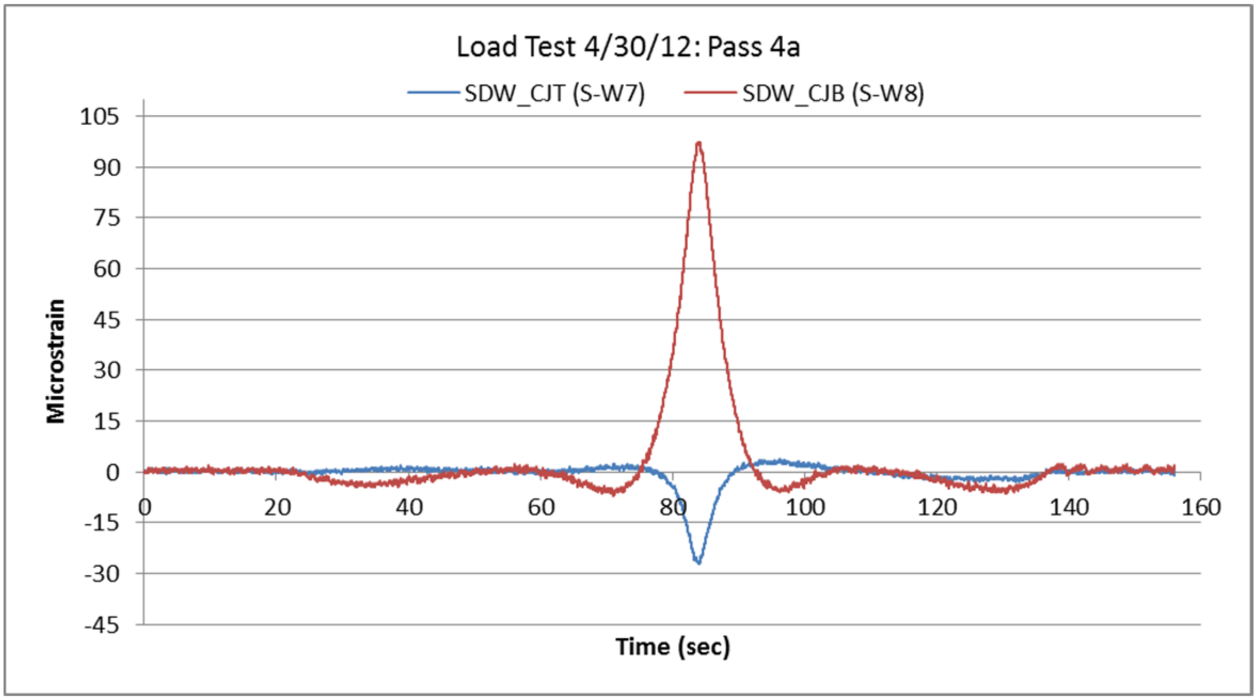

Figure B.15 West edge girder strain time history - closure joint

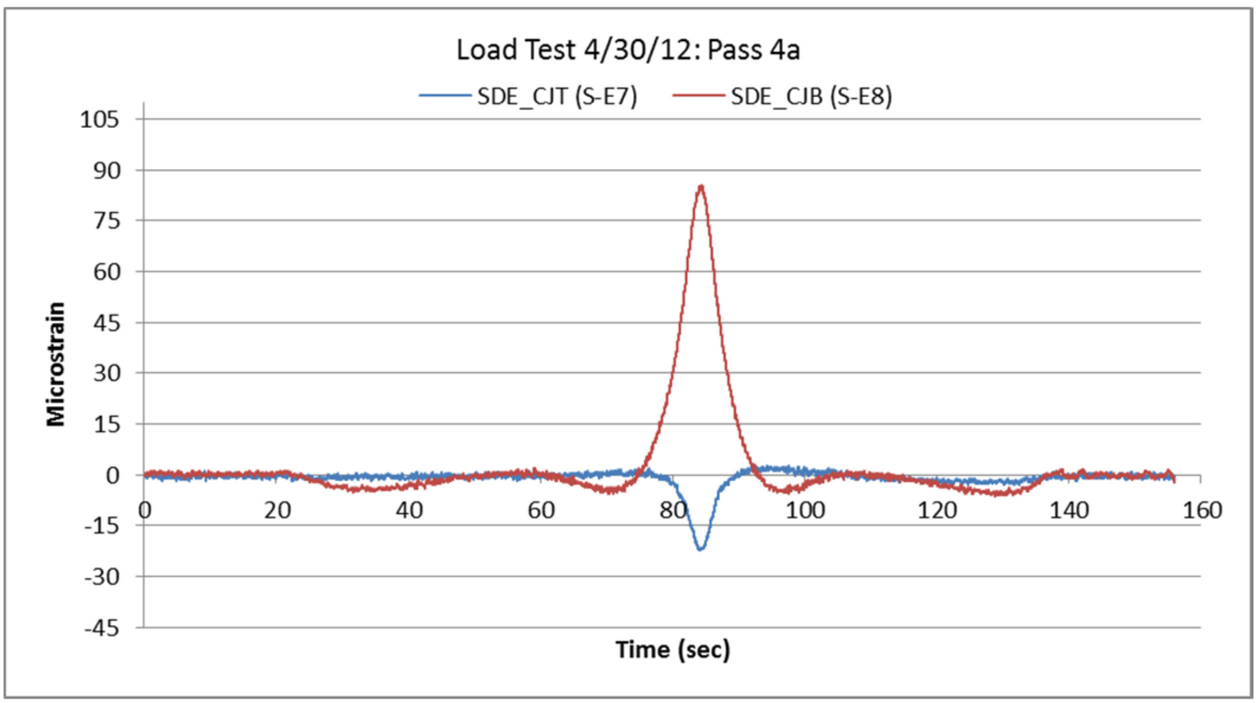

Figure B.16 East edge girder strain time history - closure joint

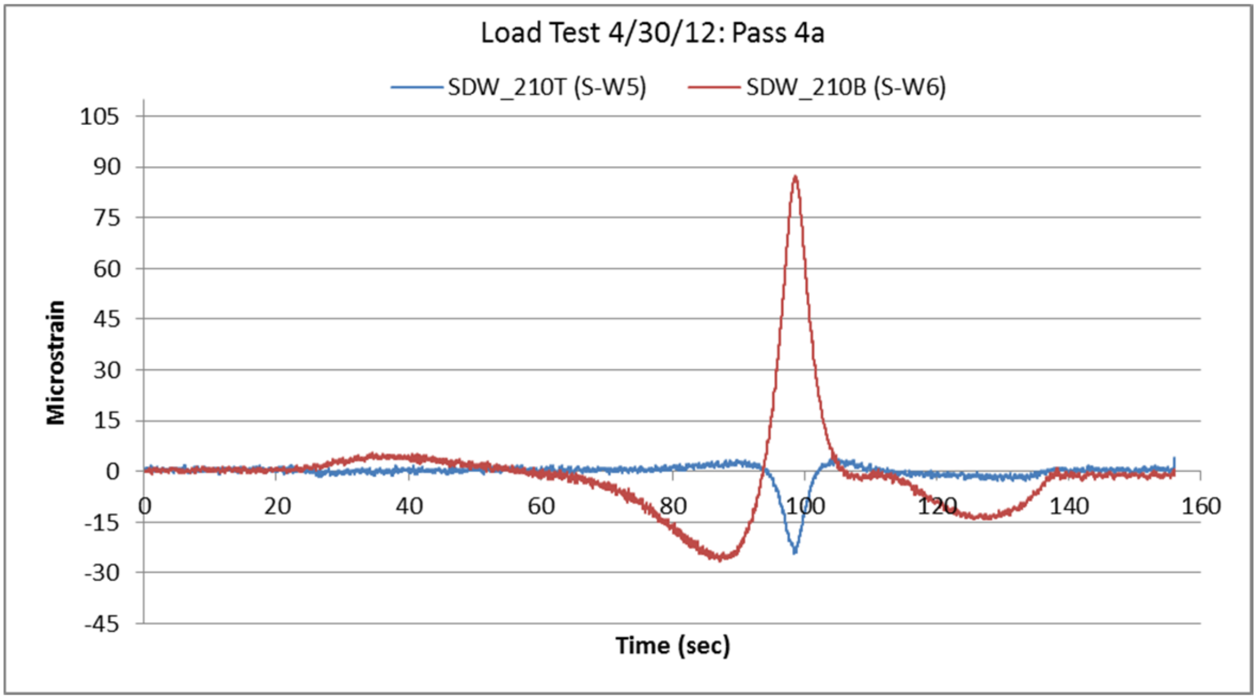

Figure B.17 West edge girder strain time history - section 210

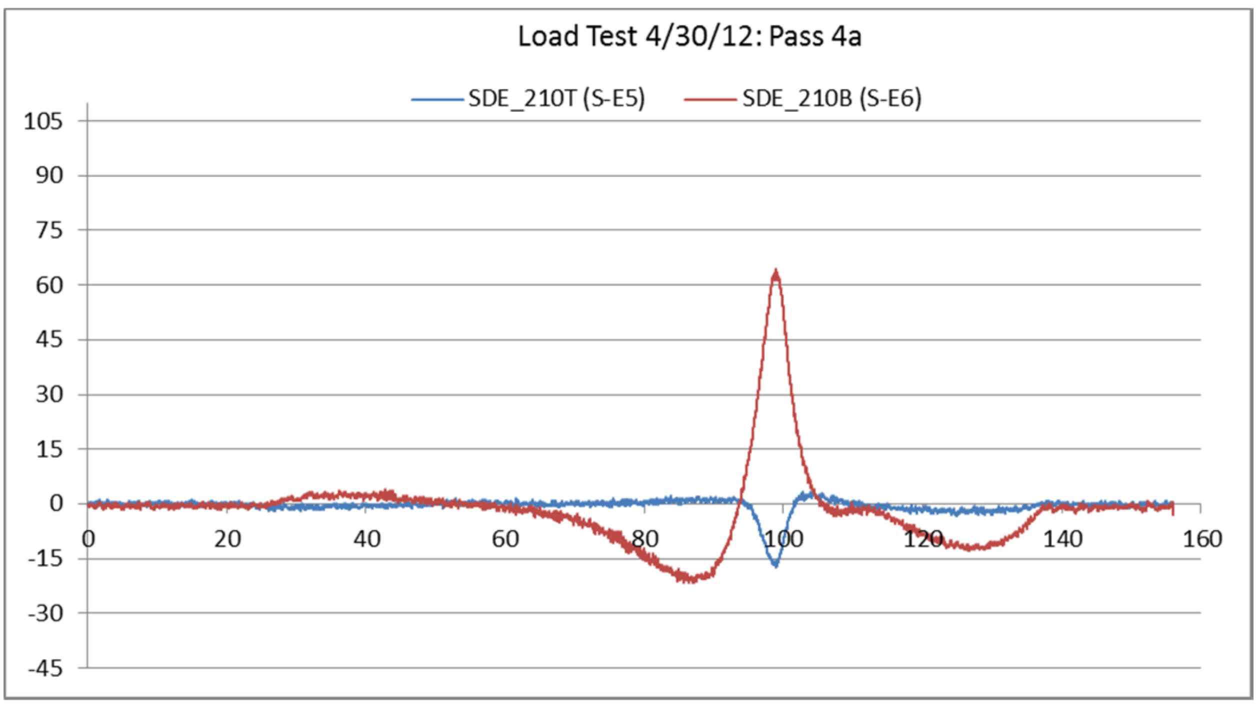

Figure B.18 East edge girder strain time history - section 210

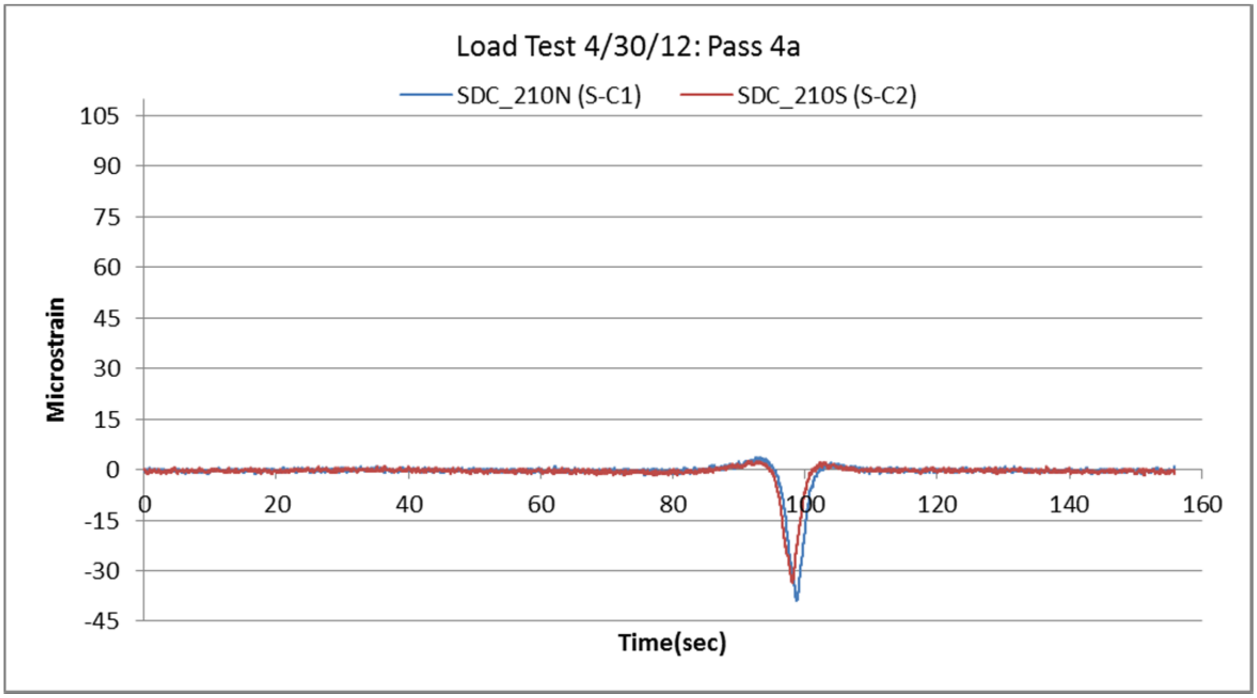

Figure B.19 Deck strain time history - section 210

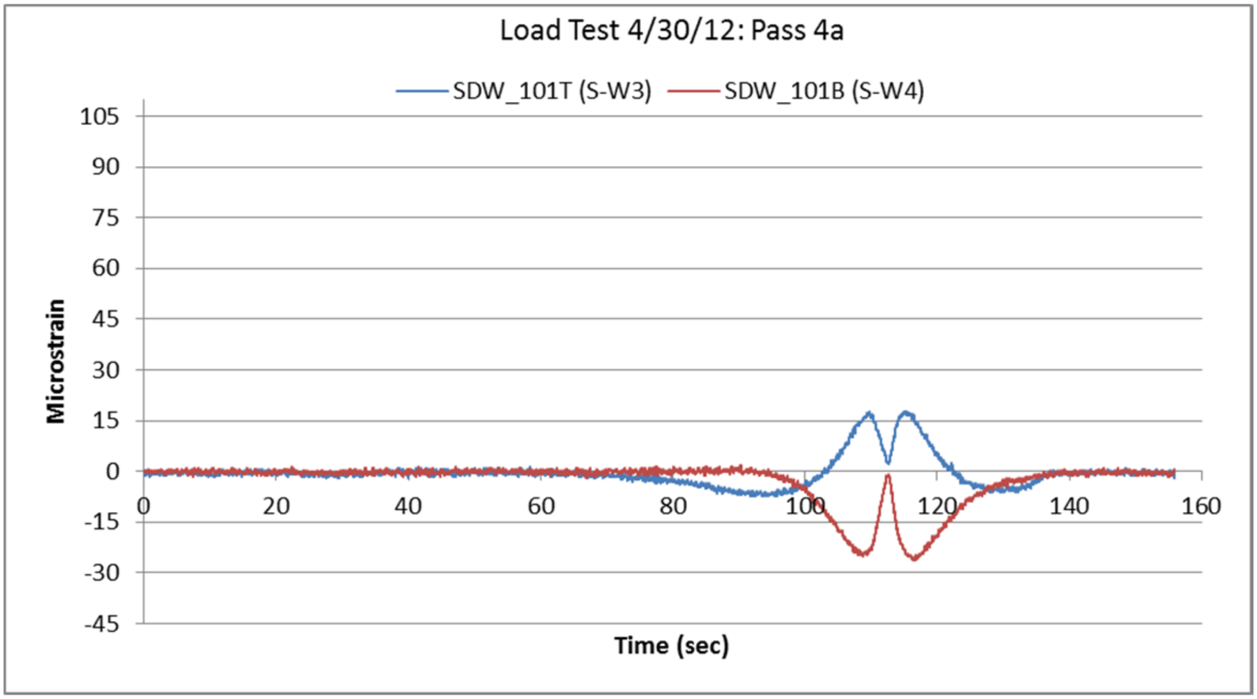

Figure B.20 West edge girder strain time history - section 101

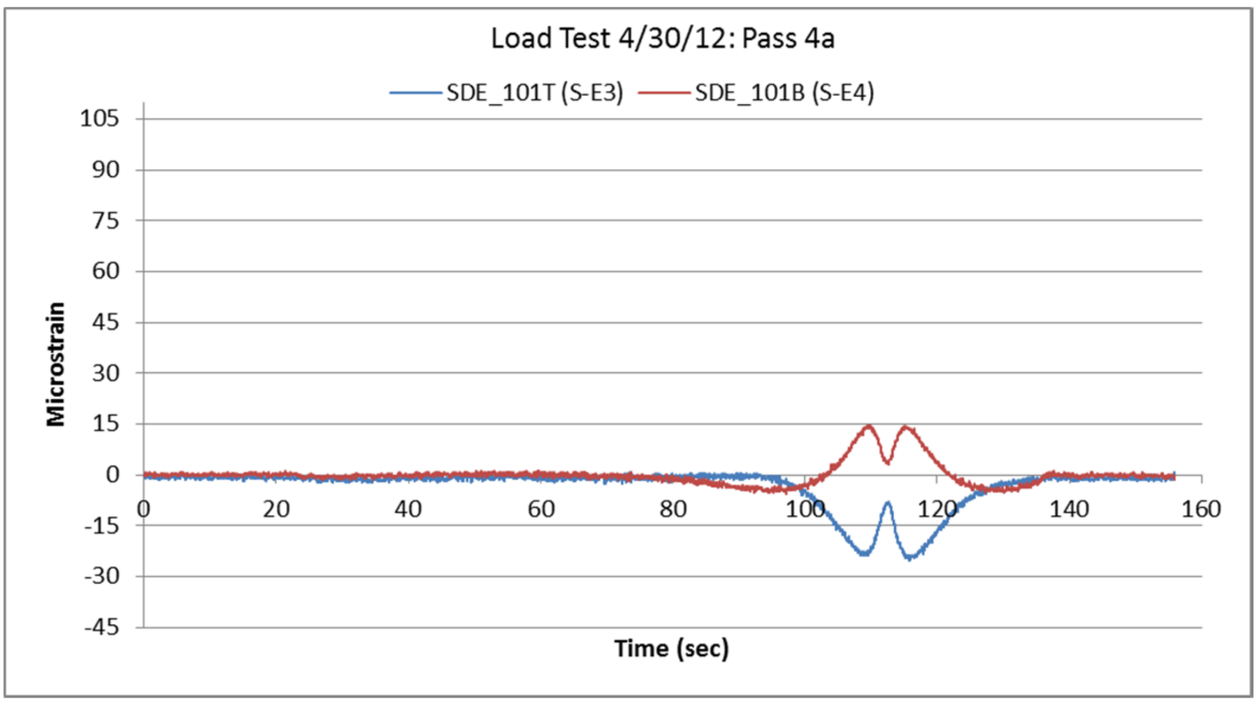

Figure B.21 East edge girder strain time history - section 101

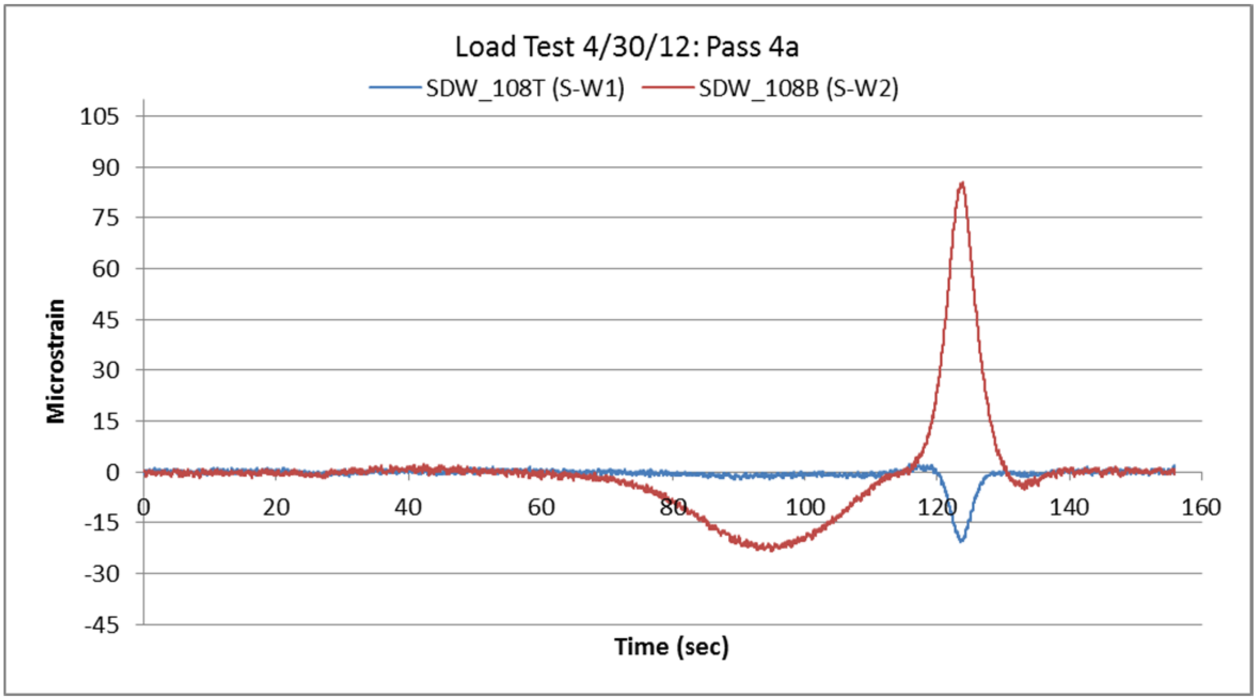

Figure B.22 West edge girder strain time history - section 108

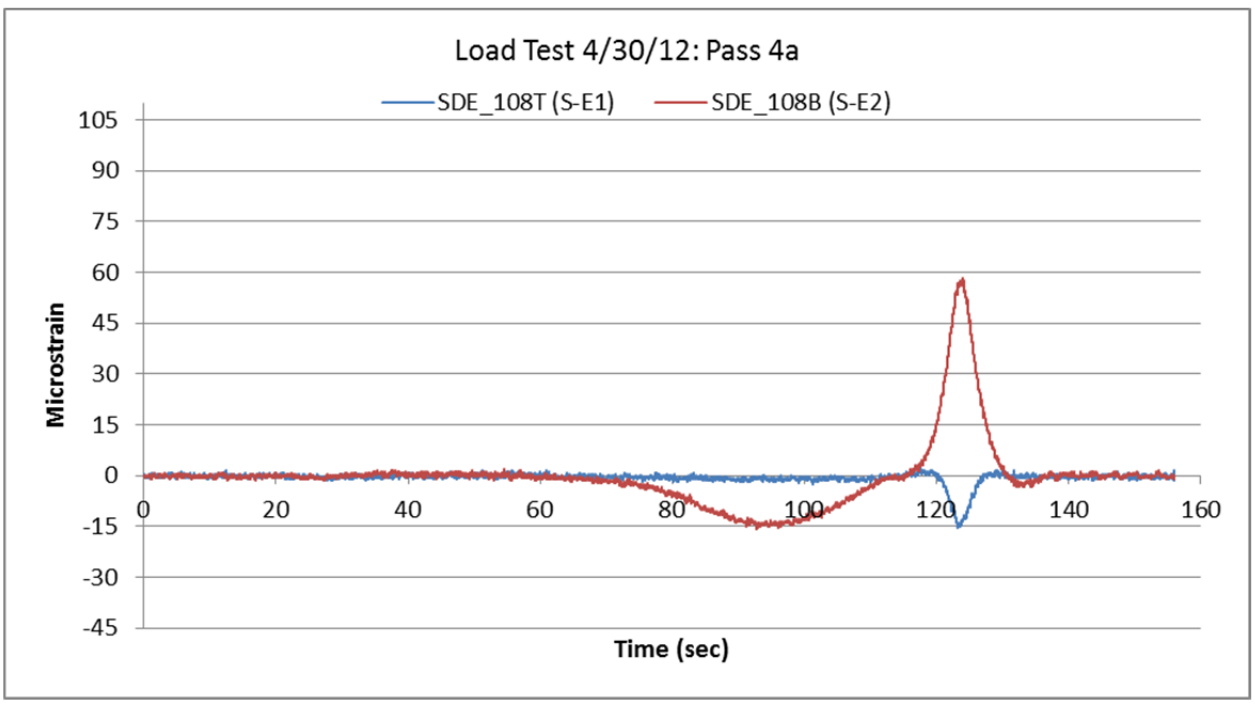

Figure B.23 East edge girder strain time history - section 108

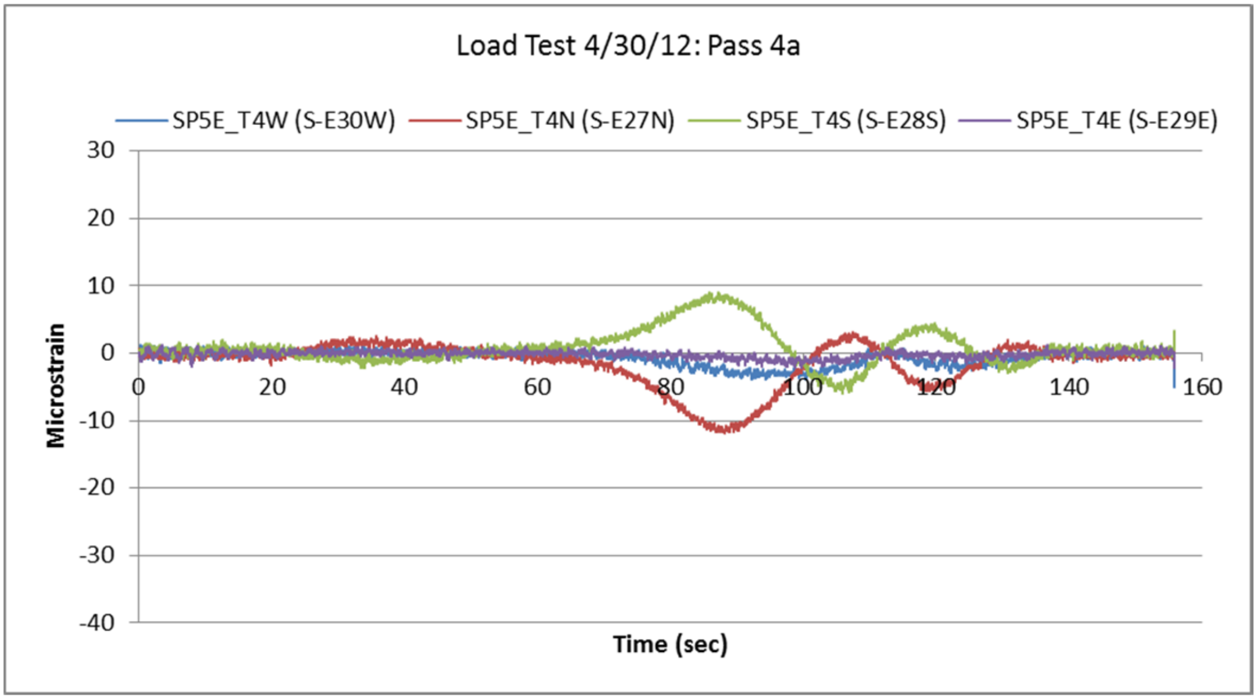

Figure B.24 Pylon 5 east strain time history - lift T4

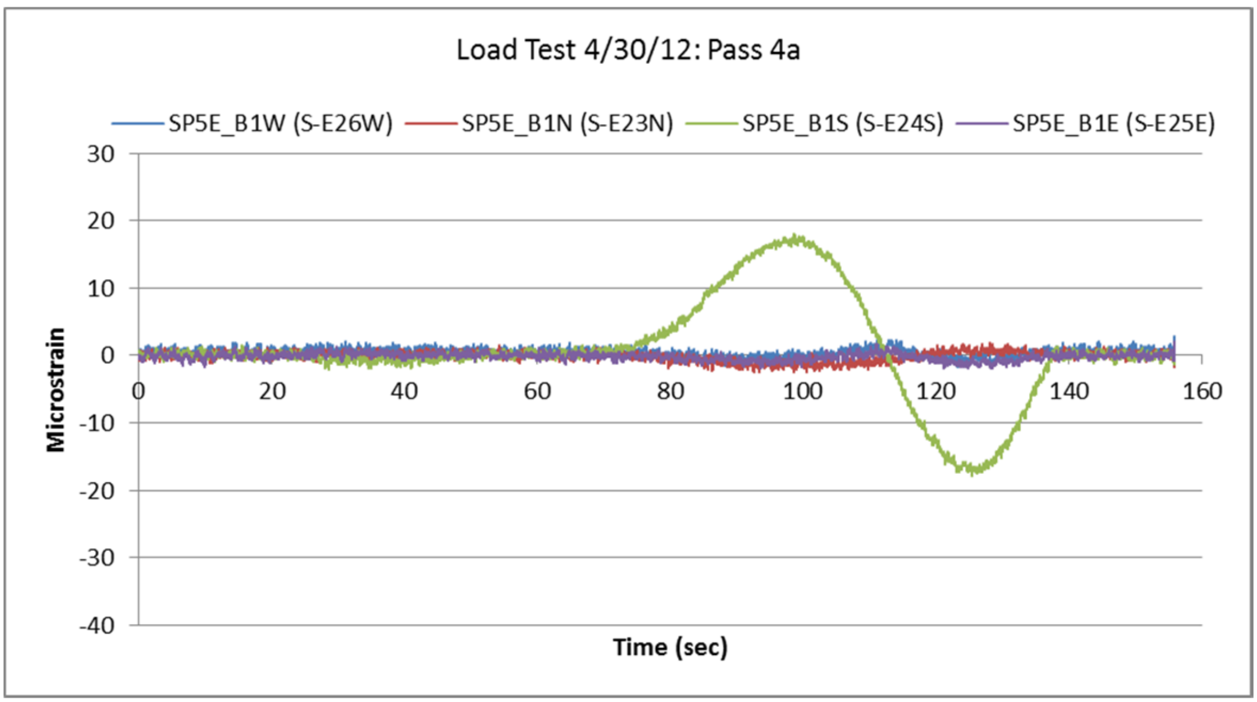

Figure B.25 Pylon 5 east strain time history - lift B1

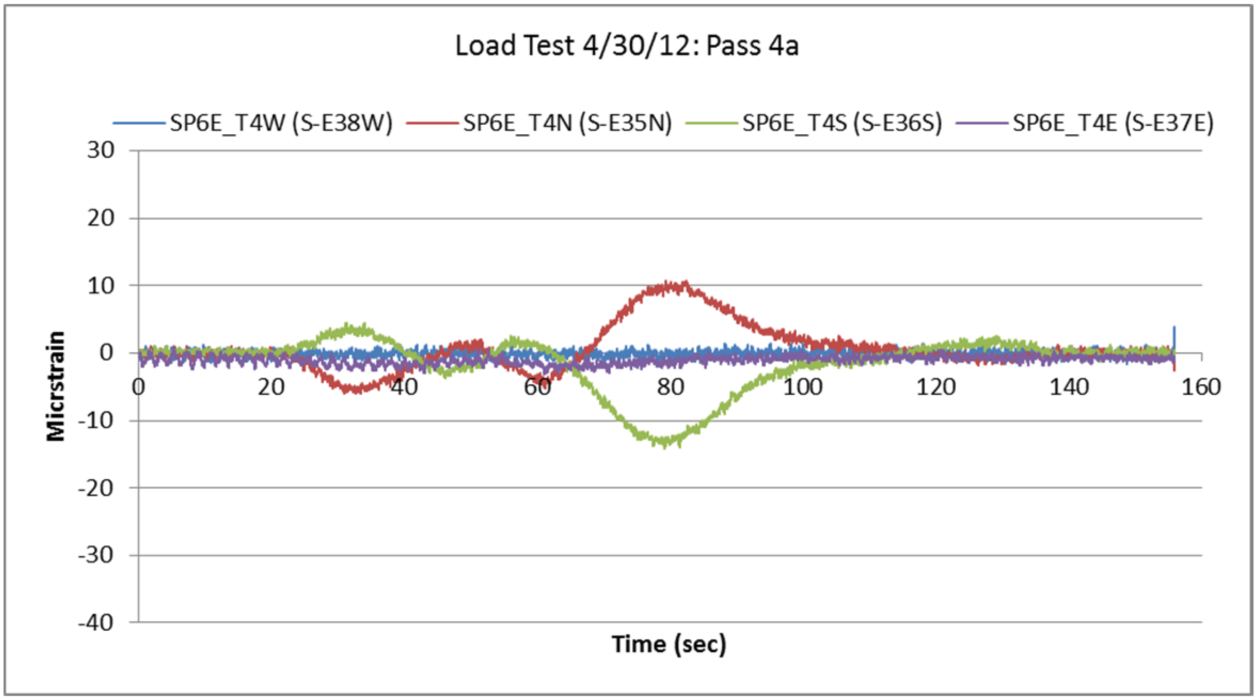

Figure B.26 Pylon 6 east strain time history - lift T4

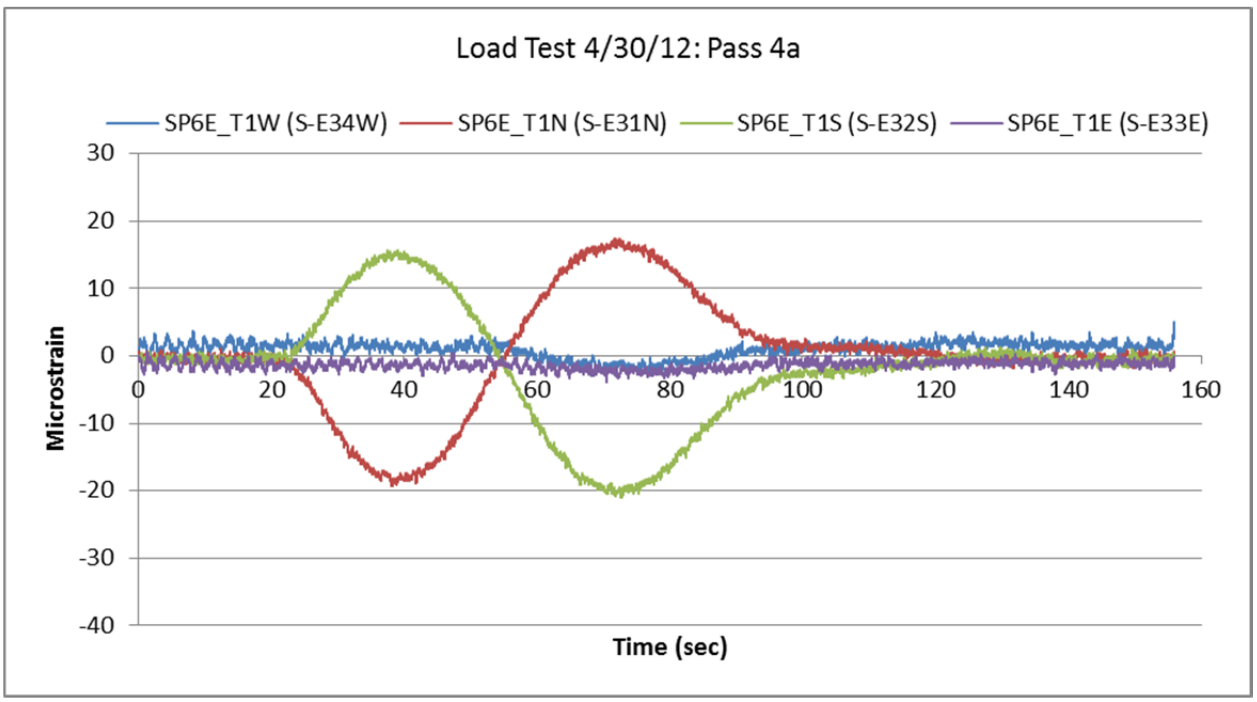

Figure B.27 Pylon 6 east strain time history - lift T1

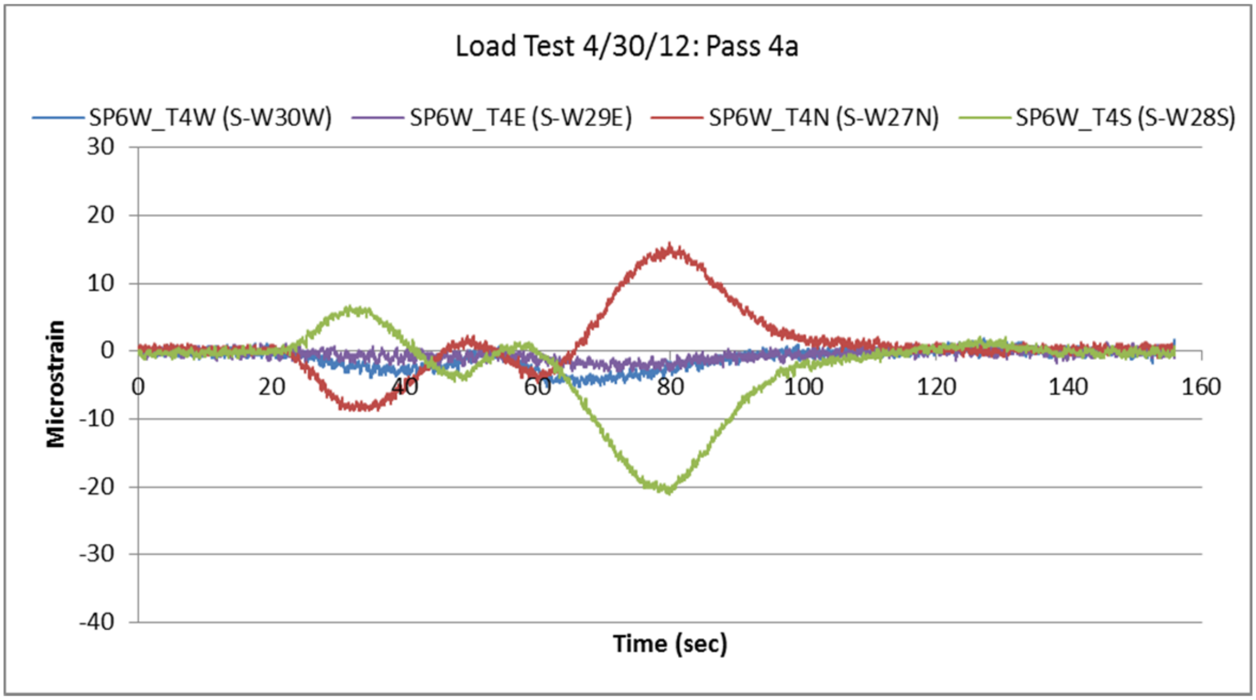

Figure B.28 Pylon 6 west strain time history - lift T4

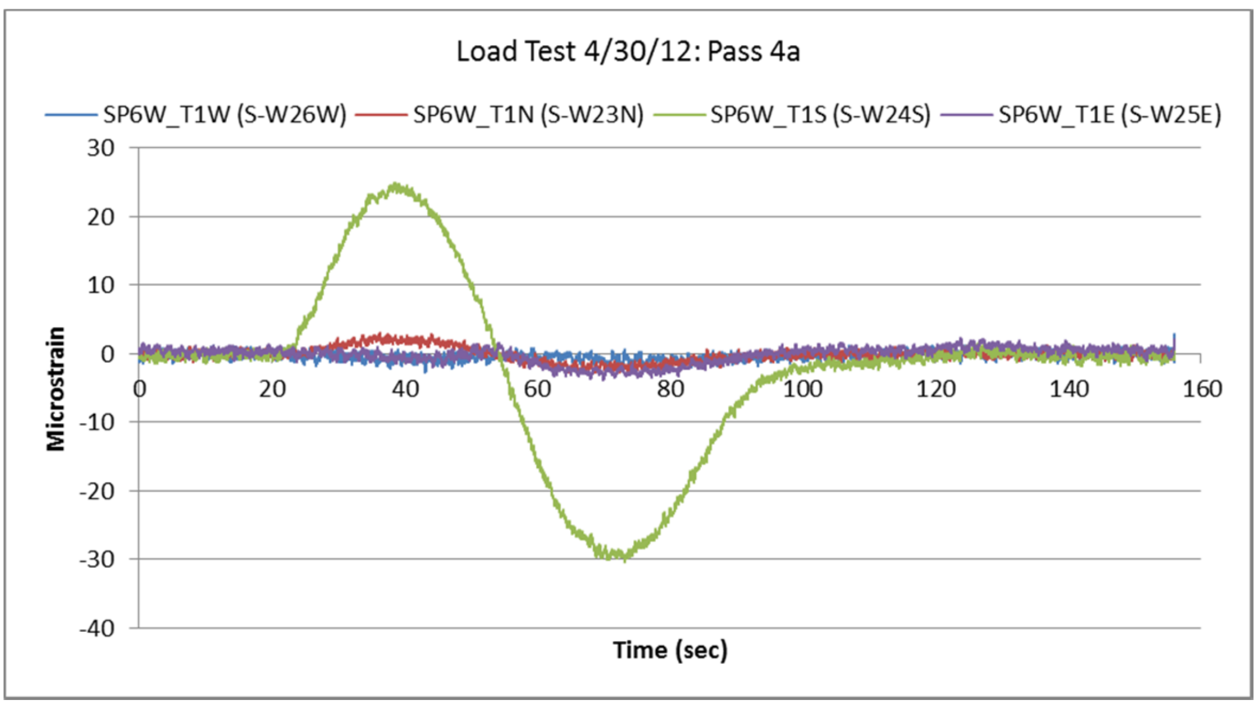

Figure B.29 Pylon 6 west strain time history - lift T1

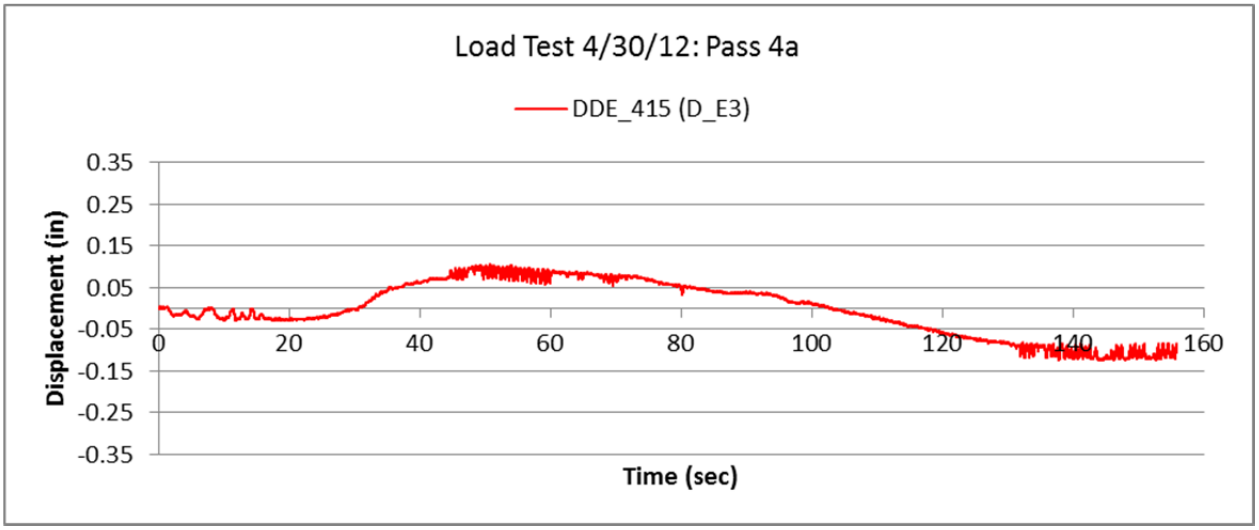

Figure B.30 Bearing displacement time history – north abutment

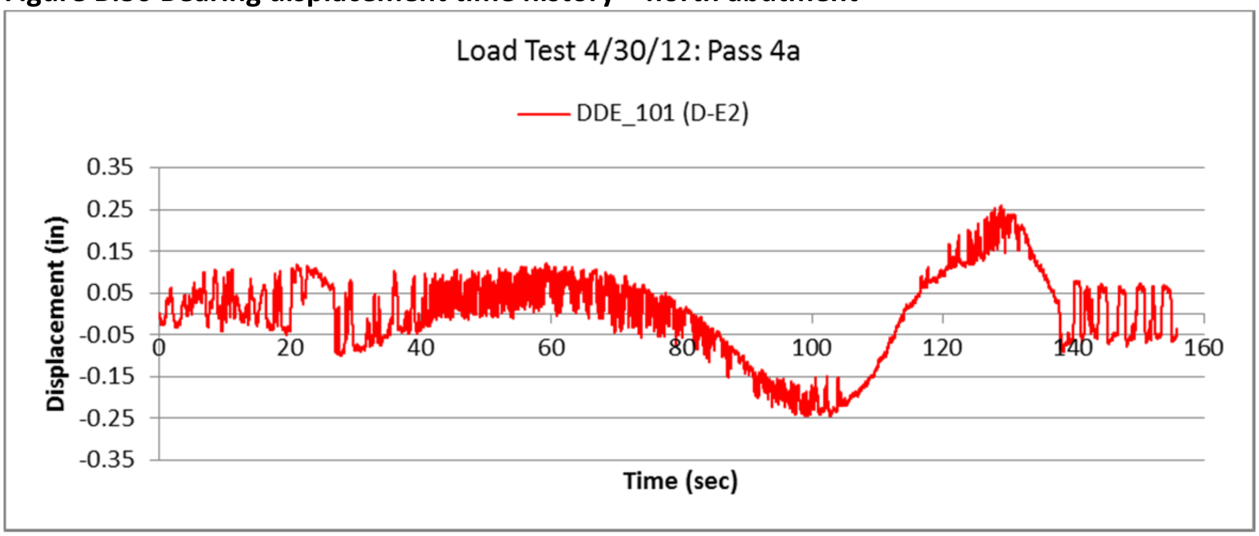

Figure B.31 Bearing displacement time history – pylon 5

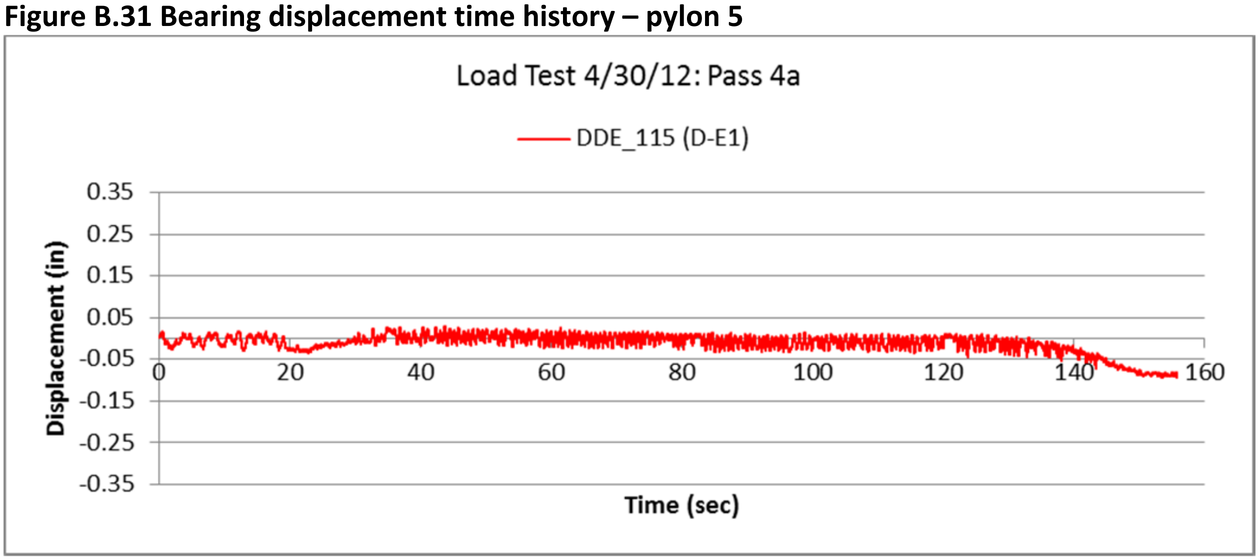

Figure B.32 Bearing displacement time history – south abutment

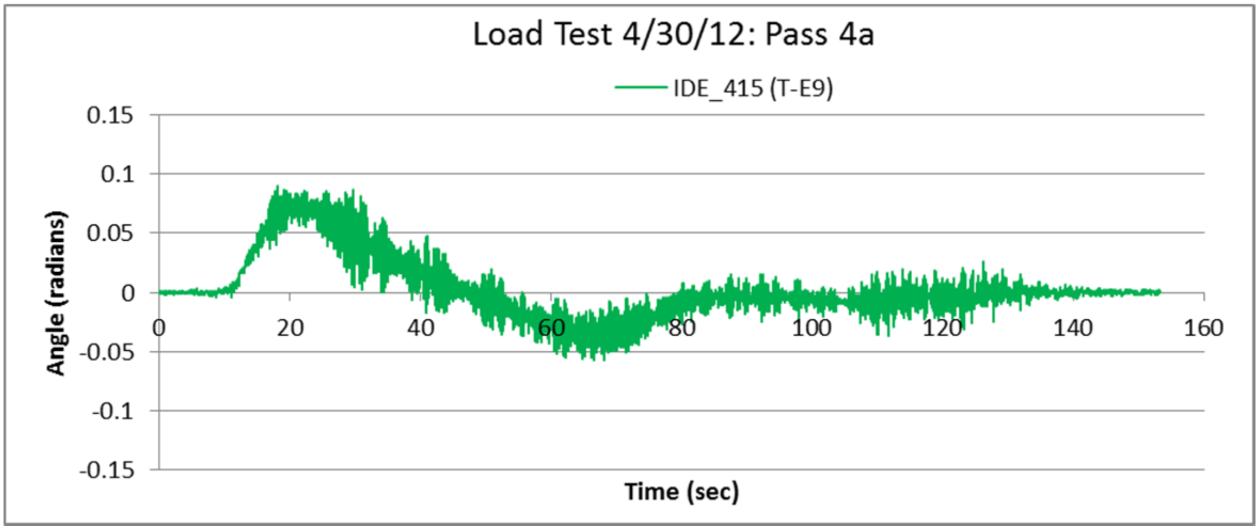

Figure B.33 Deck tilt time history - section 415

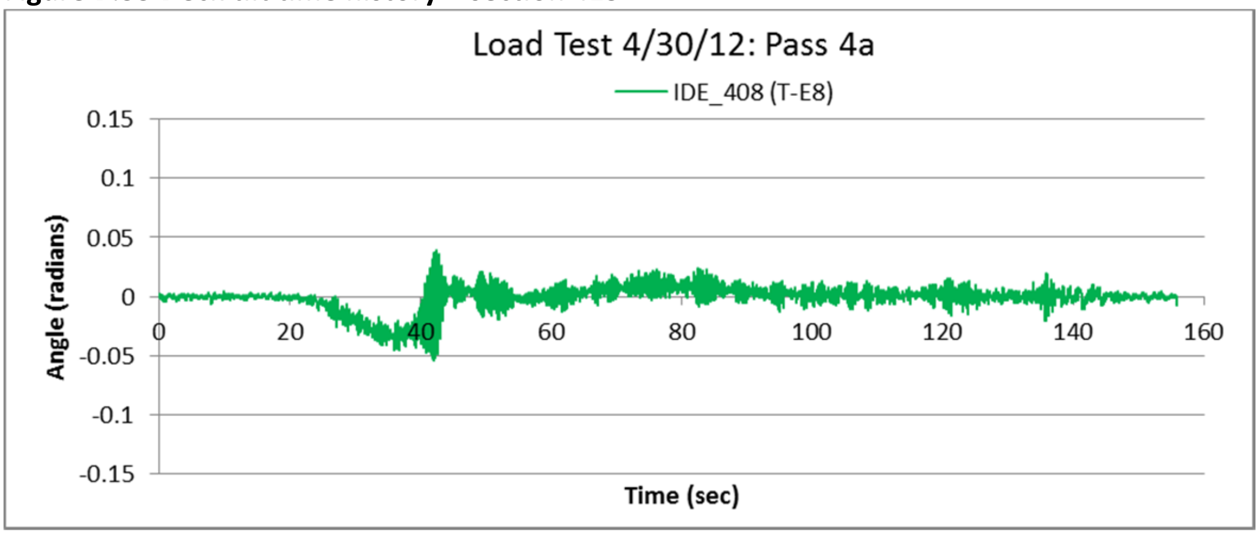

Figure B.34 Deck tilt time history - section 408

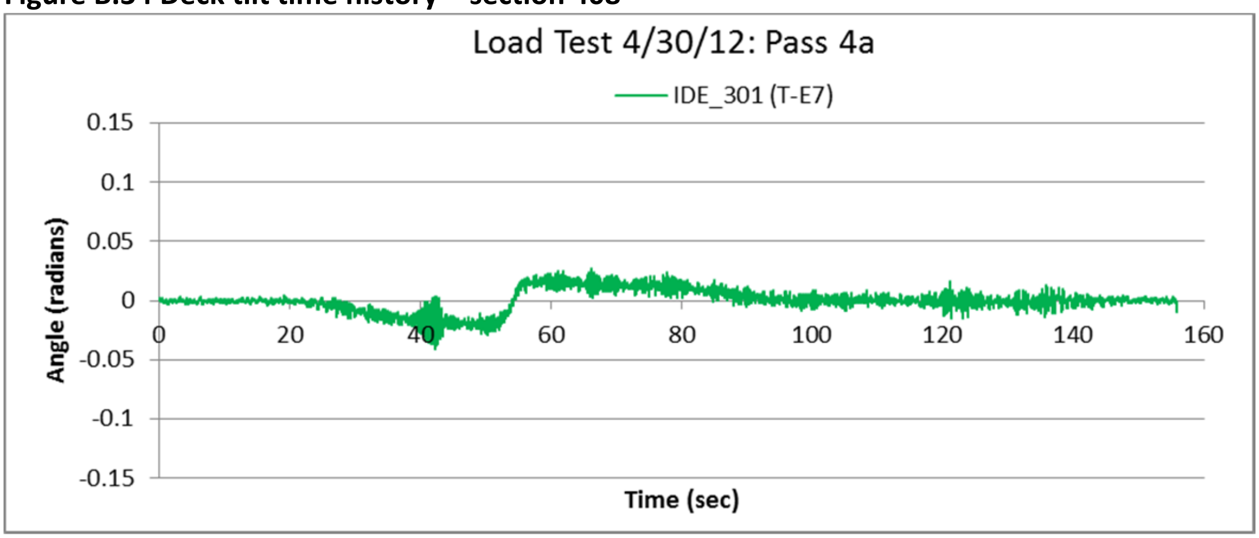

Figure B.35 Deck tilt time history - section 301

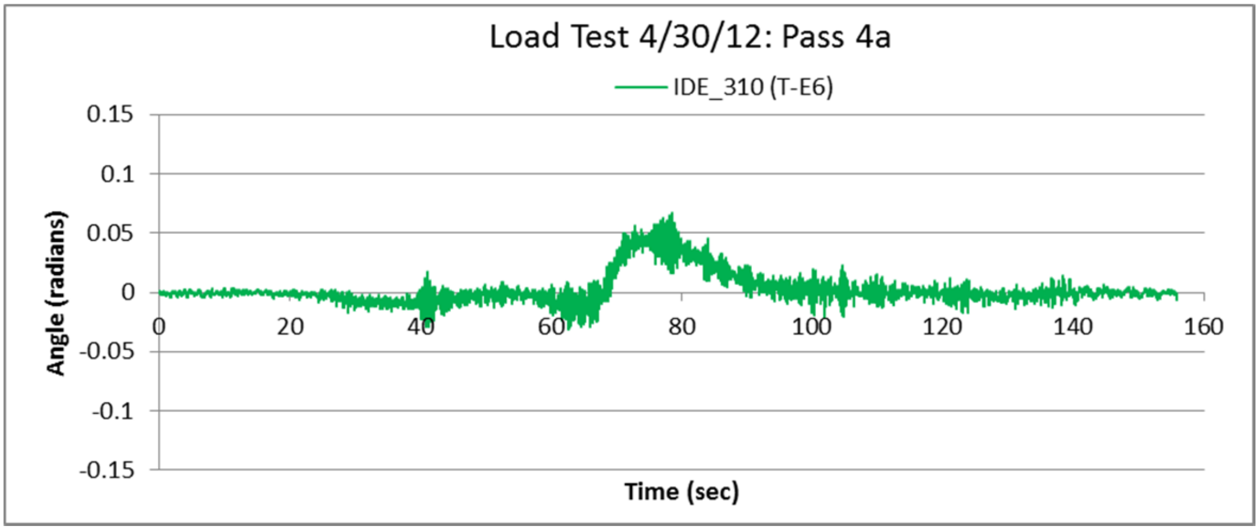

Figure B.36 Deck tilt time history - section 310

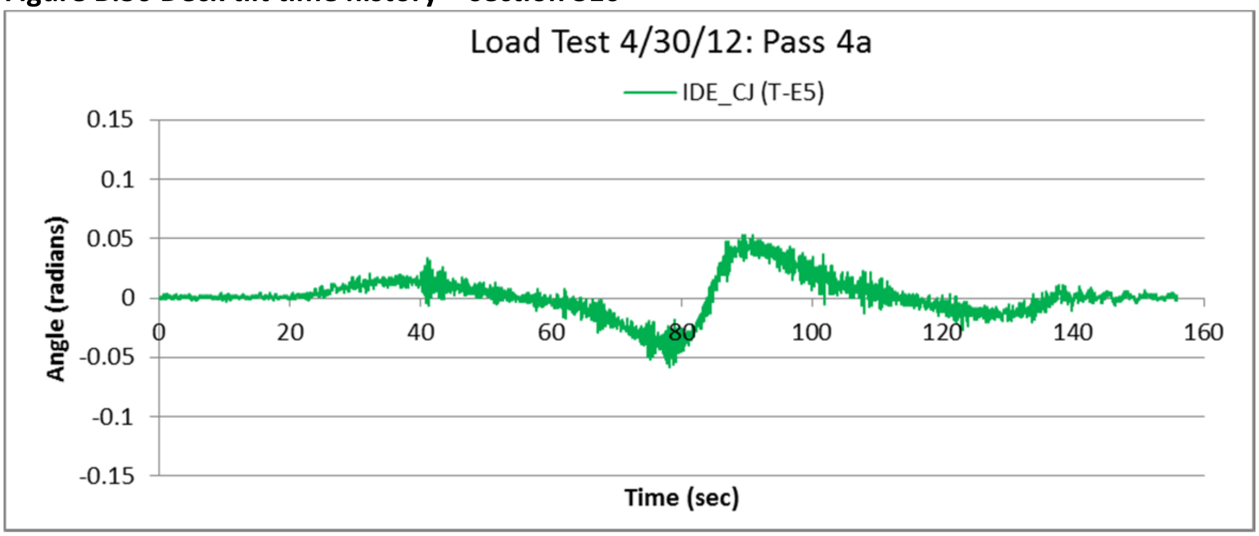

Figure B.37 Deck tilt time history - section closure joint

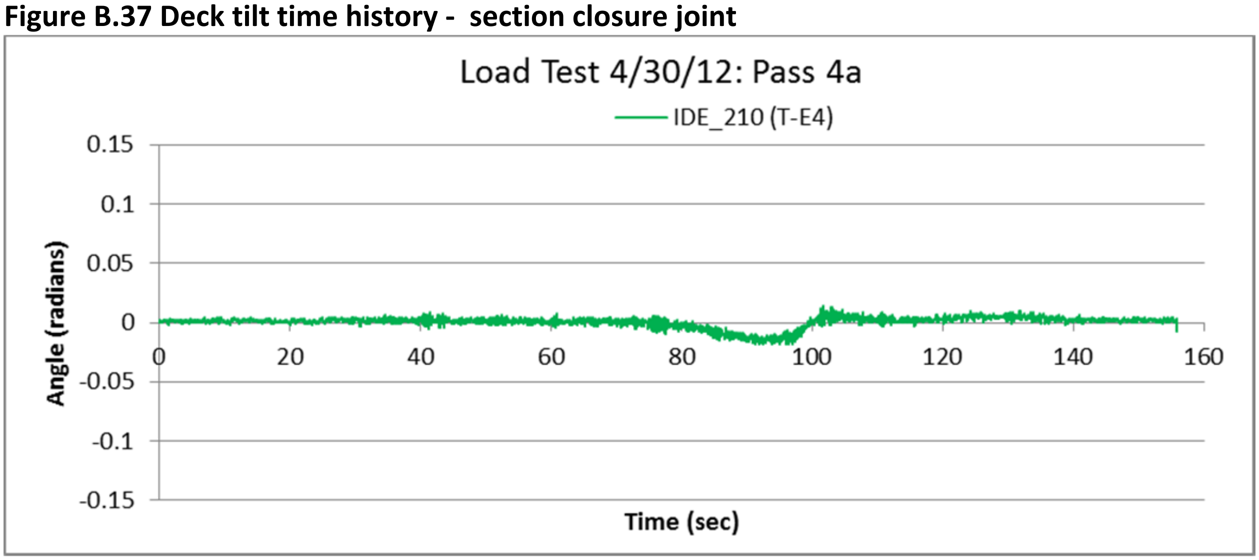

Figure B.38 Deck tilt time history - section 210

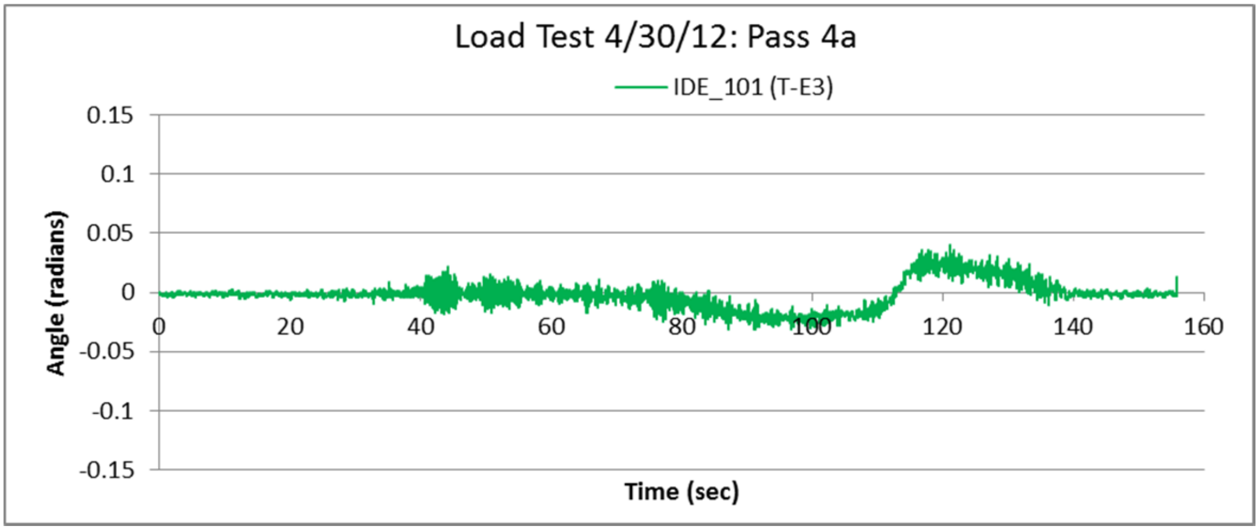

Figure B.39 Deck tilt time history - section 101

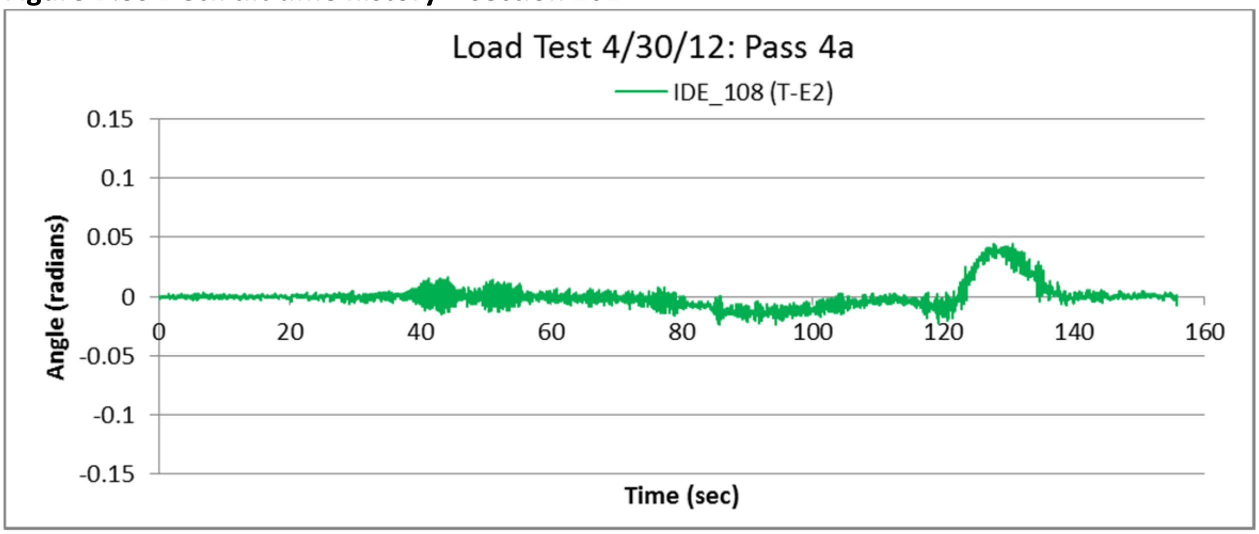

Figure B.40 Deck tilt time history - section 108

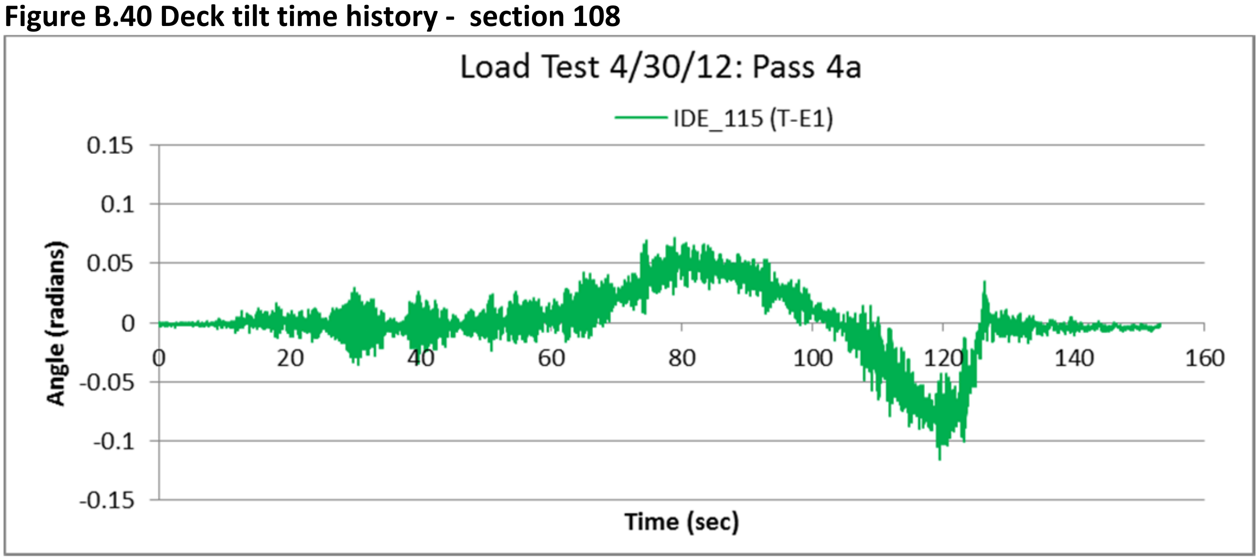

Figure B.41 Deck tilt time history - section 115

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