DEPARTMENT OF TRANSPORTATION
DES-OE MS #43
1727 30TH Street, 2ND Floor
Sacramento, CA 95816

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October 16, 2001

04-SF,Ala-80-13.9/14.3,0.0/1.6
04-012024
ACIM-080-1(085)8N
Addendum No. 4

Dear Contractor:

This addendum is being issued to the contract for construction on State highway in THE CITY AND COUNTY OF SAN FRANCISCO AND ALAMEDA COUNTY IN SAN FRANCISCO AND OAKLAND FROM 1.3 km TO 3.3 km EAST OF THE YERBA BUENA ISLAND TUNNEL EAST PORTAL.

Submit bids for this work with the understanding and full consideration of this addendum. The revisions declared in this addendum are an essential part of the contract.

Bids for this work will be opened on November 14, 2001.

This addendum is being issued to revise the Project Plans, the Notice to Contractors and Special Provisions and the Proposal and Contract.

Project Plan Sheets 885 and 914 are revised. Half-sized copies of the revised sheets are attached for substitution for the like-numbered sheets.

Project Plan Sheet 885A is added. A half-sized copy of the added sheet is attached for addition to the project plans.

In the Special Provisions, Section 3, "PRE-AWARD MEETING AND AWARD AND EXECUTION OF CONTRACT," is revised as attached.

In the Special Provisions, Section 4, "BEGINNING OF WORK, TIME OF COMPLETION AND LIQUIDATED DAMAGES," is revised as attached.

In the Special Provisions, Section 8-4.01, "STEEL AUDITS," **the fourteenth and fifteenth paragraphs are revised as follows:**

"Prior to production of a given steel element, the general steel meeting, the self-audits, and the Caltrans-audit (or the deduction) shall be approved by the Engineer.

Full compensation for conforming to the requirements of "Steel Audits" shall be considered as included in the contract prices paid for the various items of work involved and no additional compensation will be allowed therefor."

In the Special Provisions, Section 10-1.25, "TEMPORARY TOWERS," is revised as attached.

In the Special Provisions, Section 10-1.33, "MODULAR JOINT SEAL ASSEMBLIES," is revised as attached.

In the Special Provisions, Section 10-1.36, "POLYESTER CONCRETE OVERLAY (20 mm, 13 mm)," is revised as attached.

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In the Special Provisions, Section 10-1.44, "STEEL STRUCTURES," is revised as attached.

In the Special Provisions, Section 90-9, " COMPRESSIVE STRENGTH," subsection 90-9.01, "GENERAL," the seventeenth paragraph is deleted.

In the Proposal and Contract, the Engineer’s Estimate Items 8, 9, 10, 11, 12, and 13 are revised as attached.

To Proposal and Contract book holders:

Replace page 3 of the Engineer's Estimate in the Proposal with the attached revised page 3 of the Engineer's Estimate. The revised Engineer's Estimate is to be used in the bid.

Indicate receipt of this addendum by filling in the number of this addendum in the space provided on the signature page of the proposal.

Submit bids in the Proposal and Contract book you now possess. Holders who have already mailed their book will be contacted to arrange for the return of their book.

Inform subcontractors and suppliers as necessary.

This office is sending this addendum by UPS overnight mail to Proposal and Contract book holders to ensure that each receives it.

If you are not a Proposal and Contract book holder, but request a book to bid on this project, you must comply with the requirements of this letter before submitting your bid.

Sincerely,

ORIGINAL SIGNED BY

REBECCA D. HARNAGEL, Chief
Office of Plans, Specifications & Estimates
Office Engineer

Attachments

SECTION 3. PRE-AWARD MEETING AND AWARD AND EXECUTION OF CONTRACT

3-1.01 GENERAL

The bidder's attention is directed to the provisions in Section 3, "Award and Execution of Contract," of the Standard Specifications, and these special provisions for the requirements and conditions concerning the pre-award meeting and the award and execution of contract.

3-1.01A PRE-AWARD MEETING.--Bidders are advised that on **November 20, 2001** at 10:00 a.m., in the third floor conference room, 1727 - 30th Street, Sacramento, CA 95816, the apparent low bidder shall participate in a pre-award qualifications review meeting conducted by an agent of the Director. Non-attendance to the qualifications review meeting by the apparent low bidder shall be just cause for rejection of the bid and forfeiture of the proposal guaranty. At the qualifications review meeting, the low bidder shall be prepared to discuss and answer questions relative to the responses to the "Bridge Construction Information/Questionnaire" submitted with the bid. The Director's agent will prepare written findings and recommendations to the Engineer regarding award of the contract to the apparent low bidder based on the bridge construction information and responses submitted with the bid, and on the information provided at the qualifications review meeting. The Engineer's determination on the bidder's qualifications for performing bridge construction work, in a manner that is safe for the workers and the public, will be based on the bidder's experience, qualifications of on-site supervisory personnel, equipment, conceptual approach to the bridge construction work and safety history of the bidder and its supervisory personnel. The decision of the Engineer regarding the bidder's qualifications shall be final.

The second and third apparent low bidders shall participate in pre-award qualifications review meetings if requested to do so by the Department. Notification by the Department will be within 14 days after the bid opening, and will be provided at least 12 hours prior to the qualifications review meeting. Non-attendance by the second or third apparent low bidder at any such requested meeting shall be just cause for rejection of bid and forfeiture of the proposal guaranty.

3-1.01B AWARD AND EXECUTION OF CONTRACT.--The award of contract, if it be awarded, will be to the lowest responsible bidder whose proposal complies with all the requirements prescribed and who has met the goal for DBE participation or has demonstrated, to the satisfaction of the Department, good faith effort to do so and who has established to the satisfaction of the Engineer, the qualifications and ability to complete the construction work on this project in a safe and timely manner. Meeting the goal for DBE participation or demonstrating, to the satisfaction of the Department, good faith efforts to do so and establishing the qualifications and ability to complete the construction work are conditions for being eligible for award of contract.

The contract shall be signed by the successful bidder and shall be received with contract bonds by the Department within **8 days**, not including Saturdays, Sundays and legal holidays, after the bidder has received notice that the contract has been awarded. Failure to do so shall be just cause for forfeiture of the proposal guaranty. The executed contract documents shall be delivered to the following address: Department of Transportation, P.O. Box 942874, Sacramento, CA 94274-0001, Attn: Office Engineer (MS 43)- Contracts.

A "Payee Data Record" form will be included in the contract documents to be executed by the successful bidder. The purpose of the form is to facilitate the collection of taxpayer identification data. The form shall be completed and returned to the Department by the successful bidder with the executed contract and contract bonds. For the purposes of the form, payee shall be deemed to mean the successful bidder. The form is not to be completed for subcontractors or suppliers. Failure to complete and return the "Payee Data Record" form to the Department as provided herein will result in the retention of 31 percent of payments due the contractor and penalties of up to $20,000. This retention of payments for failure to complete the "Payee Data Record" form is in addition to any other retention of payments due the Contractor.

SECTION 4. BEGINNING OF WORK, TIME OF COMPLETION AND LIQUIDATED DAMAGES

Attention is directed to the provisions in Section 8-1.03, "Beginning of Work," in Section 8-1.06, "Time of Completion," and in Section 8-1.07, "Liquidated Damages," of the Standard Specifications and these special provisions.

The Contractor shall begin work within 15 calendar days after the contract has been approved by the Attorney General or the attorney appointed and authorized to represent the Department of Transportation.

The work shall be diligently prosecuted to completion before the expiration of **900 WORKING DAYS** beginning on the fifteenth calendar day after approval of the contract.

The Contractor shall pay to the State of California the sum of **$70,000** per day, for each and every calendar day's delay in finishing the work in excess of the number of working days prescribed above.

Attention is directed to "Order of Work" of these special provisions. The Contractor shall not have the exclusive right to use the marine access areas for the Contract 04-012044 (Oakland Touchdown), as shown on the plans, and shall evacuate these areas after **410 Working Days** beginning on the fifteenth calendar day after approval of the contract.

The Contractor shall pay the State of California liquidated damages the sum of **$17,500** per day, for each and every calendar day's delay in vacating the marine access areas for Contract 04-012044 in excess of 410 working days, beginning on the fifteenth calendar day after approval of the contract.

No incentive payments will be paid nor will disincentive deductions be charged on this project.

10-1.25 TEMPORARY TOWERS

Temporary towers; shown on the plans for Spans E3E, E3W, E17E and E17W; shall be designed and constructed by the Contractor in conformance with the requirements in Section 49, "Piling," and Section 51-1.06, "Falsework," of the Standard Specifications and these special provisions.

Temporary towers shall include jacking assemblies and appurtenant items necessary to jack and support the superstructure, and compensate and maintain the proper roadway alignment and profile.

GENERAL

Attention is directed to the following sections of these special provisions regarding permit restrictions and regulations that may impact temporary tower design and construction:

A. Relations with Coast Guard
B. Relations with Regional Water Quality Control Board
C. Relations with California Department of Fish and Game
D. Relations with National Marine Fisheries Service
E. Relations with Bay Conservation Development Commission
F. Relations with U. S. Army Corps. of Engineers

Attention is directed to “Sound Control Requirements,” of these special provisions.

Temporary tower foundation information and piling design procedures (including example calculations) are included in the "Information Handout" available to the Contractor as provided for in Section 2-1.03, "Examination of Plans, Specifications, Contract, and Site of Work," of the Standard Specifications.

TEMPORARY TOWER PILING

Piling shall be driven steel pipe piles.

The requirements in Section 49-1.03, "Determination of Length," of the Standard Specifications shall not apply.

Driven piling shall be of such length as required to develop the minimum bearing value, as defined in "Bearing Criteria" of this section, obtain the design penetration and to extend into the pile cap, as shown on the approved working drawings, unless otherwise specified in these special provisions or permitted in writing by the Engineer.

DRIVING EQUIPMENT

Diesel hammers shall not be used.

Jetting and drilling in conformance with Section 49-1.05, "Driving Equipment," of the Standard Specifications shall not be used.

PILE DYNAMIC MONITORING

The Contractor shall conduct dynamic monitoring of pile driving and conduct penetration and bearing analyses based on a wave equation analysis. Piles shall be monitored over the last 1/3 of the design pile length. Said analysis shall be signed by an engineer who is registered as a Civil Engineer in the State of California and submitted to the Engineer prior to completion of temporary tower erection.

The Contractor's monitoring equipment shall be capable of generating a continuous computer printout of monitoring results.

Piles shall be fitted with one set of attachments located on opposite sides of the pile.

BEARING CRITERIA

The maximum bearing value for piles supporting temporary towers shall not exceed 1.8 MN.

The first two paragraphs in Section 49-1.08 "Bearing Value and Penetration," of the Standard Specifications shall not apply.

Piles shall be driven to the design tip elevation and a minimum bearing value of not less than the design loading shown on the approved working drawings, unless otherwise specified in these special provisions or permitted in writing by the Engineer.

For piles that encounter driving refusal above the approved design tip elevation, the Contractor shall notify the Engineer in writing. The Contractor shall evaluate these piles and propose alternative pile installation techniques. Possible alternative pile installation techniques include using a higher capacity hammer and removal of the soil plug for open-ended piling. No additional compensation will be allowed for developing and using alternative pile installation methods.

The Contractor shall provide a pile driving log at the completion of driving each pile.

INDICATOR PILES

Prior to fabricating production piling for a given temporary tower location, the Contractor shall furnish and drive an indicator pile at that temporary tower location and at a position selected by the Engineer.

The Contractor shall not fabricate production piling at a given temporary tower location until the Engineer has approved the specified tip elevation at that location.

Indicator piles shall be identical to production piles at a given temporary tower location, except that the length of indicator piles shall be sufficient to conform to the requirements of "Pile Redrives," of this section.

The Contractor shall drive the indicator pile to the specified tip elevation shown on the approved working drawings at the given temporary tower location. If the bearing value of the indicator pile is less than the minimum bearing value shown on the approved working drawings, the Contractor shall redrive the indicator pile at 48 hours, 7 days, and 28 days.

Redriving piles shall conform to "Pile Redrives," of this section.

Upon completion of pile redrives, the Contractor shall evaluate the pile setup, bearing value, and specified tip elevations for a given tower location and revise the temporary tower working drawings as necessary. Revised working drawings shall conform to "Working Drawings," of this section.

PILE REDRIVES

Pile redrives shall consist of the following:

A. The pile shall be advanced a minimum of 75 mm during each redrive;
B. The redrive blow count shall be taken as the average blow count over the first 50 mm of driving. Blow count per quarter meter will be extrapolated from the blow count over the first 50 mm;

TEMPORARY TOWER DESIGN

Temporary towers shall consist of steel braced frames with bolted connections. Timber walkways and decks will be permitted. At the option of the Contractor, temporary tower pile caps may be made of reinforced concrete.

Cable bracing will not be permitted.

The first paragraph of Section 51-1.06A "Falsework Design and Drawings," of the Standard Specifications shall not apply.

Timber connections shall be designed in conformance with the procedures, stresses and loads permitted in the Falsework Manual as published by the Department of Transportation, Division of Structures, Office of Structure Construction.

The construction equipment loads shall be the actual weight of the construction equipment, material and personnel, but in no case shall be less than 960 N/m2 of deck surface area.

Temporary towers shall be designed in accordance with the following criteria/codes:

Subject	Design Code or Reference	Year
Structural Steel	AISC-LRFD	Current Edition
Structural Steel – Tubular Members	API RP2A	Current Edition
Concrete	AASHTO-LRFD Bridge Construction Code	Current Edition
Wind Loads	ASCE 7-98	1998
Falsework	State of California Dept. of Transportation – Falsework Manual	Current Edition

In case of a difference between code clauses, the more stringent clause, as determined by the Engineer, shall apply.

Design of temporary towers shall account for any change in the loads imposed on the tower by the bridge superstructure due to jacking operations, prestressing, time-dependent effects and construction sequence of the bridge.

Temporary towers shall be designed to adequately support the bridge without imparting distortion or exceeding the allowable stresses in the bridge. Allowable stresses in the orthotropic box transition span shall not exceed the allowable values given in AISC. Allowable stresses in the concrete segments shall not exceed the values recommended by AASHTO/ASBI for precast segmental bridges.

The Contractor shall ensure the stability of the tower as well as the supported bridge structure at all times during construction. The connection between the jacks at the top of the tower and the bridge superstructure shall be capable of transmitting lateral shear loads through the use of restraining keys or other such means. All jacking operations shall be submitted to the Engineer for his approval at least two weeks before the start of such operations.

The total design settlement of temporary towers shall not exceed 25 mm.

The twentieth paragraph of Section 51-1.06A, "Falsework Design and Drawings," of the Standard Specifications shall not apply.

The design of temporary towers shall be based on assumed loads that are equal to or greater than those described in this section.

Approximate dead load reactions from the bridge superstructure, based on the assumed construction sequence, are shown on the plans.

The design of the temporary towers shall conform to both the service and ultimate limit state criteria set in these special provisions as well as in the referred codes.

The Contractor shall be responsible for the proper evaluation of the falsework materials and design of the falsework to safely carry the actual loads imposed.

The fifth and sixth paragraphs of Section 51-1.06A(1), "Design Loads," of the Standard Specifications shall not apply.

Vertical Loads

Temporary towers and their foundations shall be designed to carry the anticipated total effective tower load.

The total effective tower load shall include, at a minimum, the following:

A. Tower and foundation, including piles, pile caps, and fenders;
B. Load from supported bridge; and
C. Contractor's equipment and live load.

Seismic Design Loads

Temporary towers shall be designed to resist horizontal seismic loads applied to the tower system in combination with the appropriate vertical loads covering all significant construction stages. Significant construction stages are those which produce maximum stress in one or more members. The seismic analyses shall consider the interactions of the tower system with the bridge superstructure at all appropriate stages as well as the hydrodynamic added mass associated with the submerged tower foundation and fenders.

Seismic demands shall be determined using the site-specific temporary tower response spectra (5% damped) contained in the Information Handout, and shall be applied in any horizontal direction. Pushover analyses of the tower systems shall be carried out based on displaced shapes determined form modal analyses of the tower systems and bridge superstructure. The target displacements for the pushover analyses shall be established from the modal analyses and the displacement spectrum.

The seismic performance of the tower system shall result in the bridge superstructure remaining undamaged and not stressed excessively. The temporary tower system shall remain serviceable and capable of carrying the design loads. Tower vertical load carrying members and connections shall remain elastic. Yielding of the structural steel bracing members will be permitted. Yielding of the extreme fibers of the structural steel piles will be permitted subject to a maximum of 2% strain.

Vessel Impact Design Loads

Temporary towers shall be designed for accidental vessel impact and coincident wind, wave and current loads in accordance with API RP2A.

Attention is directed to the AASHTO Guide Specification and Commentary for Vessel Collision Design of Highway Bridges (1991) regarding design for accidental impact.

Temporary towers shall be designed to resist loads from impact of the Contractor's equipment. At a minimum, temporary towers shall be designed to resist an impact load of 7.6 MN, acting between elevation +7.6 m and –1.8 m NGVD, without collapse.

The rake of the bow of a 76 m x 14 m hopper barge shall be used to determine whether the impact force will occur on the fenders and foundation or whether the vessel will impact the tower substructure.

Temporary towers shall not be used for mooring the Contractor's vessels unless they are specifically designed for mooring loads including the effects of the eccentric application of these loads.

WORKING DRAWINGS

The Contractor shall submit to the Engineer working drawings and design calculations for temporary towers, in conformance with the requirements in "Working Drawings," of these special provisions. The Contractor shall allow the Engineer the following times for the review of temporary tower working drawings and design calculations:

Location	Review Time
E3E and E3W	50 Working Days
E17E and E17W	50 Working Days

The Contractor's temporary tower working drawings shall include a pile installation schedule that is in conformance with "Progress Schedule (Critical Path)," of these special provisions.

The fourth, fifth, six and seventh paragraphs of Section 51-1.06A "Falsework Design and Drawings," of the Standard Specifications shall not apply.

When several temporary tower drawings or calculations are submitted simultaneously, or additional drawings or calculations are submitted for review before the review of previously submitted drawing or calculation has been completed, the Contractor shall designate the preferred sequence in which the plans and calculations are to be reviewed. The time to be provided for the review of any drawings and calculations in the sequence shall be not less than the review time specified above for that plan, plus two weeks for each plan of higher priority which is still under review.

Working drawings for temporary towers shall include the following:

A. Complete details showing the proposed construction sequence;
B. Concrete placing diagram;
C. Erection methods;
D. Methods and plans for release of tower to superstructure connections.
E. Removal plans, where applicable;
F. Descriptions of equipment and associated loads, including the loads shown on the plans;
G. Complete details for all jacking operations, providing grade adjustment to compensate for anticipated settlement, and ensuring proper fit up;
H. Complete details and descriptions of the displacement monitoring system described in these special provisions;
I. Details and descriptions of equipment and methods proposed for monitoring the erection, position, settlement and deflection of temporary towers; and
J. Schedule of taking displacement measurements.
K. Pile Data Table including the design loads, bearing value, and required pile tip elevations.
L. Estimates of pile set-up at 48 hours, 7 days, and 28 days.
M. Details for alternative pile installation techniques in case pile refusal is encountered above the design penetration. Techniques shall include the effects on bearing value.

Design calculations for temporary towers shall include, at a minimum, the following:

- Summary of computed stresses in the temporary towers. Computed stresses shall include effects from any grade adjustment assumed by the Contractor to insure proper grade and fit up.
- Assessment of lateral stiffness and significant periods of vibration of the temporary towers system.
- Calculations for providing grade adjustment to compensate for anticipated settlement and ensure proper fit up.
- All jacking operations.
- Calculation of pile setup period(s).
- Calculation of pile alignment and location tolerances.
- Refusal criteria
- Driving system submittal
- Dynamic monitoring equipment and setup
- Design pile length
- Schedule

Temporary Tower Driving System Submittal

The Contractor's temporary tower working drawings shall include a pile installation schedule that is in conformance with "Progress Schedule (Critical Path)," of these special provisions.

Prior to installing driven piling at a given temporary tower location, the Contractor shall provide a driving system submittal for that tower location, including a driveability analysis, in conformance with the provisions in "Working Drawings," of these special provisions. Technical data for all proposed driving systems (i.e., each hammer that may be brought onto the site) shall be included in the submittal.

The driving system submittal shall be based on the soil profiles shown in the Information Handout and shall contain an analysis showing that the proposed driving systems will install piling to the Contractor's design tip elevation, as shown on the approved working drawings without overstressing the piles. Submittals shall include the following:

A. Complete description of soil parameters used, including soil quake and damping coefficients, skin friction distribution, percentage shaft friction, and total soil resistance to driving.
B. List of all hammer operation parameters assumed in the analysis, including manufacturer's rated energy, fuel settings, stroke limitations, and hammer efficiency.
C. Driveability studies that are based on a wave equation analysis using a computer program that has been approved by the Engineer. Driveability studies shall model the Contractor's proposed driving systems, including the hammers, capblocks, pile cushions, followers and driving shoes, as well as determine driving resistance and pile stresses for assumed site conditions. For open-ended steel pipe piles, soil resistance to driving shall be computed for both plugged and unplugged cases. The range of soil resistance to driving and the percentage shaft resistance shall be determined for site conditions ranging from 5 meters above to 5 meters below the Contractor's design tip elevation shown on the approved working drawings. Separate analyses shall be completed at elevations above the design tip elevations where difficult driving or pile splices are anticipated. Driveability analysis results shall include plots of the following:

    1. Maximum pile head and pile toe compressive stress versus blows per 250 mm.
    2. Soil resistance to driving versus blows per 250 mm.

D. Copies of all test results from any previous pile load tests, dynamic monitoring, and all driving records used in the analyses.
E. Completed "Pile and Driving Data Form," which is shown in these special provisions.
F. Estimate of pile penetration due to self-weight and the weight of the hammer.

The Contractor shall use the driving system and installation methods described in the approved driving system submittal for each temporary tower location. Any change in hammers from those submitted and approved by the Engineer shall also meet the requirements for driving system submittals. Revised and new driving system submittals shall be approved by the Engineer prior to using corresponding driving systems on temporary tower piling. The Contractor shall allow the Engineer 15 working days to review each revised and each new driving system submittal after a complete set has been received, as determined by the Engineer.

Approval of pile driving equipment shall not relieve the Contractor of his responsibility to drive piling free of damage to the design penetration.

MANUFACTURED ASSEMBLIES

Manufactured assemblies shall conform to the provisions in Section 51-1.06A(2), of the Standard Specifications and these special provisions.

All jacks shall be equipped with a load cell for determining the jacking force. Pressure gages shall have an accurately reading dial at least 150 mm in diameter. Each jack shall be calibrated by a private laboratory approved by the Transportation Laboratory within 6 months prior to use and after each repair, unless otherwise directed. Each jack and its gage shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force and shall be accompanied by a certified calibration chart. Load cells shall be calibrated and provided with an indicator by which the jacking force is determined.

Jacks for temporary towers shall be load-rated for at least 125% of the design service loads.

CONSTRUCTION

The construction of temporary towers shall not start until the Engineer has reviewed and approved the drawings for that location.

The Contractor shall be responsible for monitoring the erection, position, settlement and deflection of temporary towers in accordance with the requirements of this section and submitting logs of these deflections and settlements to the Engineer. Deflection logs shall be provided to the Engineer within 12 hours of recording the measurements.

The third paragraph of Section 51-1.06B, "Falsework Construction," of the Standard Specifications shall not apply.

Welding, welder qualification, and inspection of welding for all steel members shall conform to the requirements of AWS D1.1.

Prior to erecting bridge members on the temporary towers, an engineer for the Contractor who is registered as a Civil Engineer in the State of California shall inspect the temporary towers, including grade adjustment and displacement monitoring systems, for conformity with the working drawings. The Contractor's registered engineer shall certify in writing that the temporary towers, including grade adjustment and displacement-monitoring systems, substantially conform to the working drawings, and that the material and workmanship are satisfactory for the purpose intended. A copy of this certification shall be submitted to the Engineer and shall be available at the site of the work at all times.

Grade adjustment operations shall be carefully controlled and monitored to prevent imparting distortion and excessive stresses that would damage the structure.

Adequate means shall be employed to prevent unplanned lateral and longitudinal movement of the temporary tower during jacking. The temporary towers, jacks, and the superstructure shall be stable during all phases of the operation.

The jacking system shall be designed such that pressure loss of any hydraulic system cannot cause movement after jacking operations. This may be by means of a mechanical lock off of the jacks, replacement of the jacks by supports that can be cast in, or alternative methods.

The Contractor's jacking methods shall include provisions for blocking up the superstructure from the temporary towers such that the gap between the temporary tower and the superstructure during all phases of the jacking operation does not exceed 25 mm.

No more than 150 mm of shimming will be permitted at any jacking location.

Temporary towers shall be protected from damage during construction.

Fenders and navigation lighting for temporary towers shall conform to the requirements in "Relations with Coast Guard" of these special provisions. Temporary towers shall not be used as a mooring.

REMOVING TEMPORARY TOWERS

Section 51-1.06C “Removing Falsework,” of the Standard Specifications shall not apply.

When no longer required, temporary towers BE and BW shall be completely removed. Temporary tower piling shall be removed to at least 1.0 meter below the original mudline.

MEASUREMENT AND PAYMENT

Section 49-6, "Measurement and Payment," of the Standard Specifications shall not apply.

The contract lump sum price paid for furnish temporary towers, of the types listed in the Engineer's Estimate, shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in temporary towers, complete in place, including designing, constructing, and maintaining temporary towers, furnishing and driving piles, driving system submittals, monitoring and redriving piles, necessary grade adjustment and displacement monitoring, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The contract lump sum price paid for furnish and remove temporary towers, of the types listed in the Engineer's Estimate, shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in removing temporary towers, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

10-1.33 MODULAR JOINT SEAL ASSEMBLIES

Modular joint seal assemblies shall consist of supporting elements, supports, sealing elements, and anchorage elements and shall be designed, fabricated, inspected, tested, and installed as shown on the plans and approved working drawings and supplement, and as specified in the Standard Specifications and these special provisions.

MANUFACTURER

Modular joint seal assemblies shall be a Maurer Sohne Swivel-Joist Expansion Joint manufactured and supplied by:

THE D.S. BROWN COMPANY
300 E. CHERRY STREET
NORTH BALTIMORE, OHIO 45872
TEL: (419) 257-3561
FAX: (419) 257-2200

Maurer Sohne Swivel-Joist Expansion Joints are the only modular joint seal assemblies known to the State that meet the requirements of this contract. Preliminary working drawings and technical data for each hinge location for the Maurer Sohne Swivel-Joist Expansion Joints by D.S. Brown have been submitted, reviewed, and determined to be satisfactory by the Engineer.

Maurer Sohne Swivel-Joist Expansion Joints consist of supporting elements, supports, sealing elements, and anchorage elements. Supporting elements include edge beams, center beams, and support bars. Supports include sliding plates, sliding springs, and sliding bearings. Anchorage elements include carriageway anchors at the edge beams, anchor studs at the support boxes, and support boxes. Center beams slide on obliquely arranged swiveling support bars, resting on elastic bearings. The arrangement of the support bars and the type of connection between the support bar and the center beams assure equal spacing of the center beams.D.S. Brown has agreed to furnish Maurer Sohne Swivel-Joist Expansion Joints and other services described in these special provisions at the guaranteed prices as shown in the following table:

Hinge Location	Model No.	Guaranteed Price
Hinge BW	DS1040B	$876,562
Hinge BE	DS1040B	$876,562
Hinge CW	DS960B	$798,057
Hinge CE	DS960B	$798,057
Hinge DW	DS560B	$459,538
Hinge DE	DS560B	$459,538

The guaranteed prices include design and fabrication of modular joint seal assemblies, prototype and proof testing of assemblies (including fabricating and furnishing test specimens, components of assemblies, and any appurtenances necessary for testing), delivery of assemblies to the Contractor's near site staging yard, inspection and installation consultation by a qualified representative of the manufacturer at the job-site during installation of all assemblies, and final inspection by the manufacturer of installed assemblies. The guaranteed prices also include working drawings and supplements, quality control for both the final products and test specimens, and the product warranty as specified elsewhere in these special provisions. The guaranteed prices do not include installation of modular joint seal assemblies and watertight tests. The guaranteed prices do not include sales taxes.

The above prices will be guaranteed for orders placed with D.S. Brown on or before July 1, 2002, provided delivery of at least two modular joint seal assemblies is accepted with in 24 months after the order is placed. The total price will be increased 10 percent for orders placed with D.S. Brown after July 1, 2002 and on or before July 1, 2003, provided delivery is accepted on or before July 1, 2005.

Use of the Swivel-Joist Expansion Joints is contingent on approval of the contract specific working drawing submittal and successful performance of the Swivel-Joist Expansion Joints under prototype and proof testing.

WORKING DRAWINGS

The Contractor shall submit working drawings in conformance with the provisions in Section “Working Drawings” elsewhere in these special provisions, and these special provisions.

Working drawings shall include complete details, information, and drawings of the modular joint seal assembly and anchorage components and the method, materials, equipment, and procedures of fabrication and installation that the Contractor proposes to use.

Working drawing submittals shall include the following:

A. Fabrication plans including all details, elevations, and sections of the modular joint seal assembly for each hinge location as shown on the plans. All dimensions and design tolerances shall be specified. The plans shall identify the proposed location for cutting of central beams and edge beams to accommodate the removal and replacement of the modular joint seal assembly as specified in Section “General Design Requirements” of these provisions.
B. Fabrication plans including all details, elevations, and sections of the modular joint seal assembly for dynamic testing specimen. All dimensions and design tolerances shall be specified.
C. All ASTM or other material designations.
D. Sections showing all materials composing the modular joint seal assembly with complete details of all individual components including welded splices and connections.
E. PTFE bonding methods and details.
F. Installation plans including methods, materials, equipment, sequence, lifting mechanisms and locations, details of temporary anchorage during setting, temperature adjustment devices, opening dimensions relative to temperature, installation details at curbs, seal installation details, and other procedures that the Contractor proposes to use for installation of the modular joint seal assemblies.
G. Plan for achieving watertightness including details related to performing the watertightness test as specified in these special provisions.
H. Details and material designations pertinent to the corrosion protection system and list of coating system for modular joint seal assemblies identifying galvanizing, and cleaning and painting for all steel components.
I. Anchorage components including concrete blockout details and any additions or rearrangements of the reinforcing steel from that shown on the plans.
J. Storage plans for manufacture storage, interim storage, and on-site storage details including temporary support for the modular joint seal assemblies.
K. Shipping plans including the handling during the transportation of the modular joint seal assemblies. Each shipment of the modular joint seal assembly materials shall be accompanied by a Certificate of Compliance in conformance with the provisions in Section 6-l.07, "Certificates of Compliance," of the Standard Specifications. The certificate shall state that the materials and fabrication involved comply in all respects to the specifications and data submitted in obtaining approval.

A supplement to the working drawings shall include the following:

A. Complete design and independent design check calculations including the assumptions and methods used in analyses and design of each modular joint seal assembly and its components. The design and independent check calculations shall include the fatigue design and load factor design of all structural elements including all springs and bearings, connections, and splices conforming to the requirements shown on the plans, the Standard Specifications, and these special provisions.
B. The quality control plan (QCP). The QCP of the modular joint seal assembly shall conform to the requirements in "Quality Control” of these special provisions and shall include descriptions, details, and procedures for the fabrication and installation of the modular joint seal assemblies, except that the portion of the QCP for welding shall be submitted separately in conformance with "Welding" in these special provisions.
C. Names and addresses of test facilities, time schedule for various testing, and qualifications of personnel performing the test as specified in these special provisions.
D. Details, procedures, and schedules of fatigue testing for modular joint seal assemblies conforming to the section, “Fatigue Testing of Metallic Structural Components and Connections,” of these special provisions. The fatigue testing plan shall include drafted, annotated illustrations of the test apparatus and equipment included in the testing program. The fatigue testing plan shall also include certifications that all testing equipment has been calibrated no longer than 12 months prior to testing.

E. Details, procedures, and schedules of durability testing of elastomeric support bearing for modular joint seal assemblies conforming to the section, “Durability Testing of Elastomeric Support Bearing,” of these special provisions. The durability testing plan shall include drafted, annotated illustrations of the test apparatus and equipment included in the testing program. The durability testing plan shall also include certifications that all testing equipment has been calibrated no longer than 12 months prior to testing.
F. Details, procedures, and schedules of dynamic testing for modular joint seal assemblies conforming to the section, “Dynamic Testing,” of these special provisions. The dynamic testing plan shall include drafted, annotated illustrations of the test apparatus and equipment included in the testing program. The dynamic testing plan shall also include certifications that all testing equipment has been calibrated no longer than 12 months prior to testing.
G. Details, procedures, and schedules of proof testing for modular joint seal assemblies conforming to the section, “Proof Testing,” of these special provisions. The proof testing plan shall include drafted, annotated illustrations of the test apparatus and equipment included in the testing program. The proof testing plan shall also include certifications that all testing equipment has been calibrated no longer than 12 months prior to testing.
H. Manufacturer's certificate of compliance for all PTFE sheeting, PTFE fabric, elastomer, and modular joint seal assembly sealing elements.
I. Certified test reports confirming that the springs and bearings meet the design load requirements.
J. Time line outlining milestones as specified in "Time Line" of these special provisions. The milestones the Contractor proposed shall be in accordance with the provisions in Section, “Progress Schedule (Critical Path)” elsewhere in these special provisions.
K. The manufacturer of the modular joint seal assemblies shall submit 6 bound copies of the inspection, maintenance, and replacement manual to the Engineer for the joint inspection, maintenance, and replacement. This manual shall include:

    1. Recommended frequency for joint inspection and maintenance schedule over the period of design life.
    2. Procedures and details to perform the joint inspection and maintenance.
    3. List of indication of joint or its component defects and the associated method to repair, if any.
    4. Part replacement plan to facilitate replacement of parts subject to wear. This plan shall include a list of parts, instructions for maintenance inspection, acceptable wear tolerances, methods for determining wear, procedures for replacing worn parts, and procedures for replacing seals.
    5. Recommended life expectancy for each component of the modular joint seal assemblies.
    6. Procedures and sequences for modular joint seal assemblies replacement including locations of temporary support, expected number of traffic lane closure, and any other requirements to replace the modular joint seal assemblies.
    7. Contacts, telephone numbers, and email addresses for maintenance and inspection questions.

The working drawings and supplement shall be stamped and signed by an engineer who is registered as a Civil Engineer in the United States. This registered Civil Engineer shall be an employee of the modular joint seal assembly manufacturer.

After complete working drawings and supplement are received by the Engineer, the Contractor shall allow the Engineer 40 working days to review the submittal. No fabrication of test specimen and test fixtures of the modular joint seal assembly shall begin until complete working drawings and supplement are reviewed and a preliminary approval is given, in writing, by the Engineer.

After the Engineer issues a preliminary approval in writing to the Contractor for the submitted working drawings and supplement, the Contractor shall begin conducting the prototype tests for the modular joint seal assemblies.

Within 10 working days after the prototype tests have been successfully completed, the Contractor shall submit the following documents to the Engineer for final approval:

A. Test records, results, certified test reports, and all other relevant test information
B. Revised plans, procedures, or any other modifications
C. Calculations for “Expected Friction Force” of all the production joint seal assemblies when subject to proof testing as specified in the section “Proof Testing” of these special provisions. The calculations should clearly indicate the extrapolation equations and assumptions applied in the process of establishing the expected friction force.
D. Three copies of Geometry Tolerance Control Plan including the following:

    1. For each essential element as defined in the section “Dynamic Testing” of these provisions, a target dimensional tolerance from its theoretical size.

2. Description of procedures to be used to check the target dimensional tolerances of the essential elements during the fabrication process.
3. For completed assembly, define a target tolerance on out-of-line alignment of pivoting pins, unevenness of welded stirrup heights, unevenness of height of installed sliding bearings and sliding springs.
4. Description of procedures to be used to check the target tolerances of the completed assembly during the fabrication process.

The Contractor shall allow the Engineer 30 working days to review each of the certified test reports for the prototype tests, any Contractor proposed modifications to previously submitted working drawings and supplement, the expected friction force calculations, and the geometry tolerance control plan. If the Engineer requests additional information or calculations, the Contractor shall allow the Engineer additional 10 working days to review. No fabrication of modular joint seal assembly shall begin until all certified test reports and complete expected friction force calculations are reviewed and the final approval is given, in writing, by the Engineer. Within 5 working days after final approval by the Engineer, the Contractor shall submit to the Engineer 7 copies of approved expected friction force calculations and geometry tolerance control plan.

After completion of proof testing, the Contractor shall submit the proof test reports as specified in Section "Proof Testing" of these special provisions.

Upon completion of installation, the Contractor shall submit to the Engineer certification stating that each modular joint seal assembly was installed in accordance with the approved working drawings and supplements installation procedure.

The Contractor shall provide to the State of California as a condition of acceptance of the modular joint seal assembly for incorporation into the work, a manufacturers written warranty addressed to the California Department of Transportation that includes the following provisions. For the five-year period commencing from the date of completion of the contract, the manufacturer shall warranty the performance and durability of each modular joint seal assembly. Conditions constituting unsatisfactory performance and durability include broken welds or bolts (including field splices), cracks in steel members, fatigue damage, loss of precompression in springs or bearings, debonded PTFE, breakdown of corrosion protection, and leakage. The Manufacturer shall provide the components and necessary technical staff to replace or repair any modular joint seal assembly component demonstrating unsatisfactory performance or durability within the five-year period commencing from the date of completion of the contract. All materials and technical staff that are required to satisfactorily perform warranty obligations shall be provided at the manufacturer's sole cost and expense.

MATERIALS

Attention is directed to "Welding" and "Steel Audits" in these special provisions.

Structural steel shall conform to the section "Steel Structures" elsewhere in these special provisions. Structural steel shall conform to the requirements of ASTM Designation: A 572M, Grade 345. Aluminum components shall not be used. Stainless steel shall conform to ASTM Designation: A 240, Type 316L.

Bolts, nuts and washers shall conform to the requirements of ASTM Designation: A 325 or A 325M and Section 75-1.03, "Miscellaneous Bridge Metal," of the Standard Specifications. Bolted splices shall not be permitted in supporting elements and supports.

DU self-lubricating bearing materials made by Garlock Bearings Inc. shall conform to the manufacturer's recommendations and material properties.

Polytetrafluoroethylene (PTFE) sheet shall be made from unfilled PTFE resin and shall conform to the following requirements:

Test	Test Method	Requirements
Tensile strength (Minimum)	ASTM D 4894 or D 4895	19.3 MPa
Elongation (Minimum)	ASTM D 4894 or D 4895	200 %

The PTFE resin shall be virgin material (not reprocessed), woven PTFE fabric, or dimpled PTFF conforming to the requirements of ASTM Designation: D 4894 or D 4895. Specific gravity shall be from 2.13 to 2.19. Melting point shall be 327±10°C.

Box-type sealing elements or sealing elements utilizing double webs shall not be permitted. Sealing elements shall be continuous without splices. The neoprene glands, if used for sealing elements, shall conform to the requirements in Table 1 of ASTM Designation: D 2628 and the following, except that no recovery tests or compression-deflection tests will be required:

Property	Requirement	ASTM Test Method
Hardness, Type A Durometer, points	55-70	D 2240 (Modified)
Tensile Strength	14 MPa minimum	D 412
Elongation at break	250%	D 412
Compression set, 70 hours at 100°C, maximum, percent	40%	D 395 Method B (Modified)

QUALITY CONTROL

Quality Control (QC) shall be the responsibility of the Contractor. Quality Control shall be performed by an entity having a line of responsibility distinctly different from that of the manufacturer's fabrication department. As a minimum, the Contractor shall perform inspection and testing prior to fabrication, during fabrication, and after fabrication as specified in this section and additionally as necessary to ensure that materials and workmanship conform to the requirements of the contract documents. Quality Control shall apply to each component of the modular joint seal assembly in addition to the assembly, shipping and installation of the complete modular joint seal assembly.

The QC Inspector shall be the duly designated person who acts for and on behalf of the Contractor for inspection, testing, and quality related matters for all fabrication.

Quality Assurance (QA) is the prerogative of the Engineer. The QA Inspector is the duly designated person who acts for and on behalf of the Engineer.

Each QC Inspector shall be responsible for quality control acceptance or rejection of materials and workmanship

The Contractor shall provide sufficient number of QC Inspectors to ensure continuous inspection.

The Contractor shall designate in writing a Quality Control Manager (QCM). The QCM shall be responsible directly to the Contractor for the quality of the fabrication, including materials and workmanship, performed by the Contractor and subcontractors.

The QCM shall be the sole individual responsible to the Contractor for submitting and receiving all correspondences, required submittals, and reports to and from the Engineer.

The Contractor shall submit to the Engineer 3 copies of Quality Control Plan (QCP), in conformance with the requirements in “Working Drawings,” of these special provisions. As a minimum, each QCP shall include the following:

A. A manual including equipment, testing procedures, and code of safe practices
B. The names, qualifications, and documentation of certifications for the QCM and all QC Inspectors
C. An organizational chart showing all QC personnel and their assigned QC responsibilities
D. The methods and frequencies for performing all required quality control procedures, including QC inspection forms to be used, as required by the specifications including:

    1. All visual inspections
    2. Tests
    3. Calibration procedures and calibration frequency for all equipment
    4. Geometry tolerance control plan as specified in the section “Working Drawings” of these special provisions

E. Forms to be used for Certificates of Compliance, weekly production logs, and weekly reports
F. Mill certificates and material certificates
G. Shipping plan
H. Installation plan

Prior to submitting the QCP, a pre-fabrication meeting between the Engineer, Contractor, and Fabricator, any entity performing modular joint seal assembly component fabrication or subcontractor to the Fabricator, shall be held to discuss the requirements for the QCP. The pre-fabrication meeting shall be held in San Francisco Bay Area.

After a complete QCP is submitted, the Contractor shall allow the Engineer 10 working days to review the submittal. An amended QCP or addendum shall be submitted to, and approved in writing by the Engineer, for proposed revisions to the approved QCP. The Contractor shall allow the Engineer 10 working days to complete the review of the amended QCP or addendum.

After final approval of the QCP, amended QCP, or addendum, the Contractor shall submit 7 copies to the Engineer of each of these approved documents.

It is expressly understood that the Engineer's approval of the Contractor's QCP shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work in conformity with the requirements of the plans and specifications. The Engineer's approval shall not constitute a waiver of any requirement of the plans and specifications nor relieve the Contractor of any obligation thereunder, and defective work, materials, and equipment may be rejected notwithstanding approval of the QCP.

A weekly production log for fabrication shall be kept by the QCM for each day that fabrication if performed. The weekly report from each QC Inspector shall be included in the log.

The Contractor shall submit the reports of all visual inspections, weekly production log, and a complete "As-Built Log of Measurements" to the Engineer within 7 working days following the completion of fabrication of any modular joint seal assembly. The Engineer will review the reports, production log, and the "As-Built Log of Measurements" to determine if the Contractor is in conformance with the QCP. The Contractor shall allow the Engineer 7 working days to review and respond in writing after a complete reports, production log, and the "As-Built Log of Measurements" have been received.

The QCM shall sign and furnish to the Engineer, a Certificate of Compliance in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for each modular joint seal assembly. The certificate shall state that all of the materials and workmanship incorporated in the work, and all required tests and inspections of this work have been performed in conformance with the details shown on the plans and approved working drawings and the provisions of the Standard Specifications and these special provisions. The certificate shall state that all of the as-built measurements of essential parts and completed assemblies are within the target tolerances specified in geometry tolerance control plan.

FABRICATION

The modular joint seal assembly shall be fabricated consistent with the details, dimensions, material specifications, and procedures delineated in the approved working drawings and supplement.

All modular joint seal assemblies shall be fabricated by the same manufacturer.

PTFE shall be bonded under controlled conditions and in strict accordance with written instructions provided by the PTFE manufacturer.

PTFE surfaces shall be smooth and free of bubbles after completion of bonding operations.

Stainless steel sliding surfaces in contact with PTFE shall be polished to a Number 8 mirror finish.

If welding of support bars is required, support bars shall be welded prior to attaching stainless steel sheets. Stainless steel sheets shall be welded to the support bars in accordance with AWS D1.6. The stainless steel sheet shall be clamped to provide full contact with the steel backing plate during welding. The welds shall not protrude above the sliding surface of the stainless steel sheet.

Steel surfaces, except those surfaces beneath stainless steel sheet, those to be bonded to PTFE, or those in direct contact with sealing elements, shall be galvanized.

At the Contractor's option, cleaning and painting of all new metal surfaces of the joint seal assembly, except stainless steel and anchorages embedded in concrete, may be substituted for galvanizing. Cleaning and painting shall be in conformance with the provisions in "Clean and Paint Structural Steel (Modular Joint Seal Assembly)" of these special provisions.

Finish coats will not be required on modular joint seal assemblies.

During the fabrication process the Contractor shall maintain "Log of As Built Measurements" of all individual essential parts and the completed assembly. The essential parts shall include center beams, swivel support bars, support boxes, stirrups, sliding bearings, sliding springs, spring holders, bearing holders, swivel plates, and sliding discs. The "Log of As Built Measurements" of the completed assembly shall include out-of-line alignment of pivoting pins, unevenness of welded stirrup heights, unevenness of height of installed sliding bearings, and sliding springs. The measurements shall be recorded with accuracy of 0.1mm. The Contractor shall submit to the Engineer for review and approval the "Log of As Built Measurements" at least 10 working days prior to the start of the proof testing.

GENERAL DESIGN REQUIREMENTS

The Contractor shall design the modular joint seal assemblies including all components and anchorage devices with any reinforcement required in addition to that shown on the plans. The design life of the joint seal assembly shall, whenever possible, comply with the 150 year design life of the bridge.

Each modular joint seal assembly shall extend continuously across the full width of the roadway and up into the traffic barriers as shown on the plans. The modular joint seal assembly shall be designed to allow for cutting the joint seal assembly into segments. Removal of any one segment shall not affect the load carrying capacity of the remaining segments. The segments shall be arranged to accommodate removal and replacement of the joint seal assembly while maintaining a minimum of 4 traffic lanes. Each traffic lane shall be 3.6 meter wide and additional allowance for traffic barrier shall be made for separation from the construction area.

Field splices of any part of the modular joint seal assembly shall not be permitted.

The modular joint seal assembly shall be designed with adequate access to all internal components in order to assure the feasibility of inspection and maintenance activities.

The modular joint seal assembly shall be designed to minimize concrete cracking above the support boxes. Measures taken shall include assuring adequate support box top plate thickness, specifying any additional roadway deck steel reinforcement required, and providing adequate concrete cover.

The modular joint seal assembly and concrete deck steel reinforcement shall be designed to assure that adequate concrete consolidation can be achieved underneath all support boxes.

The sealing elements shall not protrude above the top of the modular joint seal assembly.

The elastomeric or urethane springs, bearings with stainless steel surfaces, and other sliding elements shall be designed to be removable and replaceable. The removal and reinstallation of each sealing element shall be easily accomplished from above the joint with a 32 millimeters minimum gap width. The replacement of such elements shall not require closing more than 3 traffic lanes at any time.

The modular joint seal assembly shall be watertight.

Metallic attachments used to secure elastomeric seals to the center beams, if welded to the center beams and edge beams, shall be welded continuously along both their top and bottom edges.

The longitudinal movement demands in the table shown on the plans consist of movements due to temperature variation (T_{rise} and T_{drop}), creep and shrinkage (CS), functional evaluation earthquake ($FEE_{opening}$), and safety evaluation earthquake ($SEE_{closing}$ and $SEE_{opening}$). The longitudinal movement demands are normal to the transverse axis as shown on the plans.

The number of cells for each modular joint seal assembly shall conform to the following table. A cell is defined as sealing elements supported by adjacent beams.

Hinge Location	No. of Cells
Hinge BW	13
Hinge BE	13
Hinge CW	12
Hinge CE	12
Hinge DW	7
Hinge DE	7

The sealing elements shall be capable of accommodating 130 mm longitudinal movement without any damage.

When the modular joint seal assembly is subject to combined movements of $SEE_{closing}$, $SEE_{opening}$, and CS, the load carrying capability of the modular joint seal assembly shall not be degraded, and cell width equalizing mechanism shall be fully operational. No unseating of supporting elements shall be permitted. The damage to the modular joint seal assembly shall be limited to the sealing elements only and there shall be no damage to any other parts of the assembly.

The modular joint seal assemblies shall be capable of providing for a transverse displacement (relative to the ends of the joint), horizontal rotation in the plane of the bridge deck (fanning angle), and rotation about transverse and longitudinal axis as shown on the plans.

DESIGN AXLE LOADS AND IMPACT FACTORS

The center beams, edge beams, support bars, bearings, connections, and other structural components shall be designed for the simultaneous application of vertical and horizontal loads from a tandem axle. The tandem axle shall consist of a pair of axles spaced 1.2 meters apart with vertical and horizontal loads as specified elsewhere in these special provisions. The transverse spacing of the wheels shall be 1.8 meters. The distribution of the wheel load among center beams shall conform to the requirements specified elsewhere in these special provisions.

The vertical load range for fatigue design shall be a 145 kN tandem. This tandem shall be taken as two 72.5 kN axles spaced 1.2 meters apart. Only one of these tandem axles shall be considered in the design, unless the joint opening exceeds 1.2 meters. The load range shall be increased by the dynamic load allowance (Impact Factor) of 75%. Load factors shall be applied in accordance with Table 3.4.1-1 of the AASHTO LRFD Bridge Design Specifications - Second Edition.

The vertical load for strength design shall be a 220 kN tandem. This tandem shall be taken as two 110 kN axles spaced 1.2 meters apart. Only one of these tandem axles shall be considered in the design, unless the joint opening exceeds 1.2 meters. This load shall be increased by the dynamic load allowance (Impact Factor) of 75%. Load factors shall be applied in accordance with Table 3.4.1-1 of the AASHTO LRFD Bridge Design Specifications - Second Edition.

The horizontal load range for fatigue design shall be 40% of the amplified vertical load range (LL+IM) for fatigue design specified in these special provisions.

The horizontal load for strength design shall be 20% of the amplified vertical load (LL+IM) for strength design specified in these special provisions.

DISTRIBUTION OF WHEEL LOADS

The following table specifies the center beam distribution factor as a function of center beam top flange width. This factor is the percentage of the design vertical axle load and the design horizontal axle load which shall be applied to an individual center beam for the design of that center beam and its associated support bars. Distribution factors shall be interpolated for center beam top flange widths between those explicitly denoted in the table. In no case shall the distribution factor be taken as less than 50%. The remainder of the load shall be divided equally and applied to the two adjacent center beams or edge beams.

Width of Center beam Top Flange	Distribution Factor
64 millimeters	50%
80 millimeters	60%
100 millimeters	70%
120 millimeters	80%

FATIGUE LIMIT STATE DESIGN REQUIREMENTS

Modular joint seal assembly structural members, bolted and welded splices and connections, and attachments shall be designed to resist the Fatigue Limit State load combination specified in Table 3.4.1-1 of the AASHTO LRFD Bridge Design Specifications - Second Edition. The vertical and horizontal load ranges for fatigue design specified in these special provisions shall be applied simultaneously. These loads shall be distributed as specified in these special provisions.

The nominal stress ranges, Δf, at all fatigue critical details shall be obtained from a structural analysis of the modular joint seal assembly applying the design vertical and horizontal load ranges, and distributed specified in these special provisions. The modular joint seal assembly shall be analyzed with a minimum gap opening corresponding to the operating range configuration (at least 60 millimeters). The design axle load shall be applied as two wheel loads, each having a transverse width of 510 millimeters. For each detail under consideration, the wheel loads shall be positioned transversely on a center beam to achieve the maximum nominal stress range at that detail. The vertical and horizontal wheel loads shall be applied as line loads to the top of the center beams at their centerlines. The design stress range in the center beam-to-support bar connection shall be calculated according to subsections 1 and 2 below. The design nominal stress ranges, Δf, shall be used for fatigue design as specified in these special provisions.

Welded Single-Support-Bar Systems:

A. The nominal stress range, Δf, in the center beam at a welded stirrup shall be the sum of the longitudinal bending stress ranges at the critical section resulting from vertical and horizontal loading. The effects of stresses in any load-bearing attachments such as the stirrup or yoke shall not be considered when calculating the longitudinal stress range in the center beam.
B. The nominal stress range, Δf, in the stirrup or yoke shall be calculated without considering the effects of stresses in the center beam. The stress range shall be calculated by assuming a load range in the stirrup equal to 30% of the total vertical reaction force between the center beam and the support bar. The effects of horizontal loads may be neglected in the design of the stirrup.

To assure an infinite fatigue life, all modular joint seal assembly structural members, connections (bolted and welded), splices, and attachments shall satisfy the following:

$$\Delta f \leq \frac{F_{TH}}{2}$$

where:

Δf = the nominal stress range
F_{TH} = constant amplitude fatigue limit (CAFL)

FATIGUE RESISTANCE OF DETAILS

The fatigue resistance of all details shall be characterized in terms of the fatigue categories specified in Table 6.6.1.2.5-1 of the AASHTO LRFD Bridge Design Specifications - Second Edition. Many details composing modular joint seal assembly may clearly correspond to specific structural details depicted in Figure 6.6.1.2.3-1 of the AASHTO LRFD Bridge Design Specifications - Second Edition. In these cases, the applicable fatigue categories specified in Table 6.6.1.2.3-1 may be used for design. In cases where the Engineer establishes that a detail does not clearly correspond to a structural detail depicted in Figure 6.6.1.2.3-1, fatigue testing of specimens exhibiting that detail shall be conducted, in accordance with Sections "Fatigue Testing of Metallic Structural Components and Connections" and "Durability Testing of Elastomeric Support Bearings" of these special provisions, to establish the appropriate constant amplitude fatigue limit (CAFL) for that detail.

STRENGTH I LIMIT STATE DESIGN REQUIREMENTS

Modular joint seal assembly structural steel members, connections (bolted and welded), splices, and attachments shall be designed to resist the Strength I Limit State load combination specified in Table 3.4.1-1 of the AASHTO LRFD Bridge Design Specifications - Second Edition. The vertical and horizontal loads specified in Section "Design Axle Loads and Impact Factors" of these special provisions shall be applied simultaneously. These loads shall be distributed as specified in Section "Distribution of Wheel Loads" of these special provisions.

PROTOTYPE TESTING REQUIREMENTS

Prototype testing of modular joint seal assemblies consists of fatigue testing of metallic structural components and connections, durability testing of elastomeric support bearings, and dynamic testing in conformance with the requirements in these special provisions.

Dynamic testing shall be performed in the State of California.

Fatigue testing and durability testing of elastomeric support bearings shall be performed by an independent testing laboratory in the United States.

The following individuals have stated that they have access to facilities capable of performing the fatigue testing:

A. Professor Charles W. Roeder
Department of Civil Engineering
233B Moore Hall
University of Washington
Seattle, Washington 98195
Tel: (206) 543-6199
Fax: (206) 543-1543

B. Dr. John W. Fisher
ATLSS Research Center
Lehigh University
117 ATLSS Drive
Bethlehem, Pennsylvania 18015-4793
Tel: (610) 758-3535
Fax: (610) 758-5553

C. Professor Robert J. Dexter
Department of Civil Engineering
University of Minnesota
122 CivE
500 Pillsbury Drive Southeast
Minneapolis, Minnesota 55455-0220
Tel: (612)-624-0063
Fax: (612)-626-7750

FATIGUE TESTING OF METALLIC STRUCTURAL COMPONENTS AND CONNECTIONS

Methodology

A. This test procedure is acceptable for, and specifically applicable to, establishing the fatigue resistance of the center beam-to-support bar connection in modular joint seal assemblies. It is applicable to single-support-bar and multiple-support-bar systems having either welded or bolted center beam-to-support bar connections. The same methodology may be applied to establish the fatigue resistance of other modular joint seal assembly metallic structural component details, including center beam splices.
B. Each fatigue test generates a discrete datum. Each datum comprises an applied constant amplitude nominal stress range, Sr, and the corresponding number of cycles, N, associated with either a predetermined extent of crack propagation, defined as failure, or with termination of the test, defined as runout. Ten data shall be acquired for each connection detail. All data shall be in the very long life range, corresponding as closely to the constant amplitude fatigue limit (CAFL) as practical. Specifically, the number of cycles, N, associated with each datum, shall be no less than one order of magnitude less than Nmin corresponding to the detail category specific CAFL specified in these special provisions.
C. The constant amplitude nominal stress range shall be calculated at the anticipated initiation location of an incipient crack. Nominal stresses shall be calculated using conventional equations for analyzing bending and axial load. These equations are essentially the same as those used in strength design. The stress concentration effects of a weld, bolt hole, or other local features are not explicitly embodied in the conventional nominal stress equations.
D. The appropriate AASHTO detail category applicable to fatigue design shall be established by comparing acquired test data to fatigue resistance graphs representing the AASHTO detail categories. The constant amplitude fatigue limit (CAFL) applicable to fatigue design corresponds to the AASHTO detail category fatigue resistance graph representing a lower bound of the experimentally acquired data.
E. When testing is conducted exclusively in the infinite life regime and more stringent test data scatter requirements are satisfied, a unique CAFL (different from those CAFL corresponding to specific detail categories specified by AASHTO) may be established for fatigue design.

Specimens

A. Specimens selected for testing shall be full-scale center beam and support bar assemblies or subassemblies representative of those installed in field applications. A subassembly is defined as a specimen having the same physical and geometric properties as an assembly but having a reduced number of center beams.
B. Each specimen shall consist of three continuous center beam spans over four equally spaced support bars. Center beam spans between adjacent support bar centerlines shall be a minimum of 910 millimeters and a maximum of 1.35 meters. Support bar spans shall be a minimum of 910 millimeters and a maximum of 1.12 meters. The center beam-to-support bar connection being tested shall be located at the midspan of each support bar.
C. Any welded or bolted attachments used to secure equidistant springs to a support bar, center beam, or stirrup shall be fabricated as an integral part of the specimen. A rigid load path to the test fixture shall be provided to resist any horizontal forces or displacements which would normally be resisted through these attachments in a field installation. Any miscellaneous welded or bolted attachments, including welded attachments used to secure the modular joint seal assembly sealing elements to the center beams, shall also be fabricated as integral parts of the specimen.
D. Support bars of subassembly specimens that are components of single-support-bar swivel-joist type modular expansion joint systems shall be oriented perpendicular to the longitudinal axis of the center beam.

E. Prior to testing, each specimen shall be visually inspected for any defects, loose fasteners or other aberrations which could plausibly affect the tested fatigue resistance. Defects and flaws shall be defined in accordance with the appropriate governing specification (ASTM A-6, AWS D1.5, etc.). Data acquired from specimens containing such anomalies shall not be excluded from consideration except as permitted elsewhere in these special provisions. Any observed anomaly shall also be reported with its corresponding data in the tabular format stipulated in these special provisions.

Instrumentation

A. Each specimen shall be sufficiently instrumented to measure the static nominal strain range within that specimen for a specific applied load range. Best results can generally be obtained when the applied load range for the static calibration tests does not pass through zero load. Strain measurements shall be made at locations sufficiently distant from local effects, such as weld toes or bolt holes, which could significantly influence acquired test data.
B. As a minimum, eight strain gages shall be installed on the center beam top flange in the vicinity of each center beam-to-support bar connection. These gages shall be installed in pairs on each side of the connection at distances of one and two times the depth of the center beam from the centerline of the connection. Each pair of strain gages shall be located symmetrically about the centerline of the center beam. As a minimum, two strain gages shall also be installed on the support bar bottom flange in the vicinity of each center beam-to-support bar connection. One of these strain gages shall be installed on each side of the connection at a distance equal to the depth of the support bar from the centerline of the connection. These strain gages shall be installed along the centerline of the support bar.

Test Fixtures

A. Test fixtures shall have the capability to adequately support and secure the specimen throughout the duration of the test. The fixture shall be designed and fabricated to such tolerances as required to assure that additional stresses will not be generated in the specimen as a consequence of fixture misalignment. Mismatches resulting from specimen fabrication errors shall be accommodated by shimming or other such means precluding the application of force to the specimen.
B. Typical elastomeric bearings and springs used to transfer vertical loads from the support bars to the support boxes may be replaced with steel bearings in the test fixture. This modification will enable fatigue testing at higher load ranges and different frequencies than those encountered during normal service conditions.
C. Load shall be applied through two 250 millimeter long patches. Each patch shall typically comprise a steel plate and a hard rubber bearing pad placed in contact with the bottom flange of the center beam. Each patch shall be located at midspan of each outer span.
D. In order to assure adequate seating of the specimen to the test fixture, a minimum of 45 kN shall be applied at each patch location. This requirement is waived for tests of single support bar systems conducted using load reversal. Once this load has been applied, all strain measuring devices shall be rebalance to zero strain while the preload is maintained. An additional load approximately equivalent to the calculated load range shall be applied. Strain ranges shall be measured for the load range from 45 kN to the peak load. Each static calibration test shall be repeated three times while still maintaining a minimum 45 kN load at each load patch. The measured strain ranges from each repetition should vary by no more than 25% from the mean value. If the stress ranges are not repeatable, appropriate modifications shall be made to the test fixture.

Static Calibration Test

A. Prior to any fatigue resistance testing, a static calibration test shall be performed in order to validate the structural analysis model. The static calibration test shall be performed after attainment of stress range repeatability as described elsewhere in these special provisions. The structural analysis model shall be considered validated when calculated strain ranges are within ±25% of the measured strain ranges at every strain gage location.
B. For the purpose of reporting nominal fatigue resistance stress ranges at specific details, stress ranges determined through structural analysis of the model shall be preferred over stress ranges acquired directly from test measurements.

Test Procedure

A. A minimum of ten data points shall be required to establish the fatigue resistance of each detail. The center beam-to-support bar connection shall be considered as a single detail.
B. Several data points may be obtained from a single specimen by repairing the cracked sections of that specimen and resuming testing. Such repairs shall have minimal effect on the stress ranges at unfailed details still being tested. Data points derived from tests in which a repaired detail cracks again shall be discarded.
C. All data shall be in the very long life range, corresponding as closely to the constant amplitude fatigue limit as practical, but in no case less than 200,000 cycles. Either finite life regime or infinite life regime testing may be conducted. For infinite life regime testing, the number of cycles, N, associated with each of the ten data shall be at least twice the number of cycles, Nmin, designated in the table elsewhere in these special provisions.
D. Loads shall be applied using hydraulic actuators or other similar loading devices. The magnitude of the vertical load range, ΔPv, shall be maintained and continuously monitored throughout the duration of the test. Vertical and horizontal load ranges shall be applied to the specimen simultaneously. The horizontal load range shall always be equal to 20% of the vertical load range, ΔPv. This horizontal-to-vertical load ratio may be maintained by inclining the specimen 11.3 degrees with respect to the horizontal plane and applying load through vertically oriented actuators.
E. For multiple support bar systems, the loading mechanism shall be either exclusively tension or exclusively compression and shall be applied at a constant amplitude at any desired frequency. The applied load range shall be in a direction such that the reaction force between the center beam and support bar is always tensile. The load range shall not pass through zero load. Minimum preload shall be maintained throughout the duration of the test.
F. Single support bar systems may be loaded using the same procedures as those for multiple support bar systems. If premature stirrup failure occurs, an applied load range of 70% compression and 30% tension may be used.
G. The load ranges used in the test shall not be so large as to alter the observed failure mode from that which would be observed under service conditions. Under no circumstance shall imposed stress exceed the yield stress of the material in any portion of the specimen. Each specimen shall be tested using at least two different load (stress) ranges.
H. If infinite life regime testing is conducted, the first load range should be chosen so that the applied stress range is just above the postulated CAFL. The load range in the subsequent test shall be decreased if failure resulted and increased if the test resulted in a runout. A suggested increment in load is such that the stress range is increased or decreased by 14 MPa. The applicable CAFL shall be selected from those CAFL values corresponding to the AASHTO fatigue categories. The selected CAFL is the one just below the lowest stress range that resulted in cracking.
I. The following criteria shall be used to define failure of a given center beam-to-support bar connection:

Welded Center beam-to-Support Bar Connections

1. Center beam weld toe cracking originates at or near the center beam weld toe, propagates up into the center beam at some angle, and grows back over the connection. These cracks typically grow at an angle of about 45 degrees. A specimen shall be considered as failed due to this type of cracking when the crack has grown on any vertical face a length from the point of origin equal to half of the center beam depth.
2. Support bar weld toe cracking originates at or near the support bar weld toe, propagates down into the support bar, and grows back under the connection at some angle, typically about 45 degrees. A specimen shall be considered as failed due to this type of cracking when the crack has grown on any vertical support bar face a length from the point of origin equal to half of the depth of the support bar.
3. Weld throat cracking originates in the weld throat and typically grows in a plane parallel to the longitudinal axis of the support bar at about mid-depth of the weld throat. A specimen shall be considered as failed due to this type of cracking when a complete fracture of the weld throat has occurred. These cracks have been observed to turn down into the support bar, but only after significant growth. In such instances, the criteria for support bar weld toe cracking shall be applied.

Welded Stirrup Connections

1. A specimen shall be considered as failed when cracks result in the complete fracture of any stirrup leg or when cracks originating at or near a stirrup weld have grown into any face of the center beam a length from the stirrup weld toe equal to half of the center beam depth.

Bolted Center beam-to-Support Bar Connections

1. Fatigue cracks which have grown out of a bolt hole have resulted in the complete fracture of the tension flange of the center beam.
2. Fatigue cracks which have grown out of a bolt hole have extended into any face of the center beam web a distance equivalent to half of the center beam depth less the center beam flange thickness.
3. Any portion of a stirrup fractures completely.
4. Any single bolt fractures completely.

J. Alternate Criteria for Termination of a Finite Life Regime Test

1. A test may also be terminated when, for a given stress range, the specimen has survived the number of cycles required to plot the data above either a particular fatigue resistance curve or the maximum permitted in these special provisions.

K. Nominal Stress Range Calculation

Welded Center beam-to-Support Bar Systems

1. The nominal stress range for center beam weld toe cracking shall be calculated by taking the square root of the sum of the squares of the longitudinal bending stress range in the center beam and the vertical stress range at the top of the weld.
2. The nominal stress range for support bar weld toe cracking shall be calculated by taking the square root of the sum of the squares of the longitudinal bending stress range in the support bar and the vertical stress range at the bottom of the weld.
3. The nominal stress range for weld throat cracking shall be the calculated vertical stress range in the throat of the weld.
4. The nominal stress range in the center beam at a welded stirrup shall be calculated as the summation of the longitudinal bending stress ranges at the critical section resulting from vertical and horizontal loading. The entire load range shall be used in the calculation, even if the loading is partly in compression. The effects of stresses in any load-bearing attachments such as the stirrup or yoke shall not be considered when calculating the nominal stress range in the center beam.
5. The load range in the stirrup itself shall be taken as 30% of the total vertical load range carried through the connection. The effect of horizontal forces may be neglected.

Bolted Systems

1. The nominal stress range in the center beam shall be taken as the summation of the longitudinal bending stress ranges in the center beam resulting from vertical and horizontal loading. Nominal stress ranges shall be calculated using the net section. The effects of stresses in the stirrup shall not be considered when calculating the nominal stress range in the center beam.
2. The nominal load range in the bolt group and the stirrup assembly shall be taken as 30% of the total vertical load range carried through the connection. The effect of horizontal forces may be neglected.

Interpretation of Test Data

A. The experimentally acquired data and graphs representing the fatigue resistance of the detail categories delineated in Section 6.6 of the AASHTO LRFD Bridge Design Specifications - Second Edition shall be juxtaposed on a log-log scale. The equation representing the finite life fatigue resistance of these AASHTO detail categories is:

$$N = \frac{A}{S_{r,eff}^{3}}$$

where:

N =number of cycles to failure
Sr,eff = nominal effective stress range representing fatigue resistance
A = constant defined in Table 6.6.1.2.5-1 of the AASHTO LRFD Bridge - Design Specifications - Second Edition

The minimum number of cycles associated with infinite fatigue life, Nmin, and the corresponding constant amplitude fatigue limit (CAFL) for each AASHTO detail category is designated in the table below.

Detail Category	Nmin (infinite fatigue life)	CAFL(MPa)
A	1.8×10^6cycles	165
B	3.0×10^6 cycles	110
B'	3.5×10^6 cycles	82.7
C	4.4×10^6 cycles	69.0
C'	2.5×10^6 cycles	82.7
D	6.4×10^6 cycles	48.3
E	1.2×10^7 cycles	31.0
E'	2.2×10^7 cycles	17.9

B. Finite Life Regime Testing

1. The number of cycles, N, to either failure or runout, associated with each of the ten data need not exceed Nmin, designated in the table elsewhere in these special provisions.
2. The detail category applicable to fatigue design shall be that corresponding to the highest of the AASHTO detail category fatigue resistance graphs representing a lower bound of all ten experimentally acquired data.
3. If all but one datum falls above a selected AASHTO S-N curve, that one datum may be discarded and replaced by three new data obtained through additional testing. The additional testing shall be conducted using the same stress range as that of the discarded datum. The three additional data shall be plotted along with the remaining nine data. The applicable detail category shall be that corresponding to the highest of the AASHTO detail category fatigue resistance graphs representing a lower bound of all twelve data, except as limited in the previous table. For any detail, only one datum may be discarded and subsequently replaced with three additional data for any set of ten original data.

4. The maximum fatigue resistance of any detail shall not exceed that associated with the fatigue category prescribed in the table below.

Type of Detail	Maximum Permitted Category
Welded Multiple Center beam-to-Support Bar Connections	C
Weld Stirrup Attachments for Single Support Bar Systems	B
Bolted Stirrup Attachments for Single Support Bar Systems	D
Groove Welded Center beam Splices[a]	C
Miscellaneous Welded Connections[b]	C
Miscellaneous Bolted Connections	D

Footnotes:

a. Groove welded full penetration splices may be increased to Category B if weld integrity is verified using non-destructive testing (NDT).
b. Miscellaneous connections include attachments for equidistant devices.

5. The fatigue resistance for stirrups welded to a center beam flange shall not be taken greater than that defined using the fatigue details defined in Section 6.6 of the AASHTO LRFD Bridge Design Specifications - Second Edition. The applicable fatigue detail shall be a "Longitudinally Loaded Groove-Welded Attachment" or a "Longitudinally Loaded Fillet-Welded Attachment", depending on the type of connection used.

C. Infinite Life Regime Testing

1. The applicable constant amplitude fatigue limit (CAFL) for fatigue design may be selected as the highest CAFL of the AASHTO detail categories representing a lower bound to the experimentally acquired data. The CAFL of the AASHTO detail categories are designated in the table elsewhere in these special provisions.
2. A unique CAFL (different from the CAFL categories delineated in Section 6.6 of the AASHTO LRFD Bridge Design Specifications - Second Edition) may be established if all ten data are within 28 MPa of that unique CAFL.

Data Reporting

A. Fatigue Test Results and Observations

1. Data shall be reported in the typical S-N format (logarithm(S) vs. logarithm (N)) with the log of the stress range plotted as the ordinate (y-axis). Additionally, the data shall be reported in tabular format. The table shall contain the following information:

(a) Nominal stress range at the specific detail, Sr,eff
(b) Applied load range for each patch
(c) Number of cycles at initial observation of cracking (for reporting purposes only, not included as S-N data)
(d) Number of cycles at failure or termination of the test, N, and the reason for stopping the test (failure or termination)
(e) Type of crack as described elsewhere in these special provisions. A detailed description of the fatigue crack shall be provided if the observed crack does not resemble any of the crack types described elsewhere in these special provisions.

B. Miscellaneous Required Information

1. The following information shall also be reported:

(a) Expansion joint system type and manufacturer
(b) Drawings depicting shape, size, and dimensions of the specimen
(c) Drawings depicting fixture details, including specimen orientation
(d) Section properties and dimensions of the center beam and support bar
(e) Center beam-to-support bar connection details

i. Weld procedure specifications for welded expansion joint systems
ii. Bolt size, material specifications, location, and method of tightening for bolted expansion joint systems

DURABILITY TESTING OF ELASTOMERIC SUPPORT BEARINGS

Scope

A. This section provides requirements for durability testing of the elastomeric support bearings typically used in modular expansion joint systems. It is not applicable to compression springs, equidistant springs, or other elastomeric components.
B. Tests shall be performed dynamically on individual bearings. Fatigue life is evaluated by applying a displacement range to each specimen rather than a load or stress range.

Specimens

A. Specimens shall comprise full scale bearing components representative of those installed in field applications. PTFE sliding surfaces or materials typically bonded to the elastomeric support bearings shall be fabricated as an integral part of the specimen.
B. Prior to testing, each specimen shall be visually inspected for any flaws or defects that could plausibly affect fatigue resistance. Any flaws or details shall be defined and recorded. Data obtained from specimens containing such anomalies shall not be excluded from the data set. Observed anomalies shall also be reported with the test data.

Test Fixtures

A. Test fixtures shall have the capability to adequately support and secure the specimen throughout the duration of the test. The fixture shall be designed and fabricated to such tolerances as required to assure that additional stresses will not be generated in the specimen as a consequence of fixture misalignment.

Loading Details

A. Loads shall be applied through hydraulic actuators or other similar loading devices. Fatigue testing shall be performed using displacement control. Displacement and load ranges shall be continuously monitored throughout the duration of the fatigue test to assure that desired displacement range and minimum preload are maintained.
B. Load shall be applied to the specimen through flat steel plates that are smooth and free of surface corrosion. These plates shall be sufficiently thick to assure even load distribution to the specimen.

Dynamic Stiffness Test

A. Testing shall be conducted on each specimen to be subjected to fatigue testing in order to establish its dynamic stiffness for at least three different loading frequencies. The maximum of these loading frequencies shall be equal to the service load frequency corresponding to a vehicle traveling at 96 kph. The loading frequency, f, shall be calculated as:

$$f = \frac{V}{2(g + b)}$$

where:

V = vehicle speed (96 kph at service load)
g = center beam gap (assume mid-range configuration)
b = center beam width

B. The load range applied during the dynamic stiffness test shall be that obtained from structural analysis using fatigue wheel load and wheel load distribution factors as specified in Sections, "Design Axle Loads and Impact Factors" and "Distribution of Wheel Loads" of these special provisions.
C. Each dynamic stiffness test shall be performed three times. Data from individual tests shall be compared to assure consistency of test results.

Fatigue Test

A. A minimum of three fatigue tests shall be required to establish the durability of each type of bearing.
B. The fatigue test shall be conducted using displacement control. The displacement (strain) range shall be applied using a sine or other smooth waveform at any frequency less than or equal to the service load frequency calculated elsewhere in these special provisions. The magnitude of the applied displacement amplitude, Δ, shall be calculated as:

$$\Delta = \frac{R_v}{K}$$

where

Rv = vertical reaction force at the support bearing as obtained from structural analysis
K = dynamic stiffness of the support bearing as determined elsewhere in these special provisions

C. A minimum precompression strain shall be maintained in the specimen throughout the duration of the test. This precompression strain shall be approximately equal to that present in a support bearing in a field installation. The magnitude of the applied cyclic strain shall be at least equal to the precompression strain.
D. The minimum and maximum dynamic load shall be recorded at the beginning of the test. The minimum and maximum dynamic load shall be monitored and periodically recorded throughout the duration of the test.
E. At the end of each applied displacement cycle, the displacement shall be held at the precompression level for no less than one half of the period of loading in order to facilitate heat dissipation. Artificial air flow devices (electrical fans) may be used to assist heat dissipation. Excessive heat generation will adversely affect the tested fatigue life.
F. A specimen shall be accepted as having passed the fatigue test criteria after withstanding 2 million cycles of loading without failure.
G. The following criteria shall constitute failure:

1. The elastomeric material exhibits excessive deterioration or cracking.
2. The measured minimum dynamic load falls to 30% of the initial dynamic load recorded at test initiation.
3. The measured dynamic load range decreases to half of the initial dynamic load range recorded at test initiation.

Data Reporting for Fatigue Test

A. Data shall be reported in tabular format and shall contain the following information for each specimen tested:

1. Minimum (precompression) strain, maximum strain, displacement, and load at test initiation
2. Type of loading impulse (sine wave, ramp, etc.)
3. Number of cycles at initial observation of distress leading to failure (for reporting purposes only, not to be included in the data)
4. Number of cycles at failure
5. A description of the mode of failure

B. The following data shall also be reported for each specimen tested:

1. Bearing type and manufacturer
2. Drawings depicting shape, size, and dimensions of the specimen including any PTFE sliding surfaces or materials bonded to the specimen
3. Drawings depicting fixture details, including specimen orientation.

DYNAMIC TESTING

The Contractor shall perform a series of tests on one full-scale modular joint seal assembly at the laboratory designated in the approved working drawings and supplement. The tests shall verify the performance of the modular joint seal assembly during a seismic event involving high velocity longitudinal and transverse displacements. The tests shall demonstrate the satisfactory performance of the modular joint seal assembly under the specified velocities. The test will also serve as a benchmark for establishing of relationship between friction force under slow velocity movement and size of the modular joint seal assembly.

The test specimen shall be a minimum of 6 meters in length. The test specimen shall consist of a minimum of 3 spans along the length of the joint and 4 support boxes including all tributary components except sealing elements. The test specimen shall contain 7 cells. Each cell is defined by sealing elements supported by adjacent beams. The relative angle measured in plan between the support bars of the test specimen shall be as similar as possible to the relative angle between the support bars of the production modular joint seal assemblies.

Design of the test specimen for all components used in the fabrication of the test specimen including design criteria, material specifications, fabrication procedures, and quality control program shall be the same as that used in the production of modular joint seal assembly.

The Contractor shall notify the Engineer, in writing, at least 10 working days prior to the start of both fabrication and testing of the test specimen.

During the fabrication process of the dynamic specimen the Contractor shall maintain a “Log of As Built Measurements” of all individual essential parts and the completed assembly as specified in section “Fabrication” of these special provisions. The Contractor shall submit to the Engineer for review and approval the “Log of As Built Measurements” at least 10 working days prior to the start of the dynamic testing.

Instrumentation shall be installed on the test specimen and test fixtures to continuously monitor and record transverse and longitudinal joint displacements, actuator force outputs in longitudinal and transverse directions. Total travel of each bearing throughout all the dynamic tests shall be computed based on recorded data. All tests shall be recorded on video media with a minimum of two video cameras recording the picture and sound during the test. One camera shall be positioned at level of the second support bar capturing in detail behavior of the sliding bearings and sliding springs. The second camera shall be positioned on side and above the modular joint seal assembly capturing the spacing of the center beams during the tests.

Prior to the start of each test all stainless steel sliding surfaces shall be cleaned using alcohol. No greasing or lubricating agents shall be applied to the stainless steel sliding surfaces.

The Contractor shall conduct a total of 17 dynamic tests in the sequence listed in the following table. The tests are defined by the following parameters: initial rotation about vertical, transverse and longitudinal axis as shown on the plans, displacement amplitude, speed and number of cycles.

Dynamic Test No.	Initial cell width (mm)	Initial rotation @ axis (radian)			Displacement (millimeter)		Speed (mm/sec)	No. of cycles
		vertical	transverse	longitudinal	longitudinal	transverse		
1	10	0	0	0	±450	0	≤ 25	10
2	0	0	0	0	+525	0	≤ 25	N/A
3	75	0	0	0	-420	0	≤ 25	N/A
4	10	0	0	0	0	±250	≤ 25	10
5	10	0	0	0	±450	±250	≤ 25	10
6	10	0	0	0	±450	0	1000	10
7	10	0	0	0	0	±250	1000	10
8	10	0	0	0	±450	±250	1000	10
9	10	0.012	0.067	0.01	±450	0	≤ 25	3
10	10	0.012	0.067	0.01	0	±250	≤ 25	3
11	10	0.012	0.067	0.01	±450	±250	≤ 25	3
12	10	0.012	0.067	0.01	±450	0	1000	10
13	10	0.012	0.067	0.01	0	±250	1000	10
14	10	0.012	0.067	0.01	±450	±250	1000	10
15	10	0	0	0	±450	0	≤ 25	3
16	10	0	0	0	0	±250	≤ 25	3
17	10	0	0	0	±450	±250	≤ 25	3

where
+ indicates opening movement
- indicates closing movement

The Contractor shall provide the access and assistance to the Engineer to observe the tests, monitor the process, and take the measurements as necessary. The Contractor shall also provide the space in the testing room to accommodate the Engineer's monitoring equipment.

After completion of each test for Test No. 2 and Test No. 3, the Contractor shall measure and record the size of all cells at a minimum of 4 locations spaced equally along the length of the center beams.

After completion of each test, the Contractor shall inspect the test specimen, in the presence of the Engineer, to identify any damage that may have occurred to the test specimen components.

After completion of Test No. 17, the Contractor shall completely disassemble the test specimen to allow the Engineer to inspect the test specimen for accumulated damage or deterioration to the test specimen components.

The acceptance criteria for dynamic testing of the modular joint seal assemblies shall be as follows:

A. During the Test No. 1 through Test No. 5 there shall be no vibrations or excessive noise and the movement shall be smooth. There shall be no excessive shear deformations of the sliding bearings and sliding springs. There shall be no other observations that might indicate mechanical problem.
B. The ratio of the largest to the smallest cell size measured at end of the Test No 2 and Test No. 3 shall be less then 1.15.
C. After completion of Test No. 5, the sliding areas of the test specimen shall have minimum wear and no signs of uneven wear.
D. After conducting all tests, the test specimen shall have no visible signs of any binding, dislocation or unseating of its components.

E. Minor damage to the sliding components that does not impair the ability of the test assembly to carry traffic and does not impair short term functionality of the center beam equal distance mechanism will be considered acceptable as determined by the Engineer.

ACCEPTANCE OF PROTOTYPE TESTS

Prior to fabricating or assembling modular joint seal assemblies to be installed, assemblies and components of assemblies shall have successfully met, as determined by the Engineer, the requirements specified for fatigue testing of metallic structural components and connections, durability testing of elastomeric support bearings, and dynamic testing in conformance with the requirements in these special provisions.

If the modular joint seal assembly test specimen or components of assemblies fail to meet any of the acceptance criteria as determined by the Engineer, the modular joint seal assembly will be rejected. The Contractor shall modify the design, fabrication, and assembly procedures, submit to the Engineer the revised working drawings, supplement and the "Log of As Built Measurements", allow the Engineer 20 working days to review the revised documents, and conduct additional tests. Additional testing shall not begin until the Engineer has approved the revised working drawings and supplement in writing. No extension of time or compensation will be made for modifying and resubmitting working drawings and supplement, fabricating additional test specimens or components of assemblies, conducting additional tests, and all other related work resulting from rejection of failed test specimens or components.

Within 10 working days after the completion of the tests, the Contractor shall submit to the Engineer 4 copies of the final test reports including complete test results for the modular joint test specimen tested.

After the completion of the tests, the test specimen and components of assemblies shall not be used in production and it shall become the property of the Contractor and shall be disposed of as provided in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

PROOF TESTING

The Contractor shall perform proof testing on each fabricated modular joint seal assembly to be used in production except that the sealing elements shall not be installed for proof testing. All proof tests shall be performed in the United States.

The Contractor shall notify the Engineer, in writing, at least 10 working days prior to the start of each proof testing.

Instrumentation shall be installed on the modular joint seal assembly to be tested and the test fixtures to continuously monitor and record longitudinal joint displacements, actuator force outputs and total travel of each bearing throughout the proof test. All tests shall be recorded on video media. There shall be at least two video cameras recording the picture and sound during the test. One camera shall be positioned at level of the second support bar capturing in detail behavior of the sliding bearings and sliding springs. The second camera shall be positioned on side and above the modular joint seal assembly capturing the spacing of the center beams during the tests.

Prior to each test all stainless steel sliding surfaces shall be cleaned using alcohol. No greasing or lubricating agents shall be applied to the stainless steel sliding surfaces.

The Contractor shall conduct a total of 3 proof tests for each fabricated modular joint seal assembly in the sequence listed in the following table. The tests are defined by the following parameters: initial rotation about vertical, transverse, and longitudinal axis as shown on the plans, displacement amplitude, speed and number of cycles.

Proof Test No.	Initial cell width (mm)	Initial rotation @ axis (radians)			Displacement (millimeter)		Speed (mm/sec)	No. of cycles
		Vertical	transverse	longitudinal	longitudinal	transverse		
1	0	0	0	0	±n x 75	0	25	5
2	0	0	0	0	+n x 75	0	25	N/A
3	n x 75	0	0	0	-n x 60	0	25	N/A

where
n - number of cells in the test specimen
\+ indicates opening movement
\- indicates closing movement

The Contractor shall provide access and assistance to the Engineer to observe the tests, monitor the process, and take the measurements as necessary. The Contractor shall also provide the space in the testing room to accommodate the Engineer's monitoring equipment.

After completion of each test for Test No. 2 and Test No. 3, the Contractor shall measure and record the size of all cells for at least 4 locations spaced equally along the length of the center beams.

After completion of Test No. 3, the Contractor shall inspect the modular joint seal assembly, in the presence of the Engineer, to identify any damage that may have occurred to the its components.

The acceptance criteria for proof testing of the modular joint seal assemblies shall be as follows:

A. During the tests there shall be no vibrations or excessive noise and the movement shall be smooth. There shall be no excessive shear deformations of the sliding bearings and sliding springs. There shall be no other observations that might indicate mechanical problem.
B. The ratio of the largest to the smallest cell size measured at end of the Test No. 2 and Test. No. 3 shall be less than 1.15.
C. After completion of Test No. 3, the sliding areas of the modular joint seal assembly shall have no visible wear and no signs of uneven wear.
D. The measured friction forces shall comply at least with one of the following criteria:

$$\frac{Fm1}{Fe1} \le 1.15$$

or

$$\frac{abs(Fm1 - Fm2)}{\frac{1}{2}(Fm1 + Fm2)} \le 0.25$$

or

$$\frac{abs(Fm1 - Fm2)}{\frac{1}{2}(Fm1 + Fm2)} \le 0.07$$

where
Fm1 = measured friction force on the unit being proof tested
Fm2 = measured friction force on the unit with identical number of cells as the unit being proof tested
Fe1 = expected friction force on the unit being proof tested

If the proof tests fail to meet any of the acceptance criteria, as determined by the Engineer, the modular joint seal assembly will be rejected. No extension of time or compensation will be made for manufacturing, furnishing, and testing additional modular joint seal assemblies.

At the completion of successful proof testing for each modular joint seal assembly, within 10 working days, the Contractor shall submit to the Engineer 4 copies of the complete test results in conformance with the requirements for the specific test as specified in these special provisions.

Modular joint seal assembly will not be accepted and released for installation until the Engineer has reviewed and approved, in writing, the proof testing.

STORAGE, SHIPPING, AND HANDLING

Lifting mechanisms, temperature adjustment devices, and temporary anchorages shall not be welded to the center beams or edge beams.

Damage to the modular joint seal assembly during shipping or handling shall be cause for rejection of the modular joint seal assembly.

Damage to the corrosion protection system shall be repaired to the satisfaction of the Engineer prior to installation.

INSTALLATION

No modular joint seal assembly shall be installed until the Engineer has reviewed and approved, in writing, the working drawings, the results of the prototype and proof testing, and the inspection of the assemblies to be used.

A qualified installation technician shall be present at the job site to assure proper installation of each modular joint seal assembly. The qualified installation technician shall inspect the blockout prior to installation and shall be present during lowering of the modular joint seal assemblies into the blockout, leveling, adjusting of the cell width and grouting below support boxes. The qualified installation technician shall inspect anchorage reinforcement and the formwork before placing concrete and shall be present during the concrete placement operation. This technician shall be a full time employee of the manufacturer of the modular joint seal assembly. The Contractor shall comply with all recommendations made by the modular joint seal assembly manufacturer's installation technician as approved by the Engineer. Each modular joint seal assembly manufacturer's installation technician shall certify to the Engineer that the approved installation procedures were followed. All certifications to the Engineer shall be in writing and shall be signed and dated by the manufacturer's installation technician.

Each modular joint seal assembly shall be installed in accordance with the approved working drawings and supplement and the recommendations of the manufacturer's installation technician.

Each installed modular joint seal assembly shall match the finished roadway profile and grades.

The Contractor shall protect each modular joint seal assembly from damage. The Contractor shall protect concrete blockouts and support systems from damage and construction traffic prior to installation of the modular joint seal assemblies.

Each modular joint seal assembly shall be set to a gap width corresponding to the ambient temperature at the time of setting. The gap widths shall conform to the values shown on the plans and approved working drawings and supplement. The Contractor shall provide hardware for mechanically opening or closing the modular joint assembly for thermal adjustments. The manufacturer shall provide factory attached lifting devices and brackets to facilitate field handling and grade adjustments.

Each modular joint seal assembly shall be tested for watertightness after installation. The Contractor shall flood each completely installed modular joint seal assembly with water to a minimum depth of 75 millimeters for a duration of at least one hour. If leakage is observed, the modular joint seal assembly shall be repaired to the satisfaction of the Engineer at the Contractor's expense. The repair procedure shall be prepared by the modular joint seal assembly manufacturer and shall be submitted to the Engineer for approval. After repairs are completed, the modular joint seal assembly shall be retest for leakage.

The Contractor shall replace sealing elements not fully bonded to the steel extrusions with fully bonded seals at the expense of the Contractor.

The assembly shall have cast-in-place anchorage components forming a mechanical connection between the joint components and the concrete deck.

The bridge deck surface shall conform to the provisions in Section 51-1.17 "Finishing Bridge Deck," of the Standard Specifications after placing modular joint seal assemblies and anchorage.

The assembly shall be completely assembled and placed in a blocked out recess as shown on the plans.

All reinforcement other than primary reinforcement shall continue through the recess construction joint into the recess and engage the anchorage components of the assembly.

The vertical modular joint seal assembly in barrier shall be available for inspection after placement of the recess concrete around the anchorage components of the assembly.

The assembly shall make a watertight, continuous return 150 mm up into the barrier at the low side of the deck joint. Neoprene glands shall be continuous without field splices or joints, including the return up into barrier.

TIME LINE

Due to the time constraints on this contract and requirements of prototype and proof testing the contractor shall complete milestones within the duration shown in the following table.

Milestone No.	Milestone Description	Scheduled duration measured from previous milestone
0	Notice to proceed	N/A
1	Submit working drawings and supplement for the modular joint seal assembly for each hinge location and final working drawings for dynamic test specimen	60 working days
2	Approval of working drawings	N/A
3	Fabricate dynamic test specimen and ship to testing laboratory. Specimen ready to be installed in the testing rig	40 working days
4	Test specimen installed in the testing rig, dynamic test ready to proceed.	N/A
5	Conduct, successfully complete dynamic test and submit dynamic test report.	40 working days
6	Approval of dynamic test report	N/A
7	Revise and resubmit working drawings for the modular joint seal assembly for each hinge location	40 working days
8	Approval of final working drawings for each hinge location.	N/A
9	Fabricate first set of two modular joint seal assemblies. Conduct proof testing and submit proof test reports.	110 working days
10	Approval of the first set of two proof tests.	N/A
11	Fabricate second set of two modular joint seal assemblies. Conduct and successfully complete proof tests.	50 working days
12	Approval of the second set of two proof tests	N/A
13	Fabricate third set of two modular joint seal assemblies. Conduct and successfully complete proof tests.	50 working days

ALTERNATIVE MODULAR JOINT SEAL ASSEMBLY

At the Contractor's option, an alternative modular joint seal assembly may be substituted for the Maurer Sohne Swivel-Joist Expansion Joint provided:

A. The quality of the alternative and its suitability for the intended application are at least equal to the Maurer Sohne Swivel-Joist Expansion Joint specified in these special provisions.
B. The Contractor's written request for substitution of an alternative modular joint seal assembly is approved by the Engineer.
C. Acceptable working drawings and supplemental calculations are furnished as specified herein.
D. Alternative modular joint seal assembly shall conform to the following requirements:

1. Due to the time constraints on this contract, only one alternative modular joint seal assembly request for substitution will be accepted for review.
2. The acceptability, quality, and suitability of an alternative modular joint seal assembly will be made in accordance with the provisions of Section 6-1.05, "Trade Names and Alternatives," of the Standard Specifications.
3. The complete written request for substitution shall include a description of the alternative modular joint seal assembly; the name of the modular joint seal assembly manufacturer; verification that the qualifications specified herein have been met by the manufacturer for the alternative modular joint seal assembly; written evidence that alternative modular joint seal assembly conforms with all requirements specified in these special provisions, and a copy of the manufacturer's list of materials and standards used to manufacture the alternative modular joint seal assembly.

4. The Contractor shall provide written certification of the manufacturer's experience to the Engineer. This certification shall include the location of each bridge, installation date, governmental agency/owner, and the name, address, and telephone number of each owner's/agency's representative.
5. Schedule verifying that the alternative modular joint seal assembly manufacturer can meet the milestones specified in "Time Line" of these special provisions.
6. If the blockout sizes are different from that shown on the plans, the Contractor shall redesign the segment and reinforcement to comply with the design criteria. Any additional cost resulting from different blockout sizes shall be at the Contractor's expense.
7. The maximum depth and width of the blockout shall be such that the primary reinforcement to provide the necessary strength of the structural members is outside the recess.
8. The alternative modular joint seal assembly shall be a modular single support bar system. Horizontal support of the center beam on the support bar shall be sliding and resilient in torsion. The load carrying function of the joint shall be separated from the water sealing function. Multiple support bar systems or sliding bridge plate systems will not be accepted. Due to high number of sealing elements the expansion joint shall be equipped with a control system which renders the individual control of each center beam possible. The equal spacing of the center beams shall not be assured by a sequentially arranged spring based control mechanism. The center beams shall be able to be exchanged individually, leaving the functioning of the joint intact.

Standard data and catalog cut sheets from alternative modular joint seal assembly manufacturer will not be considered sufficient. The Engineer will not be responsible for seeking further data from the manufacturer, or for otherwise researching the alternative modular joint seal assembly. Failure to provide complete data will be cause for rejection of the alternative modular joint seal assembly.

Prototype and proof testing of the alternative modular joint seal assemblies shall be as specified in "Prototype Testing" and "Proof Testing" of these special provisions.

Development of the Contractor's written request for substitution of an alternative modular joint seal assembly, preparation and submittal of complete working drawings and supplemental information, and testing will be at the Contractor's expense. There will be no compensation and no extension of contract time allowed for the development and review processes to evaluate the proposed substitution of an alternative modular joint seal assembly.

The Contractor shall be responsible for any additional costs and time delays associated with selection of an alternative modular joint seal assembly incurred as a result of noncompliance with these requirements, including the failure of the manufacturer to retest revised details or material substitutions of a previously prequalified system.

No alternative modular joint seal assembly shall be installed until the Engineer has reviewed and approved, in writing, the working drawings, the results of the prototype and proof testing, and the inspection of the assemblies to be used.

MEASUREMENT AND PAYMENT

Modular joint seal assemblies will be measured by the meter from end to end along the centerline of the completed seal as shown on the plans.

The contract prices paid per meter for modular joint seal assembly, of the types and at locations listed in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in designing, fabricating, furnishing, prototype and proof testing including test specimens, storing, transporting, inspection by a qualified representative of the modular joint seal assembly manufacturer, and installing the modular joint seal assemblies, including protecting, repairing, cleaning, and painting, complete in place, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

No payment will be made for modular joint seal assemblies that fail to meet any of the acceptance or inspection criteria.

If modular joint seal assemblies are fabricated or tested more than 480 air line kilometers from both Sacramento and Los Angeles, additional shop inspection expenses will be sustained by the State. Whereas it is and will be impracticable and extremely difficult to ascertain and determine the actual increase in these expenses, it is agreed that payment to the Contractor for furnishing the modular joint seal assemblies will be reduced $5000 for each fabrication site or testing facility located more than 480 line kilometers from both Sacramento and Los Angeles and an additional $3000 ($8000 total) for each fabrication site or testing facility located more than 4800 air line kilometers from both Sacramento and Los Angeles.

Full compensation for modifications to bridge members or elements made necessary by the use of an alternative modular joint seal assembly shall be considered as included in the contract price paid per meter for modular joint seal assembly, of the types and at locations listed in the Engineer's Estimate and no additional payment will be made therefor.

Bikepath expansion joints including cover plates shall be measured and paid for separately as specified in Section "Steel Structures" elsewhere in these special provisions.

Concrete barrier including cover plates will be measured and paid for as concrete barrier (type 732 modified).

10-1.36 POLYESTER CONCRETE OVERLAY (20MM, 13MM)

GENERAL

This work shall consist of constructing a polyester concrete overlay, including application of a prime coat, in conformance with the details shown on the plans and these special provisions. Polyester concrete for the pedestrian and bikepath shall be colored as shown on the plans. Referee samples of Federal Color No. 26099, "Charcoal Gray" and Federal Color No. 26440, "Light Gray" are available for viewing. Referee samples are available for inspection by contacting the Toll Bridge Duty Senior at the office of the Toll Bridge Duty Senior at the District 4 Office, 111 Grand Avenue, Oakland California, 94612, email duty_senior_tollbridge_district04@dot.ca.gov, telephone (510)-286-5549.

Before starting deck overlay work on the project, the Contractor shall submit for approval by the Engineer, a program for public safety associated with the use of methacrylate resin and polyester concrete during the construction of the project. This program shall identify materials, equipment, and methods to be used. The Contractor shall not perform any deck overlay work on the project, other than that specifically authorized in writing by the Engineer, until the program has been approved.

If the measures being taken by the Contractor are inadequate to provide for public safety associated with the use of methacrylate resin and polyester concrete, the Engineer will direct the Contractor to revise the operations and public safety program. These directions will be in writing and will specify the items of work for which the Contractor's program for public safety associated with the use of methacrylate resin and polyester concrete is inadequate. No further work shall be performed on these items until the public safety measures are adequate, and if required, a revised program for public safety associated with the use of methacrylate resin and polyester concrete has been approved.

The Engineer will notify the Contractor in writing of the approval or rejection of any submitted or revised program for public safety associated with the use of methacrylate resin and polyester concrete in not more than 10 working days following submittal.

The State will not be liable to the Contractor for failure to approve all or any portion of an originally submitted or revised program for public safety associated with the use of methacrylate resin and polyester concrete, nor for any delays to the work due to the Contractor's failure to submit an acceptable program for public safety associated with the use of methacrylate resin and polyester concrete.

Surface preparation shall be as specified in Section "Concrete Bridge Deck Surface," of these special provisions.

MATERIALS

Polyester concrete shall consist of polyester resin binder and dry aggregate. The resin shall be an unsaturated isophthalic polyester-styrene co-polymer conforming to the following:

POLYESTER RESIN BINDER		
PROPERTY	REQUIREMENT	TEST METHOD
* Viscosity	0.075 to 0.200 Pa·s (RVT, No. 1 Spindle, 20 RPM at 25°C)	ASTM D 2196
* Specific Gravity	1.05 to 1.10 at 25°C	ASTM D 1475
Elongation	35 percent, minimum Type I at 11.5 mm/min. Thickness= 6.5±1 mm	ASTM D 638
	Sample Conditioning: 18/25/50 + 5/70	ASTM D 618
Tensile Strength	17.5 MPa, minimum Type I at11.5 mm/min. Thickness= 6.5±1 mm	ASTM D 638
	Sample Conditioning: 18/25/50 + 5/70	ASTM D 618
* Styrene Content	40 percent to 50 percent (by weight)	ASTM D 2369
Silane Coupler	1.0 percent, minimum (by mass of polyester styrene resin)	
PCC Saturated Surface-Dry Bond Strength	3.5 MPa, minimum at 24 hours and 21±1°C	California Test 551
* Static Volatile Emission	60 gram per square meter, loss, maximum	South Coast Air Quality Management District, Standard Method
* Test shall be performed prior to adding initiator.		

The silane coupler shall be an organosilane ester, gammamethacryloxypropyltrimethoxysilane. The promoter shall be compatible with suitable methyl ethyl ketone peroxide (MEKP) and cumene hydroperoxide (CHP) initiators.

Aggregate for polyester concrete shall conform to the provisions in Section 90-2.02, "Aggregates," of the Standard Specifications and either of the following combined aggregate gradings:

COMBINED AGGREGATE		
Sieve Size	Percentage Passing	
	9.5-mm Max.	4.75-mm Max.
12.5-mm	100	100
9.5-mm	83 - 100	100
4.75-mm	65 - 82	62 - 85
2.36-mm	45 - 64	45 - 67
1.18-mm	27 - 48	29 - 50
600-µm	12 - 30	16 - 36
300-µm	6 - 17	5 - 20
150-µm	0 - 7	0 - 7
75-µm	0 - 3	0 - 3

Aggregate retained on the 2.36-mm sieve shall have a maximum of 45 percent crushed particles when tested in conformance with California Test 205. Fine aggregate shall consist of natural sand only. The Contractor may modify any of the following three requirements provided that the proposed modifications produce polyester concrete with a resin content of no more than 14 percent by mass of dry aggregate:

- Aggregate gradation including modified gradation limits.
- Maximum percentage of crushed particles used in the mix.
- The use of natural sand for fine aggregate. Optional materials may include slag, fly ash, sands manufactured from larger aggregate, or manmade aggregate.

The polyester resin binder in the concrete shall be approximately 12 percent by mass of the dry aggregate; the exact percentage will be determined by the Engineer.

Aggregate absorption shall not exceed one percent as determined by California Tests 206 and 207.

At the time of mixing with the resin, the moisture content of the aggregate, as determined by California Test 226, shall not exceed one half of the aggregate absorption.

The prepared surface shall receive a wax-free, high molecular weight methacrylate prime coat conforming to the following:

High Molecular Weight Methacrylate (HMWM) Resin		
PROPERTY	REQUIREMENT	TEST METHOD
* Viscosity	0.025 Pa·s, maximum, (Brookfield RVT with UL adapter, 50 RPM at 25°C)	ASTM D 2196
* Specific Gravity	0.90, minimum, at 25°C	ASTM D 1475
* Flash Point	82°C, minimum	ASTM D 3278
* Vapor Pressure	1.0 mm Hg, maximum, at 25°C	ASTM D 323
Tack-free time	400 minutes, maximum at 25°C	California Test 551
PCC Saturated Surface-Dry Bond Strength	3.5 MPa, minimum at 24 hours and 21±1°C	California Test 551
* Test shall be performed prior to adding initiator.		

The promoter/initiator system for the methacrylate resin shall consist of a metal drier and peroxide. If supplied separately from the resin, at no time shall the metal drier be mixed with the peroxide directly. The containers shall not be stored in a manner that will allow leakage or spillage from one material to contact the containers or material of the other.

A Material Safety Data Sheet shall be furnished prior to use for each shipment of polyester resin binder and high molecular weight methacrylate resin.

The Contractor shall allow 14 days for sampling and testing of the polyester resin binder and high molecular weight methacrylate resin prior to proposed use.

If bulk resin is to be used, the Contractor shall notify the Engineer in writing 10 days prior to the delivery of the bulk resin to the jobsite. Bulk resin is any resin that is stored in containers in excess of 209 liters.

CONSTRUCTION

Prior to constructing the overlay, one or more trial overlays shall be placed on a previously constructed concrete base to determine the initial set time and to demonstrate the effectiveness of the mixing, placing, and finishing equipment proposed. Each trial overlay shall be 3.6-m wide, at least 1.8-m long, and the same thickness as the overlay to be constructed. Conditions during the construction of the trial overlays and equipment used shall be similar to those expected and those to be used for the construction of the polyester concrete overlay.

A trial overlay shall be required for each color and each thickness of polyester concrete overlay.

The trial overlay for each color approved by the Engineer shall be used as the standard of comparison in determining acceptability of color for the polyester concrete surfaces.

All materials used in the trial overlays, including the concrete base, shall become the property of the Contractor and shall be removed and disposed of in conformance with the provisions in Section 7-1.13, "Disposal of Material Outside the Right of Way," of the Standard Specifications.

When magnesium phosphate concrete is placed prior to the deck overlay, the magnesium phosphate concrete shall be placed at least 72 hours prior to placing the prime coat.

When modified high alumina based concrete is placed prior to the deck overlay, the prime coat shall not be placed on the concrete until at least 30 minutes after final set.

Expansion joints shall be adequately isolated prior to overlaying or may be sawed within 4 hours after overlay placement, as approved by the Engineer. The exact time of sawing will be determined by the Engineer Prior to applying the prime coat, the area to receive the prime coat shall be dry and blown clean by compressed air to remove accumulated dust and any other loose material. The surface temperature shall be at least 10°C and the relative humidity less than 85 percent when the prime coat is applied.

The prime coat shall be uniformly applied to completely cover the surface to receive the polyester concrete. The rate of spread shall be approximately 2.5 square meters per liter.

The prime coat shall be allowed to cure a minimum of 30 minutes before placing polyester concrete. If the primed surface becomes contaminated, the contaminated area shall be cleaned by abrasive blasting and reprimed at the Contractor's expense.

Polyester concrete shall be mixed in mechanically operated mixers. Mixer size shall be limited to a 0.25-cubic meter capacity, unless approved by the Engineer.

A continuous mixer, employing an auger screw/chute device, may be approved for use by the Engineer upon demonstrating its ability to produce a satisfactory product. The continuous mixer shall 1) be equipped with a metering device that automatically measures and records the aggregate volumes and the corresponding resin volumes, and 2) have a readout gage, visible to the Engineer at all times, that displays the volumes being recorded. The volumes shall be recorded at no greater than 5 minute intervals along with the time and date of each recording. A printout of the recordings shall be furnished to the Engineer at the end of each workshift.

The amount of initiator used in polyester concrete shall be sufficient to produce an initial set time between 30 and 120 minutes during placement. The initial set time will be determined by using an initial-setting time Gillmore needle in conformance with the requirements in ASTM Designation: C 266. Accelerators or inhibitors may be required to achieve proper set times and shall be used as recommended by the resin supplier.

The resin binder shall be initiated and thoroughly blended just prior to mixing with aggregate. The polyester concrete shall be mixed a minimum of 2 minutes prior to placing.

Polyester concrete shall be placed prior to gelling and within 15 minutes following addition of initiator, whichever occurs first. Polyester concrete that is not placed within this time shall be discarded.

The surface temperature of the area to receive polyester concrete shall be the same as specified above for the prime coat The finishing equipment used shall strike off the polyester concrete to the established grade and cross section. Finishing equipment shall be fitted with vibrators or other means of consolidating the polyester concrete to the required compaction.

The polyester concrete shall be consolidated to a relative compaction of not less than 97 percent in conformance with California Test 552.

The finished surface of the polyester concrete overlay shall conform to the provisions in Section 51-1.17, "Finishing Bridge Decks," of the Standard Specifications and these special provisions.

The finished surface of the polyester concrete overlay for the pedestrian and bikepath surfaces (13 mm) shall be broomed transversely to the line of traffic. At the option of the Contractor, clean dry sand may be thrown on the surface and used to aid in the broomed surface texturing.

The finished surface of the polyester concrete overlay (20 mm) shall be textured by grooving. Grooves shall be made parallel to the centerline of the traffic lane after the concrete has received the specified abrasive sand finish. Grooving shall be done in such a manner as to prevent the texture device from tearing the surface or causing the visible separation of course aggregate at the surface. Grooving of the polyester concrete surface shall conform to one of the following methods:

- Grooving operations shall conform to the requirements in Section 42-1, "Grooving," of the Standard Specifications.
- Grooves shall be made with spring steel tines. Spring steel tines of the final texturing device shall be rectangular in cross section, 2 mm to 4 mm wide, on 19 mm to 24 mm centers, and of sufficient length, thickness and resilience to form grooves approximately 5 mm deep in the fresh polyester concrete surface. Final texture shall be uniform in appearance and longitudinal grooves shall have a depth between 2 mm and 8 mm.

Polyester concrete surfaces shall receive an abrasive sand finish. The sand shall be commercial quality blast sand conforming to the quality and dryness requirements for polyester concrete aggregate as specified in these special provisions. Ninety-five percent of the sand shall pass the 2.36-mm sieve, and 95 percent shall be retained on the 850-µm sieve.

The sand finish shall be uniformly applied immediately after overlay strike-off and before gelling occurs to provide a minimum uniform coverage of 0.4-kilogram per square meter.

The surface texture of polyester concrete overlay surfaces shall be uniform and shall have a coefficient of friction of not less than 0.35 as measured by California Test 342. Any portions of surfaces that do not meet the above provision shall be ground or grooved parallel to the centerline in conformance with the provisions of Section 42, "Groove and Grind Pavement," of the Standard Specifications until the above tolerance is met.

Traffic and equipment shall not be permitted on the overlay for a minimum of 4 hours following final finishing. Overlays shall be protected from moisture for not less than 4 hours after finishing.

MEASUREMENT AND PAYMENT

Furnish polyester concrete overlay of the thickness listed in the Engineer's Estimate will be measured by the cubic meter. The volume to be paid for will be determined from calculations based on the quantity of resin binder used and the yield of the specified mix design. The Contractor shall furnish suitable measuring devices to assure correct proportioning of materials and accurate measurements for calculating pay quantities. The pay quantity shall be the calculated quantity of polyester concrete overlay used in the work, exclusive of material used in trial overlays, and any wasted or unused material.

Place polyester concrete overlay of the thickness listed in the Engineer's Estimate will be measured by the square meter. The area to be paid for will be based on the dimensions shown on the plans.

The contract price paid per cubic meter for furnish polyester concrete overlay of the thickness listed in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing polyester concrete, including polyester resin binder, promoter/initiator, and aggregate, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

Full compensation for furnishing and mixing color shall be considered as included in the contract price paid per cubic meter for furnish polyester concrete overlay (13mm) and no additional compensation will be allowed therefor.

The contract price paid per square meter for place polyester concrete overlay of the thickness listed in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the polyester concrete overlay, complete in place, including application of prime coat and furnishing, constructing, and disposing of trial overlays and base, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

Full compensation for compliance with the requirements for a program for public safety associated with use of methacrylate resin and polyester concrete shall be considered as included in the contract prices paid for the items of work involving polyester concrete overlay and no additional compensation will be allowed therefor.

Full compensation for grooving the polyester concrete surface shall be considered as included in the contract price paid per square meter for place polyester concrete overlay of the thickness listed in the Engineer's Estimate and no separate payment will be made therefor.

10-1.44 STEEL STRUCTURES

Construction of steel structures shall conform to the provisions in Section 55, "Steel Structures," of the Standard Specifications and these special provisions.

The Contractor shall furnish, fabricate, and erect the structural steel or metalwork, construct and remove the temporary construction, and do all work required to complete the bridge or bridges.

Fabricators and suppliers shall be certified under the AISC Quality Certification Program, Category Cbr, Major Steel Bridges, with endorsement F, Fracture Critical members.

Erectors shall be certified under the AISC Quality Certifications Program, Category CASE, Certified Advanced Steel Erector, with Endorsement F, Fracture Critical members.

Details of orthotropic box girder connections shall conform to the AASHTO Standard Specifications for Highway Bridges, unless otherwise shown on the plans.

The bikepath shall be considered part of the bridge and not an ancillary structure.

GENERAL

Attention is directed to "Welding " of these special provisions.

Attention is directed to “Working Drawings,” of these special provisions.

Attention is directed to “Construction Surveying,” of these special provisions.

Attention is directed to “Footing Construction,” of these special provisions for the footing construction sequence.

Attention is directed to “Erect Precast Concrete Segment,” of these special provisions for the hinge erection sequence.

Attention is directed to “Prestressing,” of these special provisions for post-tensioning provisions within the orthotropic box girder.

The following substitutions of high-strength steel fasteners shall be made:

METRIC SIZE SHOWN ON THE PLANS	IMPERIAL SIZE TO BE SUBSTITUTED
ASTM Designation: A 325M (Nominal bolt diameter and thread pitch (mm))	ASTM Designation: A 325 (Nominal bolt diameter (inch))
M16 x 2	5/8
M20 x 2.5	3/4
M22 x 2.5	7/8
M24 x 3	1
M27 x 3	1 1/8
M30 x 3.5	1 1/4
M36 x 4	1 1/2

Steel for members, shown on the plans as fracture critical members, shall conform to the requirements in ANSI/AASHTO/AWS D1.5, Section 12, "AASHTO/AWS Fracture Control Plan (FCP) for Non-Redundant Members." Charpy V-notch (CVN) impact values for fracture critical members shall conform to the requirements for Zone 2, except as modified by these special provisions.

All corner and T-joint groove welds shall be reinforced with fillet welds with a size of 1/4 times the thickness’ of the abutting member, or 10 mm, which ever is less.

DRAWINGS

Section 55-1.02 “Drawings,” of the Standard Specifications shall not apply.

Working drawings shall contain all information required for the construction of structural steel, including, at a minimum, the following:

A. Design geometry lines and fabrication geometry working lines, including vertical, longitudinal and transverse;
B. Panel designations, erection sequence and locations of field splicing;
C. Details of temporary fabrication in plan, elevation and section, material specification and grades, weld details and all tolerances;

D. Details of permanent fabrication in plan, elevation and section, material cuts and camber deformations, and tolerances of the fabricated panel structure. The scale of each panel plan and section shall not be less than 1: 50. Full detail scales shall be larger;
E. Material and weld designations including the ASTM material specification, processes of shop fabrication including cutting, grinding and welding, weld symbols as required by AWS D1.5, and for each weld, the "Joint Designation" as listed in figures 2.4 or 2.5 of AWS D1.5;
F. Distortion control plan in accordance with AWS D1.5, Section 3.4;

Supplemental calculations shall include, but not be limited to, the following:

A. Calculations for each panel showing how the camber for extension, angular change and profile affects the cutting, and assembly of the plate material.

For orthotropic box girder and pipe beam fabrication, shop practices shall be described in the working drawings and shall include:

A. Method of rib or pipe beam fabrication including bending equipment and procedures;
B. Details of fabrication jigs (orthotropic box girder only);
C. Lifting points;
D. Details of temporary lugs or brackets and methods of handling large elements;
E. Details of tack welds and the sequence of all welding;
F. Details of removal of temporary connections and repair of material where these connections were installed;
G. Methods of repair of elements that exceed specified tolerances; and
H. Fabrication schedule.

The Contractor shall allow the Engineer 50 working days to review the structural steel working drawings.

FALSEWORK

Falsework and attachments used for the erection of structural steel shall be fabricated in accordance with the requirements of this section and the requirements for Falsework in "Concrete Structures," of these special provisions, except that dead loads shall consist of the mass of the structural steel and any other portions of the structure which are supported by the falsework.

Section 55-1.05 "Falsework," of the Standard Specifications shall not apply.

ERECTION PLAN

The Contractor shall submit working drawings and supplemental calculations for the erection of structural steel in accordance with the requirements in "Working Drawings," of these special provisions.

Erection of the orthotropic box girder transition span shall be completed with a maximum of 4 sections.

At the option of the Contractor, lifting attachments may be welded or bolted to structural steel to assist in hoisting the load. Lifting attachments shall not be attached to the deck plate or ribs attached to the deck plate. Welds attaching these devices shall conform to the requirements of field welding specified herein. Such attachments shall not be placed in areas of stainless steel cladding and shall not interfere with the holes shown on the plans. Holes shall not be made in the permanent structure, unless otherwise shown on the plans.

Working drawings shall contain all information required for the erection of structural steel, including, at a minimum, the following:

A. Details and limits of each section to be erected;
B. Details of attachments to each section for transportation and lifting including location, welding and removal procedures;
C. Methods for transportation and lifting of each erected section;
D. Method of aligning adjacent sections during erection;

E. Details of temporary work platforms and other aids required for field welding;
F. Locations and methods for tack and final welds;
G. Timing and methods for dimensional checks; and
H. Timing and methods for visual and nondestructive examination.
I. Methods for connection and removal of supports and lifting attachments.

Supplemental calculations shall include, but not be limited to, the following:

A. Calculations indicating the stress on the permanent structure due to attachments and erection.
B. Estimates of final dimensions, including camber, based on dimensional measurements during the trial fit under support conditions that differ from those of the in-place condition.

The Contractor shall allow the Engineer 50 working days to review the erection working drawings.

Equipment and Temporary structures such as lifting lugs, brackets or other devices, needed to handle fabrications, and which are attached to the permanent structure, or which are detached but serve to lift construction loads, shall be designed by a engineer who is registered as a Civil Engineer in the State of California, and shall be submitted to the Engineer for approval before they are placed in operation.

After erection, all lifting attachments shall be removed. Removal of welds shall not damage the permanent steel structure materials. All remaining welds shall be ground flush and any damaged areas shall be repaired in accordance with the requirements of ANSI/AASHTO/AWS D1.5. Any areas of damaged paint shall be painted as directed in "Clean and Paint Structural Steel," of these special provisions.

PIPE BEAM TEMPORARY SUPPORT SYSTEM

Pipe beam temporary supports shall be designed and constructed at the locations shown on the plans and in accordance with the requirements of this section.

At Hinge AE and AW, pipe beams shall be supported from hinge pipe beam support diaphragms or soffit plate intermediate T-stiffeners only.

At Hinge EE and EW, pipe beams shall be support from concrete diaphragms only.

Coring or drilling and bonding will not be permitted on concrete diaphragms.

Welded attachments will only be permitted on soffit plate intermediate T-stiffeners.

Bolted connections will not be permitted on any steel element.

Pipe beam temporary supports shall be designed to adequately support the pipe beams without exceeding allowable stresses or damaging the pipe beam or stainless steel cladding.

Pipe beam temporary supports shall include devices to prevent movement in the longitudinal and transverse directions

Design loads for pipe beam temporary supports shall include the following:

A. Dead loads due to the weight of the pipe beams and any other temporary equipment or attachments.
B. Live loads due to any equipment,
C. Assumed horizontal load of no less than 10% of the total pipe beam dead load and other attachments. The assumed horizontal load shall be applied in the longitudinal direction and the transverse direction of the bridge.

Allowable stresses for timber and steel shall not exceed those listed in Section 51-1.06A(2) "Design Stresses, Loadings, and Deflections," of the Standard Specifications. Allowable stresses in concrete members shall not exceed those listed in the "Project Design Criteria," included in the "Information Handout" available to the Contractor as provided for in Section 2-1.03, "Examination of Plans, Specifications, Contract, and Site of Work," of the Standard Specifications.

Design of pipe beam temporary supports shall account for any change in the loads imposed on the temporary supports due to the construction sequence of the bridge, as shown on the plans.

The Contractor shall submit to the Engineer working drawings and supplemental design calculations for pipe beam temporary supports, in conformance with the requirements in "Working Drawings," of these special provisions.

Working drawings for pipe beam temporary supports shall include the following:

A. Complete details of the temporary support system

B. A step-by-step pipe beam erection procedure including the following:

1. Method of lifting the pipe beams in position
2. Method of placing the pipe beams on the temporary supports
3. Method of securing the pipe beams in position

C. A complete description of methods and materials to protect the pipe beam stainless steel surface from damage during shipping and erection

A supplement to working drawings shall include the following:

A. Temporary support design calculations

The Contractor shall allow the Engineer 25 working days for review of pipe beam temporary support working drawings and supplemental design calculations.

MATERIALS

Structural steel shall conform to ASTM Designation: A709 with Supplementary Requirement S84 "Fracture-Critical, *F*, Material; Toughness Testing and Marking" for fracture critical members and Supplementary Requirement S83 "Non-Fracture-Critical, *T*, Material; Toughness Test and Marking" for others, as modified below. Charpy V-notch (CVN) impact values for steel procurement shall be reported on the mill test report and shall conform to ASTM Designation: A 709 for Zone 2 except as stated below:

Component	Thickness (mm)	Impact Value (Joules at Temp.)
Grade 50 orthotropic box structure internal structure base metal	Up to 38 39 to 50 51 to 100	34 @ 10°C 34 @ 10°C 42 @ 10°C
Grade 50 orthotropic box section shell plating base metal	Up to 38 39 to 50 51 to 100	34 @ 4°C 34 @ - 7°C 42 @ - 7°C
As-deposited weld metal at Grade 50 orthotropic box section		34 @ - 30°C
Structural steel rolled shapes and plates used in footing frames		Per non-fracture critical steel in Zone 1 (T1) per ASTM Designation: A 709, S83

High-strength fastener assemblies, and other bolts attached to structural steel with nuts and washers shall be zinc-coated.

Material conforming to ASTM Designation: A 709M, Grade 50W or 100W shall not be substituted for ASTM Designation: A 709, non-weathering steel grades.

Orthotropic box girders, including internal floor beams, shall be made from fully killed material, conforming to the provisions for fine grain practice of ASTM Designation: A 709.

All steel used in the fabrication of the orthotropic box girder transition span shall not contain sulfur in excess of 0.01% by weight:

Steel designated as Pipe Beam Grade 70 on the plans shall conform to the requirements in ASTM Designation: A709, Grade HPS70W with Supplementary Requirement S5, "Ultrasonic Examination"; Supplementary Requirement S84 "Fracture-Critical, *F*, Material; Toughness Testing and Marking" tested for Zone 3; and Supplementary Requirement S93, "Limitations on Weld Repair (Fracture Critical Material Only)." Charpy V-Notch tests for the as-fabricated pipe beam and heat affected zone (HAZ) shall meet 48 joules (J) minimum average at –7˚ C. Weld metal shall meet the requirements of AWS D1.5, Table 12.1.

Steel designated as Pipe Beam Grade 50 on the plans shall conform to the following:

A. The steel shall conform to ASTM Designation: A 709 requirements for Fracture Critical Grade 50 with Supplementary Requirement S93, "Limitations on Weld Repair (Fracture Critical Material Only)," as modified herein.
B. The carbon content shall not exceed 0.12%, and the sulfur content shall not exceed 0.01% by weight.
C. The steel shall be fully killed and made to fine grain practice in conformance with the requirements in ASTM Designation: A709.
D. The steel shall be made using a low nitrogen and hydrogen practice such as vacuum degassing. The nitrogen content shall not exceed 0.015%.
E. The Yield Point or Yield Strength shall be within the range of 345 through 380 MPa.
F. The ratio of Yield Strength to Ultimate Strength shall be within the range of 0.75 to 0.85.
G. The tensile elongation shall be not less than 19% for a 200 mm gauge length specimen or 22% for a 50 mm gauge length specimen.
H. The reduction of area in the tensile test shall be not less than 35%.
I. Charpy V-Notch (CVN) tests for the base plate shall meet 41 J minimum average at - 40˚ C. CVN tests for the as-fabricated pipe beam, heat affected zone and the weld metal shall meet the requirements of AWS D1.5, Table 12.1.
J. Tensile and toughness tests shall be performed on a per-plate basis.

Pourable seals used with structural steel shall conform to the provisions in Section 51-1.12F(3) "Materials and Installation," of the Standard Specifications.

Grout for base plates shall conform to the provisions in Section 50-1.09 "Bonding and Grouting," of the Standard Specifications.

CHECK TESTING

Structural steel shall conform to the designated ASTM Standard and the check testing requirements of this section.

Check samples shall be furnished for each heat of maximum thickness of fracture critical members as shown on the plans.

Steel plates, shapes or bars containing check samples shall be furnished from the mill with extra length in order to provide for removal of material for check samples at the point of fabrication. Check samples may be cut from either end of the designated plate, shape or bar.

At the option of the Contractor, check samples may be removed at the rolling mill rather than at the point of fabrication. The sample will be removed from the mill plate that will be stripped by the fabricator to produce the designated plate and may be taken from any location within that plate. The mill plate from which samples are removed shall be marked with the same identifying numbers as are used on the samples.

Unless otherwise directed, material for check samples shall be removed by the Contractor in the presence of the Engineer. Check samples for plates wider than 610 mm shall be 355 mm wide and 460 mm long with the long dimension transverse to the direction of rolling. Check samples for all other products shall be 460 mm long, taken in the direction of rolling, and the width shall be the product width. Check samples shall be removed and delivered to the Engineer before the material is fabricated into components and preferably when it is still being prepared for fabrication. The direction of rolling, heat numbers, and plate numbers shall be marked on the samples with paint or other indelible marking material or may be steel stamped in one corner of the plate. Certified Material Test Reports complying with the requirements in these special provisions shall accompany the check sample.

Unless otherwise directed, check samples shall be delivered to the Transportation Laboratory at the Contractor's expense. The check samples will be tested by the Transportation Laboratory for compliance with the requirements specified in ASTM and these special provisions. Check sample test results will be reported to the Contractor within 15 working days of delivery to the Transportation Laboratory. In the event several samples are submitted on the same day, an additional day will be added for each 2 samples submitted. The test report will be made for the group of samples.

The results of the tensile and impact tests shall not vary more than 5 percent below the specified minimum or 5 percent above the specified maximum requirements except that if the initial check test results vary more than 5 percent but not more than 10 percent from the specified requirements, a retest may be performed on another sample from the same heat and thickness. The results of the retest shall not vary more than 5 percent from the original specified requirements. If the results of check tests exceed these permissible variations, material planned for use from the heat represented by said check samples shall be subject to rejection.

THROUGH-THICKNESS QUALITY

Where through-thickness quality steel is shown on the plans, the steel shall meet the low sulfur and reduction of area requirements of AWS D1.5, Section 12.4.4.1. Additionally, each plate shall be ultrasonically examined and accepted in conformance with the requirements in ASTM Designation: A578, Level I.

FABRICATION

Quality of Workmanship

The Engineer may inspect fabrications for dimensional accuracy, fabrication practices, welding, and for compliance with these special provisions.

Shop Size

The shop or yard shall be of sufficient size and shall have adequate facilities to permit checking and controlling of the alignment of the orthotropic box sections to be erected before they are shipped to the site.

Fabrication Procedure

The Contractor shall submit to the Engineer for approval in accordance with "Working Drawings," of these special provisions, detailed procedures for the fabrication of the following items:

A. Orthotropic box shell plating
B. Orthotropic box section (fabrication and splice)
C. Footings frames for Piers E3-E6, E7-E14 and E15-E16
D. Pipe beams

Procedures shall be of sufficient detail to demonstrate the proposed fabrication procedure and verify the inspectability of welds and shall include, at a minimum, the following:

A. Stages of fabrication;
B. The extent of each subassembly;
C. The use of jigs;
D. The sequence and methods for tack and final welding;
E. The timing and methods for dimensional checks;
F. The timing and methods for visual and nondestructive examination; and
G. The support conditions, fixturing, measurement methods, match marking and location for the trial fit of erection joints.

Pipe Beams

The Contractor shall fabricate pipe beams in accordance with the approved fabrication procedure conforming to the requirements of these special provisions. Welding of the pipe beam longitudinal and circumferential groove welds and stainless steel cladding shall be made using the SAW process unless otherwise approved by the Engineer.

Pipe beams shall be formed in sections that are welded with one or two longitudinal seams. Forming shall be performed at ambient temperature unless approved and qualified at elevated temperature, which shall not exceed 590˚C. Metal forming at temperatures between 150˚C and 425˚C will not be permitted. Prior to stress relieving and machining the formed pipe beam shall have a smooth surface with local roundness variations less than 5 mm, as measured against a template with the theoretical curvature and length of 20 degrees, and out-of-roundness (maximum diameter minus minimum diameter) less than 8 mm.

The grade 70 individual pile beam sections shall be stress relieved after all section and ring welding is completed and before the stainless steel cladding is placed. Stress relief shall be performed at a temperature that is equal to 10˚ C less than the final tempering temperature, but shall not exceed 538˚ C.

Welding procedures for the longitudinal and circumferential welds shall be qualified by welding test pieces with the maximum thickness to be welded in production in the as-formed condition representing the maximum strain and testing after stress relief. Charpy V-Notch tests shall be removed from the weld metal and heat affected zone for longitudinal and circumferential welds. Heat affected zone toughness tests shall be removed from the inner and outer surfaces of the formed member after the stress relief heat treatment. Test results for both weld metal and heat affected zone shall meet the requirements specified under "Materials" above.

The AISI 316L stainless steel overlay shall be welded using a procedure qualified for the Pipe Beam Grade 70 in accordance with AWS D1.6. Chemical analysis shall be performed on the qualification overlay 5 mm above the substrate and shall meet the chemical limits for grade 316L. After overlay welding, the stainless steel surfaces shall be machined to a root mean square surface finish of 0.8 μm, with no gouges or indentations, and an out-of-roundness on the machined surface (max. OD – min. OD) not exceeding 1 mm.

The two cylinders defined by the two machined surfaces shall be straight and concentric within 1 mm. The actual centerline of the sliding section of the pipe beam, as defined by the line connecting the average center of the two stainless overlay segments, shall be within 3 mm of the actual centerline of the fixed section of the pipe beam, as defined by the centers of the pipe beam OD at the hinge support diaphragms (C & D). In addition, any point on the fixed section of the pipe beam shall be within 5 mm (adjusted for the overlay thickness) of the projection of the cylinder defined by the OD of the machined stainless overlay on the sliding end.

The Pipe Beam Grade 50 (Fuse) section shall be welded to the Pipe Beam Grade 70 sections using a welding procedure qualified for circumferential welds in the Pipe Beam Grade 70.

Complete joint penetration welds shall be examined 100% by UT and MT. Fillet and partial joint penetration welds shall be examined 100% by MT. Acceptance shall be based on the criteria for tension welds in primary members. Final visual and nondestructive examination of weld shall be after stress relief and before cladding. Finish machined stainless steel surfaces, plus 100 mm of the pipe beam on either side of the stainless steel surfaces, shall be examined 100% by liquid penetrant testing (PT) in accordance with AWS D1.6 for cyclically loaded welds in tension.

Restraint brackets for pipe beams at Hinges AE, AW, EE, and EW shall be furnished by the Contractor and delivered to the Engineer in the same manner specified for spare pipe beam fuses.

Spare Fuses

In addition to pipe beams, the Contractor shall fabricate spare pipe beam fuses in accordance with the details shown on the plans and the requirements of this section. Spare pipe beam fuses shall conform to the requirements for Pipe Beam Grade 50 of this section, including the requirements for cleaning and painting.

The Contractor shall deliver the spare pipe beam fuses to the Engineer at a location to be determined by the Engineer. Said location will be within 25 km of the San Francisco-Oakland Bay Bridge Toll Plaza. Spare pipe beam fuses shall be delivered to the Engineer within six months prior to completion of the work. The Contractor shall notify the Engineer at least two months prior to delivery of spare pipe beam fuses.

Spare pipe beam fuses shall be packaged for the protection of the steel against physical damage and corrosion during shipping and storage. The shipping package shall be clearly marked with a statement that the package contains spare pipe beam fuses for the San Francisco-Oakland Bay Bridge and show the hinge location, the grade of steel, and the date packaged.

Mechanical Cutting

Mechanical shearing of material of thickness greater than 8 mm is prohibited. Mechanically sheared edges shall be ground smooth. All cracks emanating from these edges shall be removed.

Flame, Plasma And Arc Cutting

All cut edges shall be ground to remove dross, slag and hardened material.

Rib Plates

Cold-bent rolled steel rib plates shall conform to the following:

A. The plates shall be taken from the stock plates that the direction of bending will be at right angles to the direction of rolling. The entire length of rib shall be formed simultaneously. Progressive forming methods such as roll forming will not be permitted.
B. The radius of bend of closed rib plates, measured to the concave face of the metal shall be as shown on the plans.
C. Before bending, the corners of the plate perpendicular to the axis of the bend shall be rounded to a radius of 2 mm.

The Contractor's proposed method shall be capable of bending the plates without introducing cracks at the edges or along the bent section. The Contractor shall demonstrate to the Engineer that the proposed method results in satisfactory bends. The Engineer will determine if the proposed method is acceptable. Acceptance of the Contractor's proposed bending method will be based on nondestructive tests on ten ribs and destructive tests on three of the ribs previously tested nondestructively. Ribs shall be a minimum of 10 m long. The Contractor shall perform the following tests:

A. Visual observation of the bends using magnifying lens.
B. Magnetic Particle testing of 15 % of the bent parts of the ribs at locations selected by the Engineer.
C. Destructive testing of up to three ribs, with 5 samples per rib, at locations selected by the Engineer.

The Contractor shall bend and trim ribs and shell plating to ensure that the geometric control shown on the plans will be met.

Match-Marking

Match markings shall be made with low stress die stamps or other method that will not notch the steel. Bulkheads within the closed ribs shall match the diaphragm plate within 1 mm tolerance. Markings shall be sufficiently narrow to meet this requirement.

Bolted Connections

The first paragraph of Section 55-3.14 "Bolted Connections," of the Standard Specifications shall not apply.

Bolted connections in structural steel joints, unless otherwise shown on the plans or specified in the special provisions, shall be made with high-strength steel fastener assemblies. Fastener assemblies shall consist of a high-strength steel bolt, nut and hardened washer.

The method of bolt tightening shall be the "Turn-of-the-nut" method as specified in RCSC Specification.

Except where sub-punching is permitted, bolt holes shall be drilled or reamed, unless otherwise shown on the plans.

Punching

The first paragraph of Section 55-3.14A(1) "Punching," of the Standard Specifications shall not apply.

Sub-punching of structural steel conforming to the requirements in ASTM Designation: A 36 where the material is thicker than 16 mm will not be permitted. Sub-punching of high-strength structural steel where the material is thicker than 12 mm will not be permitted.

ROTATIONAL CAPACITY TESTING PRIOR TO SHIPMENT TO JOB SITE

Rotational capacity tests shall be performed on all lots of high-strength fastener assemblies prior to shipment of these lots to the project site. Zinc-coated assemblies shall be tested after all fabrication, coating, and lubrication of components has been completed. One hardened washer shall be used under each nut for the tests.

Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly.

A rotational capacity lot number shall be assigned to each combination of lots tested. Each shipping unit of fastener assemblies shall be plainly marked with the rotational capacity lot number.

Two fastener assemblies from each rotational capacity lot shall be tested.

The following equipment, procedure, and acceptance criteria shall be used to perform rotational capacity tests on, and determine acceptance of long bolts. Fasteners are considered to be long bolts when full nut thread engagement can be achieved when installed in a bolt tension measuring device:

A. Long Bolt Test Equipment:

1. Calibrated bolt tension measuring device with adequate tension capacity for the bolts being tested.
2. Calibrated dial or digital torque wrench. Other suitable tools will be required for performing Steps 7 and 8 of the Long Bolt Test Procedure. A torque multiplier may be required for large diameter bolts.
3. Spacer washers or bushings. When spacer washers or bushings are required, they shall have the same inside diameter and equal or larger outside diameter as the appropriate hardened washers conforming to the requirements in ASTM Designation: F436.
4. Steel beam or member, such as a girder flange or cross frame, to which the bolt tension measuring device will be attached. The device shall be accessible from the ground.

B Long Bolt Test Procedure:

1. Measure the bolt length. The bolt length is defined as the distance from the end of the threaded portion of the shank to the underside of the bolt head.
2. Install the nut on the bolt so that 3 to 5 full threads of the bolt are located between the bearing face of the nut and the underside of the bolt head. Measure and record the thread stickout of the bolt. Thread stickout is determined by measuring the distance from the outer face of the nut to the end of the threaded portion of the shank.
3. Insert the bolt into the bolt tension measuring device and install the required number of washers, and additional spacers as needed, directly beneath the nut to produce the thread stickout measured in Step 2 of this procedure.
4. Tighten the nut using a hand wrench to a snug-tight condition. The snug tension shall not be less than the Table A value but may exceed the Table A value by a maximum of 2 kips.

Table A

High-Strength Fastener Assembly Tension Values to Approximate Snug-Tight Condition	
Bolt Diameter (inches)	Snug Tension (kips)
1/2	1
5/8	2
3/4	3
7/8	4
1	5
1 1/8	6
1 1/4	7
1 3/8	9
1 1/2	10

5. Match-mark the assembly by placing a heavy reference start line on the face plate of the bolt tension measuring device which aligns with 1) a mark placed on one corner of the nut, and 2) a radial line placed across the flat on the end of the bolt. Place an additional mark on the outside of the socket that overlays the mark on the nut corner such that this mark will be visible while turning the nut. Make an additional mark on the face plate, either 2/3 of a turn, one turn, or 1 1/3 turn clockwise from the heavy reference start line, depending on the bolt length being tested as shown in Table B.

Table B

Required Nut Rotation for Rotational Capacity Tests[a,b]	
Bolt Length (measured in Step 1)	Required Rotation (turn)
4 bolt diameters or less	2/3
Greater than 4 bolt diameters but no more than 8 bolt diameters	1
Greater than 8 bolt diameters, but no more than 12 bolt diameters[c]	1 1/3
(a) Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance shall be plus or minus 30 degrees; for bolts installed by 2/3 turn and more, the tolerance shall be plus or minus 45 degrees. (b) Applicable only to connections in which all material within grip of the bolt is steel. (c) When bolt length exceeds 12 diameters, the required rotation shall be determined by actual tests in a suitable tension device simulating the actual conditions.	

6. Turn the nut to achieve the applicable minimum bolt tension value listed in Table C. After reaching this tension, record the moving torque, in foot-pounds, required to turn the nut, and also record the corresponding bolt tension value in pounds. Torque shall be measured with the nut in motion. Calculate the value, T (in ft-lbs), where T=[(the measured tension in pounds) x (the bolt diameter in inches) / 48 in/ft].

Table C

Minimum Tension Values for High-Strength Fastener Assemblies	
Bolt Diameter (inches)	Minimum Tension (kips)
1/2	12
5/8	19
3/4	28
7/8	39
1	51
1 1/8	56
1 1/4	71
1 3/8	85
1 1/2	103

7. Turn the nut further to increase bolt tension until the rotation listed in Table B is reached. The rotation is measured from the heavy reference line made on the face plate after the bolt was snug-tight. Record this bolt tension.
8. Loosen and remove the nut and examine the threads on both the nut and bolt.

C. Long Bolt Acceptance Criteria:

1. An assembly shall pass the following requirements to be acceptable: 1) the measured moving torque (Step 6) shall be less than or equal to the calculated value, T (Step 6), 2) the bolt tension measured in Step 7 shall be greater than or equal to the applicable turn test tension value listed in Table D, 3) the nut shall be able to be removed from the bolt without signs of thread stripping or galling after the required rotation in Step 7 has been achieved, 4) the bolt does not shear from torsion or fail during the test and 5) the assembly does not seize before the final rotation in Step 7 is reached. Elongation of the bolt in the threaded region between the bearing face of the nut and the underside of the bolt head is expected and will not be considered a failure. Both fastener assemblies tested from one rotational capacity lot shall pass for the rotational capacity lot to be acceptable.

Table D

Turn Test Tension Values	
Bolt Diameter (inches)	Turn Test Tension (kips)
1/2	14
5/8	22
3/4	32
7/8	45
1	59
1 1/8	64
1 1/4	82
1 3/8	98
1 1/2	118

The following equipment, procedure and acceptance criteria shall be used to perform rotational capacity tests on and determine acceptance of short bolts. Fasteners are considered to be short bolts when full nut thread engagement cannot be achieved when installed in a bolt tension measuring device:

A. Short Bolt Test Equipment:

1. Calibrated dial or digital torque wrench. Other suitable tools will be required for performing Steps 7 and 8 of the Short Bolt Test Procedure. A torque multiplier may be required for large diameter bolts.
2. Spud wrench or equivalent.
3. Spacer washers or bushings. When spacer washers or bushings are required, they shall have the same inside diameter and equal or larger outside diameter as the appropriate hardened washers conforming to the requirements in ASTM Designation: F436.
4. Steel plate or girder with a hole to install bolt. The hole size shall be 1.6 mm greater than the nominal diameter of the bolt to be tested. The grip length, including any plates, washers, and additional spacers as needed, shall provide the proper number of threads within the grip, as required in Step 2 of the Short Bolt Test Procedure.

B. Short Bolt Test Procedure:

1. Measure the bolt length. The bolt length is defined as the distance from the end of the threaded portion of the shank to the underside of the bolt head.
2. Install the nut on the bolt so that 3 to 5 full threads of the bolt are located between the bearing face of the nut and the underside of the bolt head. Measure and record the thread stickout of the bolt. Thread stickout is determined by measuring the distance from the outer face of the nut to the end of the threaded portion of the shank.
3. Install the bolt into a hole on the plate or girder and install the required number of washers, and additional spacers as needed, between the bearing face of the nut and the underside of the bolt head to produce the thread stickout measured in Step 2 of this procedure.
4. Tighten the nut using a hand wrench to a snug-tight condition. The snug condition shall be the full manual effort applied to the end of a 305 mm long wrench. This applied torque shall not exceed 20 percent of the maximum allowable torque in Table E.

Table E

Maximum Allowable Torque for High-Strength Fastener Assemblies	
Bolt Diameter (inches)	Torque (ft-lbs)
1/2	145
5/8	285
3/4	500
7/8	820
1	1220
1 1/8	1500
1 1/4	2130
1 3/8	2800
1 1/2	3700

5. Match-mark the assembly by placing a heavy reference start line on the steel plate or girder which aligns with 1) a mark placed on one corner of the nut, and 2) a radial line placed across the flat on the end of the bolt. Place an additional mark on the outside of the socket that overlays the mark on the nut corner such that this mark will be visible while turning the nut. Make 2 additional small marks on the steel plate or girder, one 1/3 of a turn and one 2/3 of a turn clockwise from the heavy reference start line on the steel plate or girder.
6. Using the torque wrench, tighten the nut to the rotation value listed in Table F. The rotation is measured from the heavy reference line described in Step 5 made after the bolt was snug-tight. A second wrench shall be used to prevent rotation of the bolt head during tightening. Measure and record the moving torque after this rotation has been reached. The torque shall be measured with the nut in motion.

Table F

Nut Rotation Required for Turn-of-Nut Installation(a,b)	
Bolt Length (measured in Step 1)	Required Rotation (turn)
4 bolt diameters or less	1/3
(a) Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance shall be plus or minus 30 degrees. (b) Applicable only to connections in which all material within grip of the bolt is steel.	

7. Tighten the nut further to the 2/3-turn mark as indicated in Table G. The rotation is measured from the heavy reference start line made on the plate or girder when the bolt was snug-tight. Verify that the radial line on the bolt end is still in alignment with the start line.

Table G

Required Nut Rotation for Rotational Capacity Test	
Bolt Length (measured in Step 1)	Required Rotation (turn)
4 bolt diameters or less	2/3

8. Loosen and remove the nut and examine the threads on both the nut and bolt.

C. Short Bolt Acceptance Criteria:

1. An assembly shall pass the following requirements to be acceptable: 1) the measured moving torque from Step 6 shall be less than or equal to the maximum allowable torque from Table E, 2) the nut shall be able to be removed from the bolt without signs of thread stripping or galling after the required rotation in Step 7 has been achieved, 3) the bolt does not shear from torsion or fail during the test and 4) the assembly shall not seize before the final rotation in Step 7 is reached. Elongation of the bolt in the threaded region between the bearing face of the nut and the underside of the bolt head will not be considered a failure. Both fastener assemblies tested from one rotational capacity lot shall pass for the rotational capacity lot to be acceptable.

INSTALLATION TENSION TESTING AND ROTATIONAL CAPACITY TESTING AFTER ARRIVAL ON THE JOB SITE

Installation tension tests and rotational capacity tests on high-strength fastener assemblies shall be performed by the Contractor prior to acceptance or installation, and after arrival of the fastener assemblies on the project site. Installation tension tests and rotational capacity tests shall be performed at the job-site, in the presence of the Engineer, on each rotational capacity lot of fastener assemblies.

Installation tension tests shall be performed on 3 representative fastener assemblies in conformance with the provisions in Section 8, "Installation and Tightening," of the RCSC Specification. For short bolts, Section 8(d), "Joint Assembly and Tightening of Slip-Critical and Direct Tension Connections," of the RCSC Specification shall be replaced by the "Pre-Installation Testing Procedures," of the "Structural Bolting Handbook," published by the Steel Structures Technology Center, Incorporated.

The rotational capacity tests shall be performed in conformance with the requirements for rotational capacity tests in "Rotational Capacity Testing Prior to Shipment to Job Site" of these special provisions.

At the Contractor's expense, additional installation tension tests, tests required to determine job inspecting torque and rotational capacity tests shall be performed by the Contractor on each rotational capacity lot, in the presence of the Engineer, if 1) any fastener is not used within 3 months after arrival on the jobsite, 2) fasteners are improperly handled, stored, or subjected to inclement weather prior to final tightening, 3) significant changes are noted in original surface condition of threads, washers or nut lubricant or 4) the Contractor's required inspection is not performed within 48 hours after all fasteners in a joint have been tensioned.

Failure of a job-site installation tension test or a rotational capacity test will be cause for rejection of unused fasteners that are part of the rotational capacity lot.

ASSEMBLY

Orthotropic box sections shall be fabricated in subassemblies as shown on the plans. Splices within subassemblies shall be welded. At the option of the Contractor, subassemblies may become part of larger preassembled sections before they are shipped to the site. Preassembled sections shall be dimensionally checked for matching, alignment, and camber, and shall not be shipped to the job site without approval of the Engineer.

Before shipping, preassembled sections shall be straight and square in accordance with the dimensions and tolerances shown on plans and these special provisions, except as required by camber. Subassemblies and preassembled sections shall be measured in the shop for compliance with geometry requirements. As a minimum, the preassembly procedure shall consist of assembling three contiguous sections accurately adjusted for line and camber. Successive assemblies shall consist of at least one section of the previous assembly plus two or more sections added at the advancing end. In case of structures longer than 45 m, each assembly shall be not less than 45 m regardless of the length of individual continuous sections. The support conditions shall be the same as those in the final installed condition; alternative support conditions may be proposed with details submitted under the Erection Plan and supported by calculations showing the effect of the support conditions on dimensional tolerances and section-to-section fit-up tolerances.

SURFACE PREPARATION

For all bolted connections, the 1) contact surfaces and 2) inside surfaces of bolt holes shall be cleaned and coated before assembly in conformance with the provisions for cleaning and painting structural steel of these special provisions.

WELDING

Table 2.2 of ANSI/ AASHTO/AWS D1.5 is superseded by the following table:

Base Metal Thickness of the Thicker Part Joined, mm	Minimum Effective Partial Joint Penetration Groove Weld Size, * mm
Over 6 to 13 inclusive	5
Over 13 to 19 inclusive	6
Over 19 to 38 inclusive	8
Over 38 to 57 inclusive	10
Over 57 to 150 inclusive	13
Over 150	16

* Except the weld size need not exceed the thickness of the thinner part

Backing for welds that are subject to computed stress which are left in place in the completed structure as shown on the plans or approved by the Engineer shall be a single length. Backing shall be of the same material as the structural steel being welded. Single lengths of backing shall be obtained by using a continuous strip, or may consist of lengths of backing joined by complete joint penetration butt welds. Butt welds in the backing material shall be tested in conformance with the requirements in AWS D1.5, Section 3.13.1. Butt welds in backing material shall be ground flush as necessary to obtain proper inspection and for proper fit-up in the weld joint with which the backing is to be used.

WELDING OF HPS70W STEELS FOR PIPE BEAMS

Welds in Pipe Beam Grade 70 steels shall conform to the requirements for HPS 70W in this section. All welding procedures shall be qualified by testing in accordance with the requirements in AWS D1.5 and shall be used within the qualified limits of heat input. Previously qualified welding procedures may be submitted for review based on these specification requirements. Regardless of qualification range, the heat input, preheat temperature and maximum interpass temperature shall conform to the requirements of this section.

Consumables for welding HPS70W shall be low hydrogen with H2, H4 or H8 designators as shown below. The Contractor shall test the actual level of hydrogen for each consumable using the proposed welding procedure and maximum exposure conditions anticipated during production. The level of hydrogen shall not exceed the limits specified below.

The following additional provisions shall be used for welding to HPS70W:

A. Only submerged arc and shielded metal arc welding are pre-approved for welding HPS70W steel. Consumable handling requirements shall be in accordance with the requirements of AWS D1.5-96, Sections 12.6.5 and 12.6.6.
B. Filler Metal Requirements:

    1. Filler metals for single pass fillet welds need not meet the requirements for exposed bare applications.
    2. Filler Metals for complete joint penetration groove welds connecting Grade HPS70W to Pipe Beam Grade 50 steels shall conform to the requirements listed in paragraph 3 below.

3. Filler Metals for matching fillet welds when required by design, and all groove welds connecting Grade HPS70W plates shall conform to the following requirements:

   (a) Submerged Arc Welding (SAW) Consumables;

   SAW consumables shall meet AWS Electrode/Flux Classification F9P4 EXXX-X for welds that will be stress relieved, and F9A4 EXXX-X for welds that will not be stress relieved, with supplementary moisture resistance designators-H4 or -H2, in conformance with AWS A5.23, with 1% Nickel minimum in the weld deposit.

   (b) Shielded Metal Arc Welding (SMAW) Consumables; E9018-CxRHZ*

   (* the Designator 'R', for moisture resistant coating, is required for all SMAW electrodes used for welding HPS70W steels. HZ shall be either H4 or H8, depending upon the level of preheat used.)

   (c) Other Processes

   The use of other processes will be subject to approval by the Engineer based on proposed consumables and welding parameters. Filler metals for other processes shall provide, in the as-welded or stress relieved condition as appropriate, a minimum ultimate strength of 620 MPa, minimum yield strength of 485 MPa, and the toughness specified below. Consumables shall have a low hydrogen designation of H4 or H8 (depending on the level of preheat) and shall be moisture resistance.

4. Except for single pass fillet welds, or welds that will be fully consumed in a finished weld with satisfactory weathering characteristics, welding consumables and electrodes shall produce weld deposits that meet the requirements of AWS D1.5, Table 4.3.

♦ Qualification Testing: Weld procedure qualification Test Requirements for HPS70W groove welds shall be evaluated using Welding Procedure Specification (WPS) Test Plates from the as-formed base metal and shall be stress relieved the same as the final members. The test results shall meet the following properties:

Transverse tensile ultimate strength: ≥ 620 MPa
All-Weld-Metal: yield strength: ≥ 485 MPa
All-Weld-Metal: ultimate tensile strength: ≥ 620 MPa
All-Weld-Metal: percent elongation: ≥ 19% in 50 mm
Charpy V-Notch: as specified under Materials above.

5. In addition to the requirements for WPS qualification in accordance with AWS D1.5, diffusible hydrogen (Hd) tests shall be performed on the weld metal. The deposited weld metal shall have a diffusible hydrogen level equivalent to 4 mL/100 g or less for SAW and 8 mL/100 g or less for other processes. Hd test specimens shall be prepared at the fabrication plant. Specimens shall be tested in accordance with AWS A4.3. Test results in excess of the specified limit are unacceptable, and a retest is required, with a revised welding or consumable control procedure. AWS D1.5, Section 5.7.6, “Exemption from Further Testing,” is applicable, but WPS or Hd results are not transferable from fabricator to fabricator. Fabricators with multiple plants under a common umbrella of welding equipment, welding training, and supervision will be required to perform the Hd testing only once per combination of consumables for each location. Plants audited as a single facility by the American Institute of steel Construction (AISC) as a part of their Quality Certification Program, or other owner approved equal Quality Assurance program, shall be considered one location. Multiple plants not falling under the AISC, or other 'single facility' audit definition, are considered separate facilities and additional WPS and Hd tests are required.

C. Preheat and Interpass Temperature:

1. The minimum preheat and interpass temperatures shall be in accordance with AWS D1.5, Table 12.4.
   If satisfactory results are not achieved with the above minimum preheat and interpass temperatures during development of the Welding Procedure Specification (WPS), and an increased preheat temperature is used to provide a satisfactory Procedure Qualification Record (PQR), the higher preheat temperature shall be used during pipe beam fabrication as the required minimum.
   The minimum preheat or interpass temperature required for a joint composed of different base metals and/or different thickness shall be based on the highest of the minimum preheats required by AWS D1.5, Table 12.4.
2. The maximum interpass temperature for welding HPS70W steel is 230 ˚C.

D. Heat Input (HI);

1.5 kilojoules per mm (kJ/mm), minimum
3.5 kJ/mm, maximum
as determined using AWS D1.5, Section 5.12.

E. Backing; AWS D1.5, Section 5.4.5 is modified to allow steel backing material for WPS test plates to be of grade 50W (Sulfur = 0.025 max.) or HPS70W material.
F. Transition at butt joints; AWS D1.5, Section 9.16.3, is modified to allow a straight (width) transition for butt joints with HPS70W steel consistent with the fatigue rules of AASHTO.

SHOP WELDING

General Provisions

A. Steel fabrication shall conform to the requirements of AWS D1.5, except FCMs shall be fabricated to Chapter 12 of the AWS D1.5, "AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members", except as modified in these special provisions.
B. The welding shop shall be temperature and ventilation controlled. At no time shall the temperature fall below 10 ˚C. Fumes from welding shall be removed by methods satisfying ANSI Z49.1, "Safety in Welding cutting and Allied Processes, and Safety Plans" consistent with legislation. To the extent that air movement may be harmful to welding procedures, ventilation in the welding areas shall be controlled to levels consistent with qualification procedures.
C. Welding of ancillary products – connections of ancillary products, such as bikepath railings, to the main bridge elements shall be done by bolting. No structure which is welded to the orthotropic box section or main elements of the bridge shall be considered ancillary. The provisions of AWS D1.5, Section 1.3.6, "Welding of Ancillary Products," shall not apply. The bikepath deck, and all its members shall be fabricated as a main element of the bridge and not as an ancillary product.
D. Welding of temporary fixtures such as lifting lugs or temporary shear enhancement devices shall be shown on the working drawings and shall conform to AWS D1.5. After removal, the structure shall be repaired to meet the requirements of these special provisions and AWS D1.5.
E. Welding of orthotropic deck ribs – Ribs shall be welded to the deck plate in accordance with a welding procedure that is qualified to meet penetration requirements as specified in these special provisions. The procedure shall be approved by the Engineer before it is adopted for production and shall be monitored during production using extension test pieces described below. Closed ribs shall be clamped in place and both stems welded to the deck plate simultaneously.
F. Gas metal Arc Welding (GMW) will not be permitted for welding of structural members in the orthotropic box.

Design Details

A. Unless otherwise shown on the plans or specifically approved in writing by the Engineer, all complete joint penetration (CJP) welds shall be back-gouged. Where backing bars are used, the backing bars shall be removed and the weld back-gouged and re-welded. The back gouged areas shall be ground to bright metal.

B. Weld backing shall conform to the requirements in AWS D1.5 and these special provisions.
C. Weld matching: weld electrodes shall match the lower strength of the materials joined, except where otherwise noted.
D. Tightly adhering weld spatter shall be removed by power brush or grinding.
E. Gouging for back gouging or for repair shall be done by an approved arc method and /or by grinding. Oxygen cutting will not be permitted for any form of gouging. Procedures to avoid retention of carbon deposits, slag or dross shall be used. Air-carbon-arc gouged surfaces shall be ground or filed to bright metal.
F. Weld repairs – In addition to the provisions in AWS D1.5, Section 3.7.4, re-repairs of welds or base metal shall require prior approval of the Engineer. Repairs to Fracture Critical Members shall be as specified in AWS D1.5, "AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Member," Section 12.17.
G. Dimensional Tolerances

1. Dimensional tolerances shall conform to AWS D1.5 as modified on the plans and in these special provisions.
2. The dimensional tolerances in AWS D1.5 shall be limited such that the actual location of the pile sleeve surface at any point shall be within 20 mm of its theoretical location with respect to the other piles and other geometric references in each footing.
3. Dimensional tolerances for the fabrication, assembly and erection of the orthotropic box shall conform to the tolerances in AWS D1.5, AASHTO Sixteenth Edition 1996, Division II – Construction, Section 11.4.13 – Orthotropic Deck Superstructures, and the following:

    a. Members comprising the orthotropic box, including all internal structure, shall be within 5 mm of the theoretical location shown on the plans at any point along the member in the as-installed condition.
    b. The vertical web plates, transverse diaphragms and floor beam webs shall be within 0.25% of plumb at any point along the member in the as-installed condition.
    c. The maximum offset of members restrained against bending shall be as specified in AWS D1.5, Section 3.3.3. The offset of members that are not restrained, such as field infill pieces, shall not produce a local change in member geometry or kink exceeding a slope of 2 mm in 100 mm. This local tolerance shall be in addition to member straightness tolerances in the specified codes.
    d. Where a discontinuous member provides a continuous load path on either side of a through member, the method of marking and ensuring alignment shall be described in the geometric control procedure. Misalignment between discontinuous members shall not exceed 30% of the thickness of the thinner member.

Welding of Closed Ribs to Deck Plate

A. Welding of closed ribs to deck plates shall be accomplished with a welding process and procedure capable of achieving a minimum of 80% penetration of the rib thickness. The Contractor's proposed process and rib groove detail shall undergo trials to obtain the optimum joint detail, without internal notches. In addition to these tests, the qualification procedure required by AWS D1.5 shall be followed. Production welding, with any of the processes tried, will not be permitted without the approval of the Engineer.
B. Weld Procedure Trials– For closed rib welds to the deck plate and other plate, the Contractor shall perform weld trials with a minimum of two details using the SAW automated welding process. One of the trials shall be made with a backing bar and another trial shall have no backing bar or a ceramic backing.
The trials shall be conducted with welding machines, parameters, root openings and bevels as shown in the approved WQCP. Each weld detail shall be performed on a rib prototype, which is a minimum of ten (10) meters long. During these trials, the welding shall be stopped at every 1.0 meters, and then restarted. Each rib shall have a total of 18 re-starts, 9 for each rib stem.
At completion of welding, welds shall be 100% ultrasonically tested. The rib shall then be split in two and one stem shall be selected for examination, after cutting and macroetching at anomalies as determined by UT and selected by the Engineer, but at least the ends of the rib, all the re-starts, and intermediate points between re-starts.

The Engineer will evaluate all the rib to deck plate weld details and make a selection based on the as-welded configuration of the joint. The macroetched sections of the selected welding procedure will be evaluated and given a quality status based on visual inspection (VT) and UT. The evaluation criteria for the macroetched sections shall be a minimum weld size of 80% of the rib thickness; no gross notches or burn-through at the rib inside surface that exceed 6 mm, although uniform melt-through or reinforcement shall be acceptable; a reinforcement fillet between zero and 3 mm; and a surface profile meeting AWS D1.5, Section 9.21.1 for a weld in a primary member with tension parallel to the weld axis. The worst of these macrosections that is still acceptable to the Engineer will be considered qualified welds and will be used as standards for acceptance of production welds as monitored during deck fabrication.

C. Monitoring of Production Welds – During fabrication, weld monitoring tests shall be conducted on each welding machine at least every four hours. Test specimens shall consist of run-off extensions of production deck panels. They shall be produced with a separate, unattached, piece of deck plate and an extra long bent rib plate. The rib shall be sawn off at the termination of the deck panel, thus producing a production panel and a specimen for monitoring tests. The specimen shall be 500 mm long, and shall be macroetched 25 mm from each end and at two intermediate locations as determined by the Engineer.

   In the event that the monitoring test specimens do not provide quality similar to those originally developed and accepted, fabrication shall cease. The welding parameters shall then be adjusted and production of qualified welds verified through two consecutive successful additional specimen trials approved by the Engineer before fabrication of deck panels is allowed to continue with the welding machine being monitored.

Welding Procedure Qualification

A. Qualification of Welding Procedure – Qualification testing shall be conducted for all welds and weld details as specified hereunder. Procedure qualification records (PQR) pertaining to tests conducted within the last 30 months, witnessed by Caltrans, and certified to be accurate will be accepted if the test material thickness was equal or greater than the material to be used on the project, and the properties meet the requirements of these special provisions. Otherwise, new tests shall be conducted. Qualification tests shall be performed to qualify the range of material thickness using Table 5.2 of AWS D1.5 except that the thickness of the thicker test plate shall not be less than the maximum thickness to be welded using the qualified procedure. Groove weld macroetch tests per AWS D1.5 are required for qualification of all non-standard complete joint penetration and partial joint penetration welds.

   The ductility requirements shall be 22% elongation for a gage length of 50 mm in the reduced section of the reduced section tension specimens. Charpy V-Notch impact tests shall be taken from the weld and heat affected zone. The toughness requirements are stipulated above under “Materials.”

Inspection and Testing

The Contractor shall provide the Engineer with work schedules, and expected readiness of work for quality assurance (QA) inspection by the Engineer.

Full access for the State’s QA personnel shall be provided to conduct VT for not less than 60 hours from the time the weld is completed.

All CJP welds shall be 100% UT inspected by the Contractor. All rib to wing plate and rib to web plate welds shall be 15% UT inspected by the Contractor. All rib to soffit plate and rib to deck plate welds shall also be 15% UT inspected by the Contractor in lieu of FCM requirements.

In addition, butt welds shall be inspected by radiographic methods as follows:

LOCATION	FREQUENCY OF TESTING
Orthotropic box section butt joints - deck and soffit plates and ribs	Transverse Plate Seams: 10% in lieu of FCM requirements Longitudinal Plate Seams: Minimum of 10% at locations selected by the Engineer Transverse Rib Seams: Minimum of 10% at locations selected by the Engineer
Orthotropic box section - One-sixth of web and wing plate depth starting from the deck and soffit plates	Minimum of 10%, at locations selected by the Engineer
Orthotropic box section – Central 2/3 of web and wing plate depth transverse seam	Minimum of 5%, at locations selected by the Engineer
For FCMs butt joint, except as noted above, and repairs to butt joints	100%

The Contractor shall MT 15% of each of the following type of welds at locations selected by the Engineer:

A. Fillet
B. PJP (including weld restarts)

Acceptance

For purposes of acceptance, all welds shall be considered to sustain tension.

If unacceptable discontinuities (as defined by AWS D1.5) are found in any weld not 100% nondestructively examined, the entire weld shall be examined by the same method.

FIELD WELDING

Field fabricators shall be certified under the AISC Quality Certifications Program, Category CASE, Certified Advanced Steel Erector, with Endorsement F, Fracture Critical members.

Field welding shall comply with all provisions under “Shop Welding” of these special provisions.

The Contractor shall provide suitable enclosures to permit field welding during inclement weather. Provisions shall be made to control atmospheric conditions inside the enclosures with limits suitable for field welding in accordance with the requirements of AWS D1.5 and “Welding” of these special provisions. Full compensation for providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work requiring field welding and no additional compensation will be allowed therefor.

No extension of contract time will be granted and no additional compensation will be allowed as a result of weather conditions which exceed the limits for field welding designated herein, except as approved by the Engineer.

Field welding of pile head connection plates shall conform to the following requirements:

A. Stray current corrosion of the structure shall be avoided during installation at the site. Welding machines shall be placed on the structure being welded. Where this is not practical, the insulated welded power source output “ground” lead shall be connected directly to the work at a location close to the weld being made and shall not be permitted to touch the water. The minimum total cross sectional area of the return ground cable(s) shall be 645 circular mm per 1000 amperes per 30.5 m of cable. Grounding sufficiency shall be periodically monitored by simultaneously measuring the potential of the structure being welded and that holding the welding machines using a standard calomel electrode (SCE), Ag-AgCl or other reference electrode approved by the Engineer. A change in potential reading of 10% or more shall indicate insufficient grounding.

B. Weld filler metal for the welding of ASTM A709, Grade 50 shall conform to AWS D1.5, Table 4.1 or 4.2 and shall be designated H4 or H8 by the manufacturer. All welding consumables shall be heat or lot tested by the manufacturer, and certified test reports shall be submitted to the Engineer prior to being used.
C. Prequalified welding procedures are not permitted. All field welding procedures shall be qualified by testing as required by AWS D1.5 and these special provisions. Qualification tests shall include Charpy V-Notch tests of the weld metal and heat affected zone. The tests shall meet the requirements of these special provisions.
D. Welding filler materials shall be considered an essential variable for welding procedure qualification. Any change in the filler material brand name, size or type shall require requalification of the welding procedure.
E. GMAW shall not be used for field welding.
F. The preheat and interpass temperature shall be in conformance with AWS D1.5, Table 12.3; and the minimum preheat and interpass temperature shall be 60°C. In the event welding is interrupted, preheating to 60°C must occur before welding is resumed. For welds with required preheat temperatures greater than 60°C, preheat temperatures shall be achieved and maintained using electric resistance heating bands for the entire length of the weld. The heaters shall be controlled by attached thermocouples at spacing not exceeding 2 m. For these welds, the minimum preheat temperature shall be maintained continuously from beginning to completion of the entire weld, even if welding is interrupted.
G. Welds shall not be water quenched. Welds shall be allowed to cool unassisted.
H. Slots in the piles shall be precision cut using mechanically-guided cutting equipment on tracks that span the entire length of the cut. A hole, with diameter equal to the intended slot opening, shall be drilled at the bottom of each slot before cutting commences. Cut surfaces shall be protected as necessary to prevent gouging when cutting bevels in the slots.
I. The pile sleeve wall shall be ground to bright metal at each connection plate weld to at least 50 mm beyond the full connection footprint.

FIELD WELDING QUALIFICATIONS FOR PILE HEAD CONNECTION PLATES

Difficult access and working conditions are anticipated for field welding pile head connection plates. The Contractor shall construct full-scale wood mock-ups of the pile head connection plates. After the Engineer approves the wood mock-ups, the Contractor shall construct full-scale steel mock-ups of the pile head connection plates. The Contractor shall perform qualification testing for pile head connection plates in conformance with these special provisions.

The wood mock-up shall show the pile head connection plate connections to the footing, including installation of pile head connection plates.

The steel mock-up shall include the following details:

A. De-watering cofferdam; method of attaching, sealing, drying, and protecting from welding and cutting sparks;
B. Pile head connection plate connections to footing, including installation of connection plate.

The Contractor shall submit to the Engineer for approval, a written installation and welding sequence procedure for each mock-up. The Contractor shall allow the Engineer 15 working days for review of the proposed procedures and each mock-up.

The Engineer shall be given sufficient notice to witness all fit-up of the wood mock-up and fit-up and welding for the steel mock-up.

For the steel mock-up, the procedure shall describe the equipment and details for installing the collar, field cutting slots in the piles, installing the connection plates and reinforcing steel, and performing all welding.

Welders and welding operator shall be qualified with similar access to that anticipated in the field and used in the preliminary mock-up.

Testing

Completed steel mock-up assemblies shall be examined visually and by MT, and by UT or RT for complete and partial penetration welds, using the nondestructive examination procedures proposed for production. Each mock-up pile head connection plate shall be sectioned and tested. Three macroetch specimens shall be removed from each weld between the pile head connection plate and the pile sleeve and between the pile head connection plate the pile at locations indicated by the Engineer. The size of the macroetch specimens shall be agreed with the Engineer. Each specimen shall demonstrate the required weld size and weld profile. Qualification tests shall be adequate to:

A. Demonstrate the proposed installation procedure for each orientation of connection plate considering the least favorable combination of tolerances;
B. Demonstrate the welding sequence and verify the inspectability of each weld; and
C. Confirm that satisfactory welds can be made with the heat sink on the opposite side of the through plate. This confirmation weld shall be an additional qualification test and PQR required to qualify welding procedures for this weld. The qualification weld shall be performed in accordance with the low heat input, low preheat temperature test piece per AWS D1.5, Section 5.12.2.2, except that the weld plate shall be artificially cooled. Sufficient water at the San Francisco Bay water temperature, or equivalent cooling as approved by the Engineer, shall be used as a heat sink to simulate the actual conditions. The procedure test piece shall be examined and tested per Test Plate A (Fig. 5.1) of AWS D1.5 and these special provisions, including Charpy V-Notch tests of the weld and heat affected zone.

The results of the mock-up procedure evaluation and weld procedure qualification tests shall be used to finalize the written installation and welding sequence procedure. The procedure shall describe all equipment and temporary attachments to be used in installing the collar, footing, connection plates and other work to complete the installation of the footing. Approval of the installation and welding sequence procedure shall be contingent on satisfactory results from the mock-up examination and destructive tests, as determined by the Engineer.

At completion of testing, all mock-ups shall become the property of the Contractor and disposed of as provided in Section 7-1.13, “Disposal of Material Outside the Highway Right of Way,” of the Standard Specifications.

FIELD WELDING NONDESTRUCTIVE TESTING FOR PILE HEAD CONNECTION PLATES

Field welded pile shear plates shall receive NDT as follows:

A. The root pass shall be visually inspected before placing subsequent passes.
B. UT shall be used for each complete joint penetration (CJP) field weld. UT shall be performed over the full length of weld. UT shall also be performed over the full length of welds between the pile head connection plate and the pile sleeve and the pile head connection plate and the pile. In addition, MT shall be used for 100% of all partial joint penetration (PJP) and fillet welds. The acceptance criteria shall conform to the requirements of AWS D1.5 for connections subject to tensile stress. UT and MT shall be performed, after the weld has cooled to ambient temperature, in accordance with a written procedure that shall be approved by the Engineer before use.

BEARINGS AND ANCHORAGES

Elastomeric bearing pads shall be bonded to steel with adhesive conforming to Federal Specification MMM-A-121, where shown on the plans.

MEASUREMENT AND PAYMENT

Payment for structural steel shall conform to the provisions in Section 55-4.02, "Payment," of the Standard Specifications and these special provisions.

Structural steel for use in bridge structures will be paid for at the contract price per kilogram for furnish structural steel and the contract price per kilogram for erect structural steel of the types listed in the Engineer’s Estimate, except as noted.

The contract price paid per kilogram for furnish structural steel of the types listed in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in furnishing, fabricating and delivering structural steel to the job site, ready for erection, including furnishing all bolts, nuts and washers, stud connectors, welding materials, asbestos sheet packing, preformed fabric pads and elastomeric bearing pads, or other materials required for the erection and connection or splicing of the structural steel; galvanizing the structural steel when galvanizing is required by the specifications or plans; and conforming to the qualification and testing requirements associated with member fabrication; as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The contract price paid per kilogram for erect structural steel of the types listed in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in erecting the structural steel, complete in place, including connecting and splicing the structural steel; installing stud connectors; placing asbestos sheet packing, preformed fabric pads and elastomeric bearing pads; furnishing and applying caulk; furnishing and placing mortar for masonry or bearing plates and anchor bolts; checking bolt tension; delivering restraint brackets to the location specified by the Engineer; and conforming to qualification and testing requirements associated with member erection, connection or splicing; as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

Furnishing and installing pile head connection plates will be measured and paid for as furnish structural steel (bridge footing) and erect structural steel (bridge footing), respectively.

Spare pipe beam fuses will be measured by the unit as furnish structural steel (pipe beam fuse).

The contract unit price paid for furnish structural steel (pipe beam fuse) shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in furnishing, fabricating and delivering spare structural steel pipe beam fuses to the location specified by the Engineer, including conforming to the qualification and testing requirements associated with member fabrication, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

Full compensation for mock-ups and welding qualification procedures and testing shall be considered as included in the contract prices paid per kilogram for furnish structural steel, of the types listed in the Engineer's Estimate, and no additional compensation will be allowed therefor.

Full compensation for cutting slots in steel shells for pile head connection plates shall be considered as included in the contract prices paid per kilogram for erect structural steel, of the types listed in the Engineer's Estimate, and no additional compensation will be allowed therefor.

Full compensation for repairing damaged paint surfaces shall be considered as included in the contract prices paid per kilogram for erect structural steel, of the types listed in the Engineer's Estimate, and no additional compensation will be allowed therefor.

The sixth paragraph of Section 55-4.02 "Payment," of the Standard Specifications shall not apply.

If a portion or all of the structural steel is fabricated more than 480 air line kilometers from both Sacramento and Los Angeles, additional shop inspection expenses will be sustained by the State. Whereas it is and will be impracticable and extremely difficult to ascertain and determine the actual increase in these expenses, it is agreed that payment to the Contractor for furnishing the structural steel from each fabrication site located more than 480 air line kilometers from both Sacramento and Los Angeles will be reduced $5000 or by an amount computed at $0.044 per kilogram of structural steel fabricated, whichever is greater, or in the case of each fabrication site located more than 4800 air line kilometers from both Sacramento and Los Angeles, payment will be reduced $8000 or by $0.079 per kilogram of structural steel fabricated, whichever is greater.

If a portion of or all check samples are removed at a mill more than 480 air line kilometers from both Sacramento and Los Angeles, shop inspection expenses will be sustained by the State which are in addition to expenses incurred for fabrication site inspection. Payment to the Contractor for furnishing structural steel will be reduced $2,000 for each mill located more than 480 air line kilometers from both Sacramento and Los Angeles.

ENGINEER'S ESTIMATE

04-012024

Item	Item Code	Item	Unit of Measure	Estimated Quantity	Unit Price	Item Total
1	021678	TRANSPORTATION FOR THE ENGINEER	LS	LUMP SUM	LUMP SUM	
2	021679	ENGINEER'S FIELD OFFICE	LS	LUMP SUM	LUMP SUM	
3	021680	ELECTRONIC MOBILE DAILY DIARY COMPUTER SYSTEM DATA DELIVERY	LS	LUMP SUM	LUMP SUM	
4	021681	TEMPORARY FENCE (TYPE ESA)	M	200		
5	021682	PHOTOGRAPHY OF BUILDING	LS	LUMP SUM	LUMP SUM	
6	070010	PROGRESS SCHEDULE (CRITICAL PATH)	LS	LUMP SUM	LUMP SUM	
7	070018	TIME-RELATED OVERHEAD	WDAY	900		
8	048536	FURNISH TEMPORARY TOWER (LOCATION AE)	LS	LUMP SUM	LUMP SUM	
9	048537	FURNISH AND REMOVE TEMPORARY TOWER (LOCATION BE)	LS	LUMP SUM	LUMP SUM	
10	048538	FURNISH TEMPORARY TOWER (LOCATION CE)	LS	LUMP SUM	LUMP SUM	
11	048539	FURNISH TEMPORARY TOWER (LOCATION AW)	LS	LUMP SUM	LUMP SUM	
12	048540	FURNISH AND REMOVE TEMPORARY TOWER (LOCATION BW)	LS	LUMP SUM	LUMP SUM	
13	048541	FURNISH TEMPORARY TOWER (LOCATION CW)	LS	LUMP SUM	LUMP SUM	
14	120090	CONSTRUCTION AREA SIGNS	LS	LUMP SUM	LUMP SUM	
15	074019	PREPARE STORM WATER POLLUTION PREVENTION PLAN	LS	LUMP SUM	LUMP SUM	
16	074020	WATER POLLUTION CONTROL	LS	LUMP SUM	LUMP SUM	
17	021683	TEMPORARY CONCRETE WASHOUT FACILITY	LS	LUMP SUM	LUMP SUM	
18	021684	TURBIDITY CONTROL	LS	LUMP SUM	LUMP SUM	
19 (S)	153225	PREPARE CONCRETE BRIDGE DECK SURFACE	M2	97 600		
20	048542	JACK SUPERSTRUCTURE (FRAME E1)	LS	LUMP SUM	LUMP SUM	

REVISED PER ADDENDUM NO. 4 DATED OCTOBER16, 2001