Steel Bridge Erection Guide Specification

S10.1–2023

American Association of State Highway and Transportation Officials
AASHTO

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AASHTO/NSBA STEEL BRIDGE COLLABORATION

American Association of State Highway and Transportation Officials

National Steel Bridge Alliance

Preface

This document is a guideline developed by the AASHTO/NSBA Steel Bridge Collaboration. The primary goal of the Collaboration is to achieve steel bridge design and construction of the highest quality and value through standardization of the design, fabrication, construction, inspection, and long-term maintenance. Each standard represents the consensus of a diverse group of professionals.

It is intended that Owners adopt and implement Collaboration documents in their entirety to facilitate the achievement of standardization. It is understood, however, that local statutes or preferences may prevent full adoption of the document. In such cases Owners should adopt these documents with the exceptions they feel are necessary.

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SECTION 1: GENERAL

1.1—DEFINITIONS

1.1.1—Steel Bridge Erection

Steel bridge erection is the process of transporting, handling, and assembling steel bridge components to result in a bridge structure that meets all the geometric and structural requirements of the Contract Documents.

C1.1.1

Steel erection is complete when all field connections are completed to the final design condition and falsework or temporary bracing is or can be removed. Erection should proceed in a safe, methodical fashion ensuring all performance criteria are satisfied.

1.1.2—Erector

In this document, "Erector" refers to the entity that is responsible for the erection of the structural steel.

1.1.3—Contractor

The Contractor is responsible for proper completion of all tasks required by the Contract. Subcontractors, including Fabricators, Erectors, and field painters, may be used by the Contractor, but the Contractor retains responsibility for all material, operations, and the final product. The Contractor may permit direct subcontractor interaction with the Owner to expedite the project, but subcontractors shall inform the Contractor of any proposed modifications to contract requirements accepted by the Owner.

1.1.4—Design Engineer

In this document, "Design Engineer" refers to the licensed professional who is responsible for sealing the Contract Plans. Sealing indicates that a licensed professional has performed or supervised the analysis, design, and document preparation for the structure and has knowledge of the load-carrying structural system.

1.1.5—Erection Engineer

In this document, "Erection Engineer" refers to the licensed professional who is responsible for developing, evaluating, and specifying the Contractor's specific procedures and plans for erecting the structural steel of the bridge.

1.1.6—Fabricator

In this document, “Fabricator” refers to the facility(-ies) performing such shop activities as cutting, welding, drilling, punching, cleaning, and painting of structural steel. “Fabricator” also includes any agents of the Fabricator, such as subcontracted Fabricators. In some cases, the Fabricator is subcontracted by the Contractor.

1.1.7—Inspection

The examination by the Owner, Contractor, Erector, or Fabricator of processes and products to verify conformance with the Contract requirements.

1.1.8—Owner

In this document, “Owner” refers to the entity paying the Contractor to fulfill the terms of the Contract. The Owner also encompasses the following: those preparing the Contract Documents, including those responsible for the structure’s adequate design; and those authorized to represent the Owner during construction, commonly called the “Engineer” and the “Inspector.” The Engineer and Inspector may be employees either of the Owner or of professional firms contracted for the work.

1.1.9—Plans

In this document, if not otherwise noted or modified by adjectives, the term “Plans” refers to the engineering drawings prepared by the Design Engineer. The terms “Design Plans” and “Contract Plans” are identical in meaning to the generic term “Plans.”

C1.1.9

The term “Plans” can refer to many documents, but typically refers to the engineering drawings prepared by the Design Engineer unless modified by at least one descriptive adjective to denote different meaning (e.g., “Erection Plans” refers to the engineering drawings prepared by the Erection Engineer). When not otherwise clear, the term “Plans” should be interpreted (in this document) as referring to the plans prepared by the Design Engineer, which can also be denoted as the “Design Plans” or the “Contract Plans.”

1.1.10—Erection Plans

In this document, the term “Erection Plans” refers specifically to the engineering drawings prepared by the Erection Engineer describing and specifying the erection (i.e., the field-installation and member-placement) of the structural steel. In this document, the term “Erection Plans” may also refer in a more general context to the combination of engineering drawings and Erection Procedures describing and specifying the erection (i.e., the field-installation and member-placement) of the structural steel.

C1.1.10

The intent of these definitions is not to create requirements for separating information shown on the Erection Plans from information presented in the Erection Procedures; the two documents are intended to be complementary. The required information can be shown in either the Erection Plans or the Erection Procedures as is appropriate for clear presentation, efficiency, and simplicity; the key is that all required information is presented in either one or the other.

1.1.11—Erection Procedures

In this document, the term "Erection Procedures" refers to the documents which describe the specific sequence, methods, equipment, and other directives which the Contractor is to follow in erecting the structural steel. The terms "Erection Plans" and "Erection Procedures" are not synonymous, but the Erection Plans and Erection Procedures shall be fully integrated with each other and shall together describe and specify all aspects of how the structural steel is to be erected, including, but not limited to, sequence of erection, methods or techniques to be used, equipment to be used, materials to be used, along with any temporary works or other devices necessary. Items identified as required by these specifications and not addressed in the Erection Plans shall be addressed in the Erection Procedures.

C1.1.11

The Erection Procedures should be presented in some written format (i.e., verbal directives are not sufficient to constitute Erection Procedures). The Erection Procedures can include reference to standard operating procedures of the Contractor (to avoid unnecessary repetition or excessive documentation), but in such a case, the standard operating procedures should be written, and should be available for review by the Owner.

1.1.12—Erection Engineering Calculations

In this document, the term "Erection Engineering Calculations" refers to any engineering calculations associated with the substantiation of the Erection Plans and Erection Procedures.

1.1.13—Contract Documents

In this document, the term "Contract Documents" refers to the documents that define the responsibilities of the parties that are involved in bidding, fabricating, and erecting structural steel (and other elements of the project). These documents normally include the design drawings, the specifications, and the contract.

1.2—ERECTOR QUALIFICATIONS

Structural steel shall be erected by a qualified, competent Erector. The Owner shall specify qualifications for the steel Erector based on the complexity of the project.

C1.2

A "qualified, competent Erector" has knowledge, training, and experience, and has demonstrated the technical proficiency and ability to complete the work specified. The Erector should be able to resolve common problems associated with the complexity of work proposed. American Institute of Steel Construction (AISC) credentials such as Certified Erector, or other similar industry-based qualifications, should be considered based on the requirements for such certifications and the complexity of the bridge. Certification alone may not be sufficient evidence of qualification for complex or monumental bridge structure types, such as suspension, cable-stayed, tied arch, cantilever truss, or movable bridges.

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SECTION 2: ERECTION ENGINEERING

2.1—GENERAL

2.1.1—Required Erection Plans and Procedures and Erection Engineering Calculations

The Contractor shall submit Erection Plans and Erection Procedures to the Owner for each bridge structural unit identified on the Contract Plans and specifications. In the Contract Documents language, "an erection plan is required" or similar invokes a requirement for submittal of Erection Plans and Procedures and the associated Erection Engineering Calculations as described in this Guide Specification.

The Contractor shall submit Erection Engineering Calculations to the Owner for each bridge structural unit identified on the Contract Plans and specifications. In the Contract Documents language, "Erection engineering calculations are required" or similar invokes a requirement for submittal of Erection Plans and Procedures and the associated Erection Engineering Calculations as described in this Guide Specification.

Unless otherwise specified in the Contract Documents, if the submittal of Erection Plans and Procedures (with or without Erection Engineering Calculations) is required, the Owner shall be allowed a minimum of 15 working days to review the submittal, after which the Contractor may assume the submittal has been approved by the Owner, unless the Owner provides written notification that the submittal was not approved.

C2.1.1

Formal submittal and review of Erection Plans and Procedures and Erection Engineering Calculations may not be warranted for all bridges. Owners may choose to forgo requiring formal submittal and review of Erection Plans and Procedures and Erection Engineering Calculations where the additional cost and time is not justified. For simpler structures where the risk associated with problems is minimal, the Owner may choose to rely upon the Contractor's expertise to erect the bridge without requiring a formal submittal. For example, for a shorter, rural, simple-span creek crossing bridge, formal submittal and review of Erection Plans and Procedures and associated Erection Engineering Calculations may not be warranted.

Note that, as explained in Articles 1.1.9, 1.1.10, and 1.1.11, the term "Erection Plan" encompasses both engineering drawings (defined specifically as Erection Plans) and any associated Erection Procedures documents.

2.1.2—Erection Plans and Procedures Overview

The Erection Plans and Procedures shall be prepared by a licensed professional engineer licensed in the state(s) or jurisdiction(s) in which the subject bridge is being built. The Erection Plans and Procedures submittal shall address all requirements for erection of the structural steel into the final designed configuration. Any and all written review comments provided by the Owner shall be addressed to the Owner's satisfaction prior to the start of erection. As a minimum, the Erection Plans and Procedures shall include consideration of all items described in Article 2.2.

C2.1.2

The qualifications of the Erection Engineer preparing the Erection Plans and Procedures and the Erection Engineering Calculations should be evidenced by knowledge, training, and experience in steel erection, and having demonstrated the ability to resolve problems related to steel bridge erection. Many states also require that erection procedures and temporary falsework design be prepared by a professional engineer licensed or registered in that state. Some states may specifically require licensure or registration as a Structural Engineer (SE); in such cases, the specification language should be revised as appropriate.

The submission date(s) and review period(s) should be established and agreed to by the Owner and the Contractor as soon as possible after the Contract award, and should be established such that sufficient time is allotted for development of the erection submittal by the Erection Engineer and for review by the Owner. Erectors are encouraged to attend prebid and preconstruction meetings to help understand the complexities associated with the steel erection well in advance. Projects that involve complex erection or multi-agency reviews can be expected to require additional time for review of the submitted Erection Plans and Procedures. In these cases, the established submission dates and review periods should reflect the need for appropriate reviews by all involved parties. In some cases, particularly for bridges with complex erection schemes, it may be appropriate to establish one or more interim submittals including an early submittal of preliminary Erection Plans and Procedures that illustrate the proposed erection sequence and reflect any fabrication changes required to accommodate the proposed erection sequence.

2.1.3—Erection Engineering Calculations Submittal

Erection Engineering Calculations to substantiate the structural adequacy and stability of the erected structure and any associated temporary works, temporary components, or both, do not need to be included in the Erection Plans and Procedures submittal, unless otherwise specifically required on the Contract Plans or in special provisions. However, the Owner reserves the right to request the submittal of Erection Engineering Calculations for review and approval at any time. If requested, such calculations shall be submitted within 14 calendar days of request by the Owner.

In the absence of Erection Engineering Calculation submittal requirements, the Contractor may provide calculations in any format of their own choosing, including without limitation electronic analysis files, spreadsheets, copies of hand calculations, etc. The Contractor shall provide reading software for any electronic analysis files prepared using analysis software not otherwise already owned and used by the Owner or freely available to the Owner.

C2.1.3

Complex or signature structures should have specific requirements noted in the Contract Documents. Complex erection projects may require input from the Design Engineer in addition to the original design calculations such that the Contractor can confirm constructability of the structure during various erection stages. The Owner should ensure that the Design Engineer is available to consult with the Contractor in these cases. Further, it is beneficial for the Owner to discuss with the Contractor particular issues or concerns with the Erection Plans and Procedures to secure an explanation.

When calculations are required, it is beneficial for the Owner to specify their preferred format for submittal. Printed (or PDF) reports of output are common; if the Owner would like actual data files, this should be explicit in the Contract Documents.

A checklist listing all items discussed below is provided in Appendix A as an aid for engineers preparing or reviewing erection submittals.

2.2—ERECTION PLANS AND PROCEDURES

2.2.1—Plan of Work Area

The Erection Plans shall include:

a) a plan of the work area showing the proposed bridge,
b) the permanent support structures (piers and abutments),
c) roads,
d) railroad tracks,
e) waterways (including location and dimensions of any navigational channel(s) and any navigational clearances to be respected during construction),
f) overhead and underground utilities,
g) structures and conditions that may limit access (consideration of clearance requirements over roadways or railroads),
h) staging or material storage areas,
i) right-of-way and property lines,
j) information, plans, etc. regarding maintenance of traffic requirements, lane or road closures, restrictions, durations, etc. necessary to protect public safety for all erection operations over or adjacent to live traffic, and
k) any other information that may be pertinent to the steel erection.

Unless otherwise clearly allowed by the Owner's standard specifications or unless otherwise clearly allowed in the Contract Documents, erection of structural steel over live traffic shall not be permitted.

C2.2.1

The plan of work area drawing should provide a general overview of the area where the bridge is to be erected, preferably drawn to scale. It allows all involved to see site conditions, access routes and staging areas, utilities, roadways, existing structures, and other possible site constraints, and better understand why certain procedures or details are being specified.

Example Erection Plans can be found in Appendix D.

2.2.2—Erection Sequence

The Erection Plans and Procedures shall indicate the erection sequence for all primary members (including indication of any attached secondary members), noting the use of temporary support conditions, such as (but not limited to) holding crane positions, temporary supports, and falsework. The erection sequence shall be shown in an illustrative plan view of the bridge for each erection stage, highlighting the structural components to be erected, their weights and center of gravity locations, lifting crane locations for primary member picks, and any temporary support conditions that are necessary during that particular stage. The illustrative plan view shall be accompanied with a written narrative of the procedure to be followed by the steel

C2.2.2

The erection sequence should indicate specific structural components to be erected at a given stage, such as (but not limited to) the girders, cross-frames, and lateral bracing. The erection sequence should also indicate lifting crane positions, as well as any temporary support conditions necessarily to facilitate a certain erection stage, such as (but not limited to) temporary supports, holding crane positions, tie-down stability provisions, and blocking of the bearings. The erection sequence drawings should provide instructions for construction of the bridge and should be written, and followed, as mandatory directives.

Erector, which shall state items such as structural components to be erected, use of temporary supports, use of temporary bracing, hold cranes, etc. Member reference marks, when reflected on the Erection Plans and Procedures, should be the same as used on shop detail drawings.

2.2.3—Delivery Location

The Erection Plans and Procedures shall indicate the delivery location and orientation of all primary members.

C2.2.3

The maximum crane lift radius is often controlled by the material delivery location, hence the need to indicate the delivery location on the Erection Plans and Procedures. Correct girder segment orientation at the delivery location is important since the ability to rotate long segments under the crane boom may be restricted.

2.2.4—Crane Information

The Erection Plans and Procedures shall show the location of each crane to be used for each primary member pick (see Article 2.2.2), the crane type, crane pick radius, the crane support methods (crane mats, barges, work trestles, etc.), and the means of attachment to the girders being lifted or supported.

The erection submittal shall include capacity charts or tables that address, and demonstrate the adequacy of, each crane configuration, boom length, counterweight configuration, outrigger configuration, and pick weight required to do the proposed work. The Erection Plans and Procedures shall also indicate any potential above- or below-ground obstructions or restrictions to crane operations (existing structures, utilities, etc.). When cranes are required to be placed on or near new or existing structures (bridges, abutments, retaining walls, culverts, etc.), the structure shall be evaluated to ensure it has adequate capacity to withstand crane loading.

In the event that the submitted cranes are not available at the time of construction, the Contractor can propose alternate cranes, subject to review and approval by the Owner. The submittal package for alternate cranes shall include capacity charts or tables that address, and demonstrate the adequacy of, each crane configuration, boom length, counterweight configuration, outrigger configuration, and pick weight required to do the proposed work, but resubmittal of the full Erection Plans and Procedures and the Erection Engineering Calculations package is not required.

C2.2.4

The erection submittal should include adequate documentation of any items needed to support cranes. For example, if a work trestle is used to support a crane, the erection submittal should include plans for the work trestle. Likewise, if the steel erection takes place on a navigable waterway, the configuration of the barges, loading sequence, and stability provisions (tie-downs, supports, etc.) should be provided in the Erection Plans and Procedures.

Communication between the Contractor and the Erection Engineer is vital to ensure the cranes assumed by the Erection Engineer are available to the Contractor. Providing the crane types, pick radii, pick weight, boom lengths, possible obstructions, etc. in the erection submittal will help to prevent crane failures, overloads, and interferences during the steel erection process in the field. Owners should recognize that it is not uncommon for Contractors to need to substitute alternate cranes at the time of construction, due to lack of availability of the originally proposed cranes, mechanical problems, etc. The Owner and the Contractor should agree to procedures and review times for alternate crane submittals as part of their establishment of dates and review periods for erection submittals. Typically, crane submittals are relatively simple to review, so it is generally appropriate to establish relatively short review periods to allow the Contractor reasonable flexibility in managing their equipment needs.

Any plans associated with crane supports (crane mats, barges, work trestles, etc.) shall also be included. When applicable, Manufacturers' certification documents or catalog cuts for pre-engineered devices or equipment may be used to meet this requirement; these items shall be included with the Erection Plans and Procedures and shall be subject to review and approval by the Owner. Calculations for crane supports (crane mats, barges, work trestles, etc.) do not need to be included in the Erection Plans and Procedures and calculations submittal, unless otherwise specifically required on the plans or in special provisions, but the Owner reserves the right to request their submittal for review and approval at any time. If requested, such calculations shall be submitted within 14 calendar days of request by the Owner.

2.2.5—Primary Member Crane Pick Information

The Erection Plans and Procedures shall include the lifting weight of the primary member picks, including all rigging and pre-attached elements (such as cross-frames or splice plates). The Erection Plans and Procedures shall also include the approximate center of gravity locations for the primary member picks of non-symmetric girders and assemblies.

C2.2.5

The lifting weights and the approximate centers of gravity for each pick will provide the steel Erector with necessary information to safely lift various components. The centers of gravity provided on the plans should be taken as approximate locations, as these are typically calculated assuming nominal material sizes and approximations of minor items such as bolted connections, etc. The actual center of gravity locations should reasonably match these approximate locations and will aid the steel Erector in determining the proper lifting location in the field.

2.2.6—Lifting Devices and Special Procedures

The Erection Plans and Procedures shall include the details, weight, capacity, and arrangement of all rigging (beam clamps, lifting lugs, etc.) and all lifting devices (such as spreader and lifting beams) required for lifting primary members. The Erection Plans and Procedures shall also specify details for rigging or lifting devices bolted or welded to permanent members, including the method and time (shop or field) of attachment and capacity, as well as methods, time, and responsibility for removal.

C2.2.6

Assumptions regarding the weight of rigging, spreader beams, etc., should be included in the Erection Plans and Procedures. Explicitly indicating all details related to rigging and spreader or lifting beams will help to ensure that the appropriate devices are being properly used in the field. Special considerations may be required for lifting attachments, including additional bolt holes or welding to the top girder flange. Some proprietary beam clamps apply clamping forces to secure the clamp to the girder. Effects of clamping forces on the girder flange should be considered to ensure there will be no damage or effect on the in-service performance of the girders.

As necessary, the Erection Plans and Procedures shall provide special lifting/handling procedures for any primary member with potential stability or slenderness issues.

Slender beams, traditionally defined as those having a length-to-flange-width ratio (L/b) greater than 85, are prone to lateral–torsional buckling and require particular attention during lifting/handling operations. The flange width, b, should be taken as the smallest width flange within the field section being lifted. The definition of a slender beam as having an L/b ratio greater than 85 should only be used as an approximate guide; research has suggested other means of identifying the potential for instability during lifting and handling. In addition, other types of structural members may also have issues of slenderness, stability, or both, which should be addressed in the Erection Plans and Procedures as appropriate.

2.2.7—Bolting Requirements

The Erection Plans and Procedures shall indicate the bolting requirements for field splices and cross-frame (or diaphragm) connections for each stage.

Refer to Article 6.7 for minimum bolting requirements during erection.

C2.2.7

Steel I-girders depend on their connections to adjacent girders through bracing members for their stability and stiffness during steel erection. This is especially true for curved steel girders, as the cross-frames serve as primary load-carrying members. Therefore, loosely connected cross-frames should not be used during steel girder bridge erection, as this may compromise the girder alignment (geometry control) and stability. The bolting requirements for girder field splices during steel erection need to be considered as well. In accordance with the *AASHTO LRFD Bridge Construction Specifications*, Article 11.6.5, splices and field connections shall have one-half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before installing and tightening the balance of the high-strength bolts. In addition, the Erection Engineer developing the Erection Plans and Procedures shall ensure that the number of bolts or erection pins provides enough capacity for transfer of loads for the given stage of steel erection. The final tensioning sequence for field splices and cross-frames should be considered by the Erection Engineer when evaluating bolting requirements.

2.2.8—Bearing Blocking and Tie-Down Details

The Erection Plans and Procedures shall indicate blocking details, tie-down details, or both for the bridge bearings, and associated force demands, as necessary.

C2.2.8

Depending on their details, bridge bearings may allow movement (translation) in any direction and rotation about any axis. During steel erection, in addition to other stability provisions, the bearings may require blocking to prevent or limit the translational movements and rotations. In addition, bearings may need temporary tie-downs to prevent uplift at various stages during construction. The Erection Engineer should determine the blocking and tie-down requirements such that the structure remains stable during all stages of erection and such that the behavior of the physical structure shall be consistent with the behavior determined in the analysis and assumed in the Erection Plans and Procedures.

2.2.9—Load Restrictions

Restrictions regarding wind loading and construction dead and live loadings, and any other applicable loading restrictions, shall be included on the Erection Plans and Procedures, as necessary.

C2.2.9

Limits may be placed on wind velocities during lifting of girder field pieces or during various stages of erection when the structure is only partially complete. The limitations on wind velocities are intended to prevent girder overstress and instabilities that could be caused by certain wind speeds and associated wind pressure loading. Calculations may show that a girder or girder system may not be stable at a certain wind velocity, and this needs to be communicated to the Contractor and Erector via the Erection Plans and Procedures. If appropriate, the Erection Plans and Procedures should include instructions and details for temporary support or tie-down of partially completed structures during high wind conditions. The Erection Plans and Procedures should also explicitly state restrictions on construction live loads (vehicles, equipment, personnel, etc.) and construction dead loads (formwork/falsework, stored materials, etc.). Inadvertent overloading by construction loads could lead to structural collapse and could also affect geometry control.

For additional recommendations and guidance on the application of wind loads during construction, see AASHTO's *Guide Specifications for Wind Loads on Bridges During Construction*.

2.2.10—Temporary Supports

The Erection Plans and Procedures shall include the location of any temporary support structures (see Article 2.2.2) and bracing, as well as details of the temporary support structure itself. If the temporary support is to be prefabricated (selected from a supplier's catalog), the type and capacity shall be defined in the Erection Plans and Procedures; lateral capacity as well as vertical capacity requirements shall be considered, as appropriate. If the temporary support is to be constructed by the Contractor on site, a complete design with full details, including member sizes, material properties, connections, and bracing elements, shall be provided in the Erection Plans and Procedures. In either case, details regarding the upper grillage and temporary bearing assembly,

C2.2.10

In many cases, temporary supports are integral to maintaining profile and alignment in the construction of a steel bridge. As such, they should be included in the Erection Plans and Procedures, whether the support is a falsework tower, hold crane, tie-down, bearing blocking, or other support.

Refer to Article C9.3 for discussion of "as-fabricated" camber and how it may influence girder erection elevations.

(e.g., details of how the steel girders will bear on the temporary support), including the top of falsework (bottom of structural steel) elevations, shall also be included in the Erection Plans and Procedures. In addition, all foundation requirements for temporary support structures shall be provided in the Erection Plans and Procedures.

The Erection Plans and Procedures shall indicate the location of hold cranes used to provide temporary support to the steel assembly (see Article 2.2.2) and the associated crane loads. The hold crane type, capacity, boom lengths, pick radius, and means of attachment to the girders shall also be indicated in the Erection Plans and Procedures.

The Erection Plans and Procedures shall include the location and details for temporary tie-downs that are required to facilitate the steel erection, as well as the associated tie-down loads. At a minimum, the details shall include the tie-down, girder attachment devices, and anchoring devices.

The Erection Plans and Procedures shall clearly indicate when, and under what conditions, any temporary supports or holding cranes may be released in the erection sequence, and if they may be left in place while subsequent erection proceeds.

The Erection Plans and Procedures shall clearly indicate appropriate restraint of girders from twisting or layover at supports. Girders should be restrained from twist or layover at supports unless the need for such restraint is demonstrated to be unnecessary by appropriate analysis in the Erection Engineering Calculations.

2.2.11—Jacking Devices

The Erection Plans and Procedures shall indicate jacking devices that will be required to complete the steel erection. Their location, type, size, and capacity shall be indicated on the Erection Plans and Procedures, as well as their intended use, sequence of engagement, load level, jack pressure table, and any other key parameters of their operation.

C2.2.11

In some cases, jacking devices may be required at temporary support structures, or at the permanent supports, to align the structure during the erection process. If the Erection Plans and Procedures do indeed require jacking devices, they should be indicated in the Erection Plans and Procedures to alert the Contractor to their need, and their intended use should be explicitly presented.

2.3—GUIDELINES FOR METHODS OF STRUCTURAL ANALYSIS

The Owner may specify in the Contract Documents the minimum requirements regarding the methods of structural analysis used in any structural engineering calculations supporting the erection procedures submittal. Note that the Owner's specification of minimum requirements for methods of analysis does not in any way relieve

C2.3

The Owner should specify their minimum expectations regarding the methods of structural analysis in order to identify prior to bidding what is required. This helps establish a uniform basis for bidding by communicating these requirements to the Contractor in advance. The required methods of analysis should reflect the complexity the Contractor or the Erection Engineer of their obligations to perform correct and appropriate structural analyses.

If the Owner does not specify the minimum requirements regarding the methods of structural analysis to be used, the Contractor may elect to use any appropriate methods of analysis, provided that the methods can be demonstrated to be appropriate for the given analysis task(s), and that the methods meet or exceed the recognized or implied standard of care for similar analysis tasks.

of the structure and the complexity of the erection sequence (at least of the erection sequence presented in the Contract Documents). Since each project is different, requirements regarding the methods of structural analysis will vary from project to project. Some Owners may choose to establish standing rules or categories in this regard and publish those in their standard specifications. In lieu of this, the minimum requirements should be specified in the Contract Documents.

Recommendations for the selection of the appropriate method of structural analysis can be found in NCHRP Report 725, *Guidelines for Analysis Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges* (NCHRP Project 12-79). NCHRP Report 725 provides recommendations on the appropriate methods of analysis to employ when investigating the adequacy of the erection sequence of curved or skewed steel girder bridges. The methods of analysis considered include 1D (approximate), 2D, and 3D methods. Tables are provided to aid in selection of the appropriate analysis method. For bridges with straight girders and non-skewed supports, 1D (approximate) analysis methods are generally adequate. A summary of these recommendations, including some more recent updated recommendations, can be found in Appendix B of AASHTO/NSBA Steel Bridge Collaboration document G13.1, *Guidelines for Steel Girder Bridge Analysis*.

The FHWA's *Engineering for Structural Stability in Bridge Construction*, publication number FHWA-NHI-15-044, provides guidance for erection engineering analysis of steel girder bridges and preparation of erection submittals. It also serves as the reference manual for the identically named National Highway Institute training course, NHI 130102.

Note that a checklist, listing all items discussed below, is provided in Appendix B as an aid for preparing or reviewing erection submittals.

2.4—REQUIREMENTS FOR ERECTION ENGINEERING CALCULATIONS FOR STRUCTURAL ADEQUACY AND STABILITY

Appropriate Erection Engineering Calculations to substantiate the structural adequacy and stability of the bridge system for each step of the steel erection shall be performed to substantiate the erection procedures. Requirements addressing the submittal of calculations are presented in

C2.4

This Section provides guidance on a variety of topics associated with calculations for structural adequacy and stability. As a general default, the AASHTO specifications referenced in this commentary are cited for criteria, but some opportunity is provided for the Erection Engineer

Article 2.1. This Section only addresses the content of calculations.

The Erection Engineering Calculations shall be performed in accordance with erection design criteria established or approved by the Owner, or as stated in the Contract Documents.

to exercise reasonable discretion, subject to the approval of the Owner in advance.

For each project, the Owner (or the Owner's Design Engineer) should evaluate the complexity of the bridge and of the proposed erection sequence prior to bidding. If there are any particular areas of concern, the Owner (or the Owner's Design Engineer) should specify their expectations explicitly in the Contract Documents. This may include specification of design criteria, analysis methods, or identification of specific items to be addressed in the Erection Plans and Procedures, procedures, and calculations submittal, including identification of how these items are expected to be addressed.

The specifications in this Section provide only the minimum requirements regarding calculations for structural adequacy and stability. This Section does not provide a comprehensive "checklist" of items needing evaluation for erection of any steel bridge; each project is unique and may have particular issues requiring the attention of the Erection Engineer. Only basic requirements and suggested evaluation items (in commentary) are presented herein.

2.4.1—Design Criteria

The Erection Engineering Calculations shall be prepared in accordance with the *AASHTO LRFD Bridge Design Specifications*, the *AASHTO LRFD Bridge Construction Specifications*, and the AASHTO *Guide Design Specifications for Bridge Temporary Works*, unless otherwise directed by the Owner or the Contract Documents. The Contractor can propose supplemental criteria for specific items necessary for erection engineering. Supplemental criteria shall be limited to specifications published by AISC, American Society of Civil Engineers (ASCE), American Concrete Institute (ACI), or other recognized, national specification-writing organizations. Proposals for supplemental design criteria shall be submitted by the Contractor for review and approval by the Owner prior to the Contractor or the Erection Engineer beginning work on the Erection Plans and Procedures, procedures, and calculations. Unless otherwise specified in the Contract Documents, the Owner shall be allowed a minimum of 10 working days to review the submittal, after which the Contractor may assume the submittal has been approved by the Owner, unless the Owner provides written notification that the submittal was not approved.

C2.4.1

Traditionally, the Erection Engineer has been allowed reasonable discretion in identifying appropriate design criteria for Erection Engineering Calculations for the design of temporary works, etc. In some cases, the provisions published in AASHTO documents do not address the unique situations associated with erection engineering and temporary works. In other cases, Erection Engineers have established efficient and effective methods based on criteria other than AASHTO specifications. Commonly cited supplemental design specifications include AISC specifications for steel design and ASCE specifications for wind loads, among others. Applicable design criteria are provided in Appendix D of FHWA-NHI-15-044, *Engineering for Structural Stability in Bridge Construction*.

2.4.2—Loads and Load Combinations

The Erection Engineering Calculations shall consider all applicable loads, including permanent dead load, construction dead load, construction live load, and wind loads, and any other loads which may be applicable.

Wind loads shall be considered in each step of the steel erection analysis and are to be computed in accordance with the agreed erection design criteria. Provisions shall be made by the Erection Engineer to ensure that girders are stable in wind events. It is permissible to set limits on maximum wind velocities during steel erection; these limits shall be stated in the Erection Plans and Procedures. If applicable, include provisions in the Erection Plans and Procedures for temporary supports, tie-downs, or both to address high wind conditions.

Load combinations shall be in accordance with the *AASHTO LRFD Bridge Design Specification*s, unless otherwise noted in the Contract Documents, or unless otherwise approved by the Owner. If the Contractor proposes supplemental design criteria (in accordance with the provisions of Article 2.4.1), the Contractor may also propose supplemental load combinations for specific items provided the supplemental load combinations are consistent with the proposed design criteria. Proposals for supplemental load combinations shall be submitted by the Contractor for review and approval by the Owner prior to the Contractor or the Erection Engineer beginning work on the Erection Plans and Procedures and the Erection Engineering Calculations. Unless otherwise specified in the Contract Documents, the Owner shall be allowed a minimum of 10 working days to review the submittal, after which the Contractor may assume the submittal has been approved by the Owner, unless the Owner provides written notification that the submittal was not approved.

C2.4.2

Permanent dead loads typically include the self-weight of the structural members and detail attachments. Construction dead and live loads may consist of deck placement machinery, Contractor's equipment, deck overhang brackets, concrete formwork, or other similar attachments applied in the appropriate sequence.

2.4.3—Girder and System Stability

The Erection Engineering Calculations supporting the erection procedures shall verify the stability both of individual girders and also of the entire erected steel framing for each step of the bridge erection. These calculations are dependent upon the particular features of the bridge being erected and also of the particular sequence of erection of each part of the bridge. The assumptions used in the analysis should directly

C2.4.3

The constructability provisions of Article 6.10.3 of the *AASHTO LRFD Bridge Design Specifications* should be referenced by the Erection Engineer when investigating structural adequacy and stability during steel erection. A partial list of suggested evaluation items and guidelines regarding appropriate investigations follows:

and fully conform to all steps and all details in the Erection Plans and Procedures.

Single-Girder Stability

Particular attention should be given to the lateral–torsional buckling capacity of a singly erected I-girder. One of the most critical stages during I-girder erection is when the first girder has been erected, but not yet connected to adjacent girders in the cross section. Assuming the girder is adequately braced at the supports, and there is no additional bracing within the span, the unbraced length for the girder will be the distance between supports. Long unbraced lengths typically correspond to very low lateral–torsional buckling capacity of the girder. Tub-girders typically have much higher lateral–torsional buckling capacity, but only if provided with a properly-designed top flange lateral bracing system that provides for quasi-closed section behavior of the girder.

Global overturning stability is also a concern for single curved girders, whether I- or tub-girders. The offset of the center of gravity of the girder from a chord line drawn between the support points results in an overturning moment. Single girders typically have no torsional restraint at their supports unless tie-downs or bracing, or temporary shoring or hold cranes, are provided.

Multi-Girder (Global) Stability

A girder system may be vulnerable to global buckling during the steel erection sequence, during deck placement, or both. Narrow, long-span segments during steel erection are the most susceptible to this global buckling phenomenon. Methods to investigate the global stability of girder systems are available in FHWA *Engineering for Structural Stability in Bridge Construction*, publication number FHWA-NHI-15-044.

Second-Order Amplification Estimates

Second-order amplification of the girder lateral–torsional stresses may cause a loading condition that is greater than the theoretical elastic buckling load. In this situation, the lateral–torsional displacement of the girder results in non-linear torsional loading. In addition, the displacement amplifications may complicate the prediction and control the structure's geometry during erection. AASHTO/NSBA Steel Bridge Collaboration document G13.1, *Guidelines for Steel Girder Bridge Analysis*, provides further discussion of second-order amplification considerations.

In addition, a relatively simple method for identifying potentially adverse response amplifications due to second-order effects was developed as part of NCHRP Project 12-79 (NCHRP Report 725). In this method, the linear response prediction obtained from any first-order analysis is multiplied by a simple amplification factor.

Cantilever Girders

During the various stages of erection of most steel girder bridges, there are often cases where field sections of girders are supported in a cantilevered position. Typically, these intermediate cantilever conditions were not addressed by the Design Engineer during the original bridge design, so it is incumbent on the Erection Engineer to investigate these conditions. For long cantilevers, lateral–torsional buckling will typically govern over yielding of the section. To examine cantilevers, the lateral–torsional buckling capacity can be estimated using the procedures provided in Ziemien (2010) or a similar appropriate method. For curved girders, additional consideration needs to be given to the torsional forces that develop due to the offset centroid of the cantilever.

2.4.4—Uplift

The potential for uplift at temporary and permanent supports during steel erection shall be considered and accounted for in the development of the Erection Engineering Calculations.

C2.4.4

Typically, uplift is undesirable and should be prevented, either by changing the Erection Plans and Procedures or by providing tie-down restraints. If uplift is indicated in the analysis, but no tie-down restraint is provided, then the analysis should recognize the absence of vertical restraint at that particular support by modeling the boundary condition appropriately. Curved or skewed I-girder bridge systems are particularly susceptible to uplift during various stages of steel erection due to the torsional twisting of the system caused by curvature or skew. Incorrect consideration of uplift invalidates the analysis. If not considered correctly, uplift can result in girder misalignment, unintended lateral/longitudinal movement, or potential instability.

2.4.5—Temporary Hold Cranes

Hold crane loads (if used) shall be properly accounted for in the Erection Engineering Calculations.

C2.4.5

Hold cranes are used to apply an upward load at some location within the span of a girder, thereby reducing the load carried by the girder. Often, the hold crane load is used to reduce the girder flexural moment due to self-weight (and any other applied loads) to a level at which the moment is less than the lateral–torsional bucking capacity. Typically, a hold crane should not be considered as a brace point in the evaluation of the lateral–torsional buckling capacity of a girder; in most cases, the crane cable and crane system are flexible and not capable of providing the lateral resistance necessary to be considered as a brace point.

2.4.6—Temporary Support Loads

Temporary support loads (if used) shall be properly accounted for in the Erection Engineering Calculations. Calculations shall include computations for all loads on any and all temporary supports provided at critical stages of the erection sequence.

Temporary bracing shall be verified to have adequate strength and stiffness to provide stability to girders and resist appropriate force effects from assumed lateral loads that may occur during erection.

C2.4.6

These loads may include vertical and lateral reactions from the superstructure, self-weight of the temporary support, wind loads on the temporary support, etc.

2.4.7—Bearings

The Erection Engineering Calculations shall consider bearing rotations during construction. Computed bearing rotations during construction shall not exceed the rotational capacity of the bearings.

C2.4.7

Skewed bridges are particularly vulnerable to twisting about the longitudinal axis of the girder. During steel erection, the girder could be rotated beyond the rotational capacity of the bearing, regardless of the vertical load on the bearing.

2.4.8—Cross-Frames and Bracing

The number, size, and location of installed cross-frames and/or other bracing members required to ensure adequate strength and stability before girders are released from lifting cranes, hold cranes, or both shall be addressed in the Erection Engineering Calculations, including evaluation of associated connection details and evaluation of the strength and stiffness of the provided cross-frames. The required number, size, and location of cross-frames and other bracing members shall be indicated in the Erection Plans and Procedures.

C2.4.8

The presence and correct installation of cross-frames in curved or skewed steel I-girder bridge erection is an important issue. The cross-frames and bracing members and their associated connections shall be structurally adequate, and they shall also provide sufficient stiffness to the bridge system.

During steel erection, the Erector may choose to install the minimum required number of cross-frames when initially erecting the girders, so as to decrease erection time, allowing a follow-up crew to install the remaining cross-frames later. Therefore, correct determination of the minimum number of required cross-frames to prevent lateral–torsional buckling of the girders is critical to ensuring the stability of the girders during erection. The FHWA's *Engineering for Structural Stability in Bridge Construction*, publication number FHWA-NHI-15-044, provides a general method to check whether cross-frames in a girder system provide sufficient bracing for the girders. Additional calculations may be required to check that individual cross-frame members and connections have adequate capacity. Another reference available is Volume 13, *Bracing System*

Design, of the *Steel Bridge Handbook,* publication number FHWA-HIF-16-002.

2.4.9—Structural Adequacy of Temporary Components

Substantiate the structural adequacy and stability of any and all temporary support components (including temporary shoring, temporary crane supports, crane mats, barges, work trestles, girder tie-downs, jacking devices, or any other temporary components) necessary for each step of the steel erection. When applicable, Manufacturers' ratings or catalog cuts for pre-engineered devices may be used to meet this requirement.

C2.4.9

Temporary works are a critical part of many steel bridge erection projects, and their design should be subject to a standard of care similar to other Erection Engineering Calculations. The Erection Engineering Calculations should be done in accordance with design criteria established by the Owner, or as stated in the Contract Documents.

An existing bridge may be used during steel erection, rehabilitation, or widening of an adjacent bridge. Typical uses of an existing structure may include temporary bracing to new members, supporting cranes, delivery trucks, construction materials, or other equipment. Analysis of the existing structure should be performed by the Erection Engineer and submitted in the same fashion as the Erection Engineering Calculations.

Temporary support structures should be designed by a licensed professional engineer to carry all applicable vertical and horizontal loads resulting from the proposed erection sequence and possibly occurring during construction. As necessary, calculations for the design of an upper grillage, temporary bearings, and foundations should also be included. The elevation of the bearing support (bearing seat elevation) at the top of the temporary support structure should be computed and provided in the Erection Plans and Procedures. The bearing seat elevations at the temporary supports can aid the steel Erector in controlling the geometry of the structure during steel erection.

Lifting beams, lifting devices, rigging components (rigging), and jacking devices shall meet all applicable Occupational Safety and Health Administration (OSHA) requirements for marking with rated loads and for proof testing of special custom design grabs, hooks, clamps, or other lifting accessories for prefabricated structures to 125 percent of their rated loads. Below-the-hook lifting devices shall be designed in accordance with American Society of Mechanical Engineers (ASME) standard BTH-1.

Special custom design lifting accessories are a critical part of many steel bridge erection projects. Applicable OSHA regulations and other codes and standards require proof testing such devices to 125 percent of rated loads. OSHA requires marking rated loads on manufactured hooks, shackles, beam clamps, slings, etc.

Tie-downs are a critical part of many steel bridge erection projects and their design should be subject to a standard of care similar to other erection engineering calculations. The Erection Engineering Calculations should be done in accordance with design criteria established by the Owner, or as stated in the Contract Documents. Tie-downs may be used to resist wind loads, uplift, lateral dead load forces resulting from horizontal curvature, or other loads.

Jacking devices are a critical part of many steel bridge erection projects and the selection of appropriate jack types and the determination of jacking loads should be subject to a standard of care similar to other erection engineering calculations. Any load calculations should be done in accordance with design criteria established by the Owner, or as stated in the Contract Documents. Manufacturers' rated jack capacities should not be exceeded. In addition, written jacking procedures should be prepared and submitted for review and approval and should be included with the Erection Plans and Procedures.

2.4.10—Miscellaneous Calculations

2.4.10.1—Crane Pick Locations

Crane pick locations shall be determined with consideration of the center of gravity of the entire assembly being lifted, including the girder as well as any attached cross-frames, splice plates, stiffening trusses, or other attached items.

C2.4.10.1

The center of gravity should be determined by reasonably accurate calculations to facilitate correct rigging of lifts to avoid instability problems during lifting.

2.4.10.2—Support Conditions

The boundary (support) conditions assumed in the erection analysis shall accurately reflect the actual support conditions in the structure at all stages of erection (including accurate consideration of any and all temporary supports). If the character of the support at a location changes at various stages in the erection sequence, this shall be considered in the analysis model.

C2.4.10.2

Improper modeling of boundary conditions leads to erroneous results and invalidates the analysis.

2.5—COORDINATION ITEMS

The Erection Procedures submittal shall include documentation of all required coordination items. These include, but are not necessarily limited to, the following:

a) review/approval by other agencies as required, e.g., railroads, Coast Guard, local jurisdictions, and
b) construction activities which occur concurrently with steel erection, such as setting forms, or concrete deck pours.

C2.5

The Contractor should coordinate activities with the Owner/Engineer, Fabricator, and Erector. Special coordination requirements may be included in the Contract Documents. Examples would be maintenance and protection of traffic, waterway navigation, school bus routes, and emergency vehicle routes. Safety measures (e.g., emergency boat, notification plans), coordination plan for regulatory agencies and other water traffic, and the details and anticipated schedules of obstructing the navigable channel should be shown.

SECTION 3: TRANSPORTATION

3.1—RESPONSIBILITY

The Contractor is responsible for coordinating delivery of the product from the Fabricator to the jobsite and for providing adequate site access.

C3.1

Although some Contractors erect, haul, or even fabricate the product, this is relatively uncommon. Often, the Contractor will subcontract fabrication, hauling, erection, or a combination of these three to the Fabricator, a hauler, or Erector. Depending on the subcontract, some of these responsibilities may flow down to these other parties.

3.2—TRANSPORTATION PLAN

The Contractor shall prepare a Transportation Plan that addresses all requirements for transportation of primary members to the jobsite. If required in Contract Documents, the Contractor shall submit the Transportation Plan to the Owner. The Transportation Plan shall include, but not be limited to:

a) Hauling route, including identification of applicable permits
b) Vehicle geometry and loads (including vehicle overall length, gross vehicle weight, and axle spacing of trailer units)
c) Member dimensions and weights
d) Temporary support type and locations
e) Lateral bracing (if needed)
f) Tie-down configuration (including type, size, and location)

Calculations to substantiate the structural adequacy and stability of the member during transportation do not need to be submitted, unless specifically required in the Contract Documents.

C3.2

The Owner may choose to forgo formal submittal and review of Transportation Plans where the additional cost and time is not justified. For simpler structures where the risk is minimal, the Owner may choose to rely upon the Contractor's expertise to ship bridge components without submittal. The Transportation Plan may be required for submittal if members are unusually heavy, wide, deep, or long for the selected transportation mode. If submittal of the Transportation Plan or calculations is required, it is best if this requirement is clear in the Contract Documents or provided well in advance of shipping to avoid potential delays during erection. Some examples when submittal of the Transportation Plan with supporting calculations may be warranted include, but are not limited to:

a) Members transported with webs in horizontal orientation
b) Curved members overhanging supports by more than 25 feet
c) Member overhanging supports by more than 30 feet
d) Curved members with radii smaller than 600 feet
e) Members with special stability considerations (e.g., long, slender members or high flange length-to-width ratios)

The *AASHTO LRFD Bridge Design Specifications* and the *AASHTO LRFD Bridge Construction Specifications* do not specify load factors or deflection limitations during transportation of straight girders. Article 11.8.4 of the *AASHTO LRFD Bridge Construction Specifications* provides guidance for limiting stresses in curved girders which may be applicable to straight girders as well. Some Owners specify additional dynamic and wind loading during transportation.

When the truck and loaded member exceed the legal limits for weight, length, height, or width, permits shall be obtained from all applicable permitting agencies between the point of fabrication and the jobsite.

Permit cost and availability may vary depending on the extent of the oversize or overweight load, vehicle configuration, axle loads, and axle spacing. Although permitting requirements vary by jurisdiction, Table C3.2-1 provides general shipping guidance.

Table C3.2-1—Generalized Permit Types for Bridge Girder Loads

	Overall Length	Overall Width	Overall Height (1)	Max Axle Weight	Gross Vehicle Weight (2)
Legal Load Limit	80 ft	8 ft 6 in.	13 ft 6 in.	10 tons (17 T tandem)	40 tons
Permit Load Limit (3)	140 ft	12 ft 3 in.	14 ft-0 in.	10 tons (varies)	80 tons

Notes: Values are approximate and may vary by individual agencies along haul route.
(1) Height must allow for camber.
(2) Unloaded vehicle assumed to weigh approximately 20 tons.
(3) Loads exceeding permit limit may be possible with special consideration in some jurisdictions.

Girder designs may designate optional field splices. While considering optional field splices, the Contractor should consult with the Fabricator, hauler, and Erector to evaluate the potential for unintended stresses or other complications for fabrication, handling, hauling, and erection (e.g., crane sizes, truck turning radii, availability of trucking equipment, rigging requirements, hauling permits).

3.3—HANDLING AND SECURING

All members shall be handled and supported in such a manner to avoid damage during loading, transportation, and unloading.

Wherever practical, girder sections should be shipped in the same orientation as in the completed structure (i.e., webs should be vertical). Girders shall be supported in such a manner to maintain stability without permanent deformation.

Care shall be exercised to avoid coating damage from slings, chokers, clamps, tie-down restraints, etc. when handling, hauling, or storing.

C3.3

During transportation, members may experience loads and stresses that differ from design load cases. Damage to the members during handling and transportation can take several forms including:

a) Permanent deformation
b) Cracked welds or members from overstress or repeated stress reversals
c) Coating damage

Limiting the length of members overhanging the rear wheels of a trailer may reduce the range of stress reversals and potential damage from ground strikes.

Although fabricated structural steel is exempt from some sections of 49 CFR Part 393, Subpart I, “Protection Against Shifting and Falling Cargo,” this regulation provides guidance for tie-down design to secure loads. Use of additional tie-downs during

Members shall be securely and adequately fastened to the shipping vehicle to prevent the members from shifting during transportation.

The end-to-end orientation of the girder relative to the truck should be coordinated between the Fabricator and Erector to correspond to the Erection Plans prior to loading.

transport should be considered for increased safety and redundancy.

Orienting the girder on the truck in accordance with the Erection Plans, e.g., piece mark toward cab end, will eliminate unnecessary movements at the project site. Rotating long, heavy girders end-to-end with jobsite cranes may not be possible. Depending on site constraints, the truck may not be able to turn around onsite to obtain the proper girder orientation.

3.4—FASTENERS

Ship all fastener components in sealed, watertight containers, with contents clearly listed on external tags.

C3.4

High-strength steel fastener thread lubrication requires protection from the elements. This does not apply to anchor rods or end-welded shear studs.

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SECTION 4: MATERIAL STORAGE AT JOBSITE

4.1—FABRICATED MATERIAL

Store fabricated material on blocking above the ground. Properly drain the ground and keep material clean. Store primary members upright and shored or braced for stability. Support all members to prevent permanent distortion or damage.

4.2—FASTENERS AND MACHINE-FINISHED PARTS

Store fasteners in covered containers to protect them from dirt and moisture. Store fastener containers and machine-finished parts inside covered structures or otherwise protect them from the weather. Install fasteners removed from covered containers by the end of the work shift. Return unused fasteners to covered containers at the end of a work shift or otherwise protect them from the weather. Do not install fasteners that have accumulated dirt or rust, or otherwise deviate from their manufactured condition. Fastener components, other than those incorporated into twist-off type fastener assemblies, may be cleaned and relubricated by the Erector. Relubricated fasteners shall be subsequently retested per Article 7.4 to verify bolt installation method.

C4.2

Fastener manufactured condition is defined as that which exists when the Manufacturer's sealed container is first opened.

Fastener Manufacturers apply various coatings and oils that become an essential variable in the bolt installation method. If these coatings are compromised after a tested lot of bolts have been verified for a specific installation method, the test is not valid for those bolts with the compromised coating.

4.3—WELDING CONSUMABLES

Store and handle welding consumables in accordance with the AASHTO/AWS D1.5M/D1.5 *Bridge Welding Code* (referred hereafter as "D1.5M/D1.5").

C4.3

Refer to Article C8.3.5 for more information regarding consumable storage.

4.4—DAMAGE

Report any damaged structural steel to the Owner, including a description of the damage and proposed Contractor disposition (repair or replace).

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SECTION 5: BEARINGS AND ANCHORAGES

5.1—SURVEY

Prior to the start of erection operations, verify all substructure locations (lateral and longitudinal), existing anchor rod locations, bearing seat elevations, and other pertinent information in a Contractor survey. Resolve any discrepancies between the Contractor-conducted survey and Contract Plans with the Owner prior to performance of erection operations.

C5.1

The Owner, Contractor, and Erector should review substructure survey data prior to beginning erection operations. The Contractor and Erector should propose actions to mitigate discrepancies in bridge seat elevations to the Owner for review; review by the Design Engineer may also be appropriate depending on the nature of the discrepancies and the proposed mitigation actions. See Article C5.2 for further discussion of bridge seat elevation discrepancies and possible mitigation actions. For straight I-girder bridges with simple framing arrangements, a discrepancy of $^1/_8$ in. or less between adjacent beam seats or top of bearing elevations typically will not result in difficulties with cross-frame fit-up or gaps between the bearings or girders. However, more significant discrepancies in beam seats and top of bearing elevations (especially discrepancies in the relative heights of adjacent beam seats and bearings) often cannot be easily accommodated in the connections of cross-frames at the bearings when standard-size holes are used and/or when complicated framing arrangements result in greater stiffness of the structure. See Article C6.9 for further discussion on field reaming.

5.2—BRIDGE SEATS

Place bearing devices on properly finished bridge seat bearing areas. Notify the Owner if seats are not level or are at incorrect elevations and propose corrective actions.

Prior to placing girders, confirm that temporary blocking is not required.

C5.2

Placing a girder on a bearing surface that is not within the geometric constraints required by the plans and specifications may affect the erection and performance of the bridge. Problems such as poor fit-up, beams that are not well-seated on bearings, and difficulty erecting skewed or curved steel structures may be caused by bearing surface discrepancies but may result from the geometry of the partially erected structure. The Engineer should evaluate the as-built bearing geometry to determine if adjustments are required to correct discrepancies in bearing surfaces. If fit-up issues occur during an intermediate stage of erection, the Erection Engineer should be consulted prior to determining if beam seat adjustments are warranted.

While various methods exist to rectify the situation, the chosen solution shall be approved by the Engineer. Various choices are available when a bearing seat does not have the as-designed geometry:

a) grinding of a concrete surface such as a concrete pedestal (assuming extra cover was provided to allow for the possibility),
b) providing steel fill plates of a material and finish compatible with the expected performance and serviceability of the bridge,
c) loosening bolts of select cross-frames to allow the framing to “settle” into the as-provided geometry, or
d) loosening and reaming the bolt holes of select cross-frames to allow the framing to “settle” into the as-provided geometry (provided that doing so will not result in a loss of control of the constructed geometry and potential fit-up problems elsewhere in the steel framing)

Some Owners also choose to provide one ply of one end of the connection to have oversized holes to provide for some erection tolerance.

5.3—TEMPERATURE ADJUSTMENTS

When setting bearings, make appropriate corrections for ambient temperature and anticipated rotation due to dead load deflection of the supported member. Position high-load, multi-rotational bearings such that the initial position, including corrections for temperature and dead load rotation, is within Manufacturers’ requirements. Notify the Owner if anchor bolt locations do not permit proper positioning and propose corrective actions.

C5.3

See recommendations in the AASHTO/NSBA Steel Bridge Collaboration’s G9.1—*Steel Bridge Bearing Design and Detailing Guidelines* for thermal movement calculations.

5.4—TOLERANCES

In addition to the dimensional tolerances in D1.5M/D1.5 for steel bearing contact areas, members shall seat on bearing devices with no final gaps exceeding $^1/_{16}$ in.

SECTION 6
LIFTING AND ASSEMBLY

6.1—GENERAL

Lift, position, and assemble all members in accordance with the procedures in Section 2. The proposed crane location(s) and member delivery location(s) may require modification in the field to suit changing jobsite conditions. However, cranes and material shall be located such that the lift is safe and within the crane Manufacturers' rated capacity for all required positions.

C6.1

Jobsite conditions vary on a daily basis and are often not as they were anticipated to be when the erection procedure was conceived and submitted to the Owner. Consequently, the need to deviate from the submitted erection procedure may arise during the course of a bridge project. It is the Contractor's responsibility to erect the steel in a safe and efficient manner. The Owner's review and disposition of erection procedure changes to suit jobsite conditions should be handled in an expeditious fashion and avoid delaying the work.

6.2—LIFTING DEVICES

Install lifting devices, including welded lugs and bolted assemblies, in accordance with Erection Plans and Procedures.

6.3—ERECTION STABILITY

Girders shall be stabilized with falsework, temporary bracing, holding cranes, or a combination of thereof until a sufficient number of adjacent girders are erected with diaphragms or cross-frames connected to provide the necessary local and global stability, and make the structure self-supporting.

C6.3

Removal of falsework, temporary bracing, or holding cranes shall be in accordance with stability calculations provided in the erection procedure.

6.4—TRUSSES

Trusses erected by assembling individual components in place (stick built) shall be erected on falsework unless approved by the Owner. When erecting trusses on falsework, the falsework shall remain in place until all connections are completed and the truss is self-supporting. Specific cases that may not require falsework include balanced cantilevered erection, cable-stayed truss erection, and trusses spliced in the air while in the falls of two cranes.

6.5—FALSEWORK AND TEMPORARY SUPPORTS

Shoring towers may be used to provide stability and aid in fit-up during erection by providing additional supports, controlling deflections, and reducing the unbraced lengths. Therefore, the shoring should be lowered or removed before the concrete deck is placed, unless it is explicitly designed for by the Design Engineer.

C6.5

Shored construction is permitted by the *AASHTO LRFD Bridge Design Specifications*; however, per Article 6.10.1.1.1a of those specifications, it is not recommended for composite bridges. Per the commentary, "there has been limited research on the effects of concrete creep on composite steel girders under large dead loads. Also, there have been only a very limited number of demonstration bridges built with shored construction in the U.S.

Furthermore, there is an increased likelihood of significant tensile stresses occurring in the concrete deck at permanent support points when shored construction is used."

If dead load, beyond the steel dead load, is to be applied to the structure while temporary supports remain in place, provisions to release the temporary supports are required.

6.6—PINS

Pins are normally used to align holes for bolted field connections. Field reaming to facilitate fit-up will only be allowed in accordance with Article 6.9 or with the Owner's prior approval. Any abnormal distortion of the member or of the holes during the alignment process shall be immediately reported to the Owner.

C6.6

Examples of abnormal member distortion would include strain exceeding yield and perceptible web distortion. Abnormal hole distortion may include holes that are non-cylindrical, not perpendicular to the faying surface, or out of round by more than $^1/_{16}$ in.

6.7—CONNECTIONS

For splice connections of primary members, as well as connections of diaphragms or cross-frames designed to brace curved girders, fill at least 50 percent of the holes prior to crane release. The 50 percent may be either erection bolts in a snug-tight condition or full-size erection pins, but at least half (25 percent of all holes) shall be bolts, and sufficient pins shall be used near outside corners of splice plates and at member ends near splice plate edges to ensure alignment. Uniformly distribute the filled holes. The 50 percent requirement may be waived if a reduced percentage is calculated as sufficient and shown on the approved erection procedure.

Permanent bolts may be used as erection bolts, provided they are installed in accordance with Article 7.5. For complex structures (arches, trusses, etc.), install bolts and pins in accordance with erection procedures.

Primary member splice connections that are made up on the ground (prior to erection) shall be 100 percent complete, in the no-load condition, prior to any lifting operation.

C6.7

Filled holes should be distributed between the web and flange connections for primary members such that approximately 50 percent of the web connections are filled and approximately 50 percent of the flange connections are filled. For diaphragms or cross-frames, the filled holes should be uniformly distributed between all the bolt groups connecting the diaphragm or cross-frame to the primary member.

Achieving the no-load condition on the ground will require blocking. Refer to Article C9.3 for discussion on "as-fabricated" camber and how it may influence girder blocking.

6.8—ABNORMALITIES

Any abnormal member deformation or brace deflection after crane release or temporary support removal shall be immediately reported to the Owner, seeking immediate resolution. Further work affecting the area, except for restoring support or adding bracing, shall be stopped until the deformation or deflection is resolved.

6.9—FIELD REAMING

Field reaming may be used to correct minor misfits, without prior approval of the Engineer, subject to the following limitations:

a) Ream no more than 10 percent of the holes in a connection.
b) Ream no single hole more than $^1/_8$ in. larger than the nominal bolt diameter.
c) Assemble and securely hold connecting parts together.
d) Perform reaming with twist reams placed perpendicular to connecting parts.
e) Remove burrs on the outside surfaces.

For members with defects that cannot be corrected by reaming within these limits or that prevent the proper assembly of parts, the Contractor shall submit proposed corrective methods to the Engineer for review and approval.

All field reaming shall be documented and performed in the presence of the Engineer or Inspector. Upon completion, documentation of field reaming shall be submitted to the Engineer for record purposes.

C6.9

Correction of misfit bolted connections within the limits of this Section should not significantly affect the performance of a connection from a strength or service perspective. For conditions outside these limits, review by the Engineer is necessary to investigate the potential reduction in connection capacity. In cases of substantial misfit at a connection, the Contractor's proposed corrective plan should include a root cause analysis. When evaluating the as-built geometry of partially erected structural steel framing, a clear understanding of the anticipated behavior of the structure at the given stage of erection is critical and consultation with the Erection Engineer is encouraged. It is important to understand the cause of the misfit so that any underlying issues are also corrected and so the corrective action does not inadvertently cause additional problems.

If members are hot-dip galvanized after connections are initially drilled in the shop, holes may need to be reamed or otherwise cleaned and drips or runs on members may need to be ground to avoid interference during assembly. This work is typically performed during fabrication and is not associated with field reaming for misfit connections.

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SECTION 7:
FIELD-BOLTED CONNECTIONS

7.1—GENERAL

Final installation of high-strength structural bolts shall be performed in accordance with the *AASHTO LRFD Bridge Construction Specifications* and *LRFD Steel Bridge Fabrication Specifications,* unless the Contract Documents specify otherwise.

Although all pertinent provisions of the *AASHTO LRFD Bridge Construction Specifications* and *LRFD Steel Bridge Fabrication Specifications* apply to fi eld bolting, the following provisions are shown below for emphasis.

7.2—ROTATIONAL-CAPACITY TESTING

Rotational-capacity testing by the Manufacturer shall be required for all fastener assemblies with ASTM F3125/F3125M Grade A325 or A490 bolts. Rotational-capacity testing shall not be required for twist-off bolts (ASTM F3125/F3125M Grade F1852 or F2280). Direct tension indicators (DTI) or captive DTI/nuts shall not be included in rotational-capacity testing assemblies. Assemblies specifi ed as galvanized shall be tested after galvanizing. Washers shall be required as part of the test even though they may not be required as part of the installation procedure. Rotational-capacity testing shall be performed in accordance with ASTM F3125/F3125M Annex A2.

Additionally, perform the rotational-capacity test at the point of installation if the condition of the fastener assembly, the lubrication, or both are in question.

C7.2

An assembly lot is defined as a combination of fastener components of different types which are configured as they are to be installed in the steel. An example would be a bolt, nut, and washer. Each component in an assembly lot will have come from a production lot of similar components. Any change in component lots warrants additional testing of the assembly lots into which the component lots are integrated.

Rotational-capacity testing is not appropriate for twist-off bolts (ASTM F3125/F3125M Grade F1852 or F2280), or for DTIs and captive DTI/nuts, because these installation processes do not rely upon the ductility of the fastener. DTIs and captive DTI/nuts do not have to be included in rotational-capacity testing assemblies as this test is designed only to test the capacity of the nut and bolt.

The required starting tension in the ASTM F3125/F3125M rotational-capacity test is 10 percent of the required minimum installation tension and is assumed to bring the connection to a snug-tight condition.

The required nut rotations from the snug-tight condition in the rotational-capacity test are approximately twice the required rotations adjusted to provide roughly equal ductility demand across different bolt sizes.

7.3—FAYING SURFACES

No loose mill scale, dirt, metal shavings, or other conditions that would preclude solid seating of the parts or frictional transfer of load are allowed on faying surfaces of bolted connections.

C7.3

The steel Erector is generally not responsible for faying surface preparation, unless required by the Contract Documents or to correct impediments to proper assembly. The Erector is responsible for keeping the faying surfaces free from contamination during erection. If tightened fastener assemblies do not bring adjacent faying surfaces into complete contact due to non-parallel areas, sufficient frictional transfer of load may be provided by the total clamping force acting on the areas that are in contact (see Article C7.5 for additional commentary).

7.4—PREINSTALLATION VERIFICATION

Verify bolt installation method prior to bolt installation, in accordance with the *LRFD Steel Bridge Fabrication Specifications.*

C7.4

It is important to have the bolting crew rather than an inspector perform the installation verification test, because part of the function of this test is to verify that the installer's notion of "snug-tight" leads to the required installation tension. If the same crew is repeatedly installing the same bolts, there should be no need to repeat the verification test for turn-of-the-nut or DTI installation. Daily verification is required for the calibrated wrench method to ensure that the equipment is still accurate.

Where daily testing is not required, it is recommended that tests on particular sizes, lengths, and grades be performed shortly before those particular fastener assemblies are installed, rather than testing all fastener assemblies at the beginning of the project. Testing each fastener assembly type as it comes up for installation will help keep the crew familiar with that particular fastener assembly. Too long a time interval between testing and installation may be considered reason to question the understanding of the crew. Owner and Contractor should agree on an appropriate interval, taking into account the complexity of the project and the experience of the crew.

7.5—INSTALLATION

Install fastener assemblies using any of the methods allowed per the Contract Documents. Pretension assemblies to the tension required by the specifications.

Fastener assemblies specified to be pretensioned may remain temporarily snug-tight but untensioned, if necessary to permit subsequent steel erection or adjustment before final tensioning.

C7.5

Proceeding from the interior to the free edges, all bolts in a connection are typically brought to the snug-tight condition prior to pretensioning, which will follow a similar pattern. For large primary member connections, which have many bolts and/or plies of thick material, bringing all bolts to the snug-tight condition may require repeating the sequence multiple times as deformations in the plates are reduced. To expedite the snugging process, the Owner may permit filling a portion of the connection with pretensioned temporary fit-up bolts prior to installing permanent bolts in the remaining holes to the snug-tight condition. Snug-tight permanent bolts can then replace the temporary bolts, resulting in a connection completely filled with snug-tight bolts.

Thick elements (e.g., over 2 in. [50 mm]) at slip-critical joints may have deformations permitted by ASTM A6/A6M that prevent intimate contact with adjoining material by snug-tight or even fully pretensioned fastener assemblies. As long as these deviations affect a small percentage of the total.

faying surface, the connection should perform as designed. If the deviations cause a significant loss of contact between faying surfaces, the Engineer and Fabricator should be contacted to determine appropriate actions. Using higher strength fastener assemblies to increase clamping force or sealing the edges with structural epoxy are two options to prevent corrosion. In extreme cases, machining to remove high spots and refinishing surfaces may be an option if the remaining material will be adequate. When snug-tight fastener assemblies have suitably compressed the plies, pretensioning can proceed in accordance with the specifications.

When possible, pretension bolts before exposure to the elements, which can affect their rotational characteristics. Fastener assemblies left exposed for an extended period prior to pretensioning may experience a loss in their lubrication. Tension-control bolts and bolts installed using the calibrated wrench may not achieve the required pretension due to increased friction affecting their resistance to rotation. Bolts installed using turn-of-the-nut or DTIs may experience torsional distortion, affecting their tension and integrity. If there is a question regarding the adequacy of the lubrication, remove and test representative assemblies to determine if all fastener assemblies are required to be relubricated or replaced. Relubricated fastener assemblies should be subsequently retested per Article 7.4 to verify their adequacy. Tension-control bolts may only be relubricated by the Manufacturer.

If a fastener assembly with an indicating method, such twist-offs bolts or DTIs, is pretensioned before connection plates are drawn firmly together to a snug-tight condition, the fastener may loosen once the plies are pulled together. Therefore, care shall be taken not to engage the pretensioning indication mechanism until all the fastener assemblies are snug-tight with the plies solidly joined. Additionally, twist-off type bolts or direct tension indicators may provide false indications if over-tensioned while snug-tightening.

7.6—BROKEN FASTENERS

Any bolts broken during field erection shall be replaced by a bolt that meets the project specifications and functions properly.

C7.6

Broken bolts can occur for a variety of reasons during erection, such as over-tensioning, lack of lubrication, or improper pretensioning techniques or sequence. If repeated bolt failures occur during erection, further investigation is warranted, and the installation method may need to be reexamined.

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SECTION 8: FIELD-WELDED CONNECTIONS

8.1—GENERAL

Field welding and nondestructive testing (NDT) shall be performed in accordance with D1.5M/D1.5 or other codes as specified in the Contract Documents. Field welding on permanent material is not allowed unless shown on the plans or approved by the Owner.

Although all pertinent provisions of D1.5M/D1.5 apply to field welding, the following provisions are shown below for emphasis.

C8.1

D1.5M/D1.5 is written mostly for use in shop fabricating of structural steel members. Field-welding structural steel members presents environmental and geometric conditions that exceed those in the shop. Rain, humidity, temperature, and wind are examples of conditions that are more difficult to control in the field than in the shop. D1.5M/D1.5 does have provisions to address weather and wind. Difficulty in steel fit-up, access to the joint by the welder, and welding position are geometric constraints that can adversely affect the quality of the weld.

However, despite the environmental and geometric challenges, experience on numerous bridges over the past 50-plus years has shown that field welding can readily be accomplished successfully and provides a useful tool for experienced Contractors.

Because bridge field welding is not customary in many states, the Contract Documents should make it clear whether or not field welding is allowed.

Both shop and field welding require low-hydrogen practices and can produce good quality welds when done in accordance with D1.5M/D1.5. When wind speeds exceed 20 mph, the granular flux required for submerged arc welding (SAW) may blow away if precautions are not taken to block strong winds. Welding with gas shielded processes is prohibited when wind speeds exceed 5 mph (barely perceptible) because of potential loss of shielding gases; however, special wind shielding may alleviate this concern.

8.2—QUALIFICATION

8.2.1—Welder Qualification

Qualify welders in accordance with D1.5M/D1.5 and any additional Owner requirements for the positions and processes approved for field welding.

C8.2.1

Unlike shop welding, workers welding in the field for Contractors move from project to project and keeping track of welders that are qualified can be difficult. Some owners have programs that address qualification of field welders.

8.2.2—Welding Procedure Qualification

Field welding shall be performed in accordance with welding procedure specifications (WPSes) approved by the Owner for the specific application and location. Welding procedures that do not satisfy D1.5M/D1.5 requirements for prequalification shall be qualified by test per D1.5M/D1.5.

C8.2.2

Welding procedure qualification tests should be performed prior to arrival at the jobsite. Variations in consumables or geometry are governed by D1.5M/D1.5.

8.3—WELDING REQUIREMENTS

8.3.1—Welders

Welders shall have a written copy of the approved WPS.

8.3.2—Contact Surfaces

Prior to welding, the contact surfaces and joints to be field-welded and the surrounding area shall be cleaned of contaminants in accordance with D1.5M/D1.5.

8.3.3—Joined Parts

The parts to be joined shall be aligned in accordance with D1.5M/D1.5, and joint faces shall comply with the geometric tolerances of D1.5M/D1.5.

8.3.4—Environmental Conditions

Field welding shall not be allowed when the ambient air temperature is below 0°F or during periods of precipitation unless the welder is housed in a heated or protected area in a manner approved by the Owner.

C8.3.4

When the ambient air temperature is below 0°F, when surfaces are wet or exposed to rain or snow, or the welders' ability to make sound welds is a concern, heating, housing, or both should be used. See D1.5M/D1.5 Commentary for a detailed explanation of the effect of environmental conditions on welds.

8.3.5—Consumables

Electrodes and flux shall be purchased, stored, dried, and used in accordance with D1.5M/D1.5.

C8.3.5

It is required that electrodes and flux be kept dry at all times. Electrodes should be purchased in hermetically sealed containers. If electrodes are not stored according to the requirements of D1.5M/D1.5, they will absorb moisture and produce poor quality welds during production welding. Electrode drying ovens should be at the project site located near the welders' work station at all times. Once the electrode container is opened, electrodes should be placed in the ovens and stored at temperatures meeting the requirements of D1.5M/D1.5.

8.3.6—Preheat

Surfaces to be welded shall satisfy preheat requirements of D1.5M/D1.5 for 3 in. in all directions from the weld. Higher preheat, post-weld heating, or both may be required for fracture-critical welds, for welds in areas with high restraint, or to avoid defects. Preheating methods shall avoid damage to adjacent coated surfaces, neoprene bearings, and other heat-sensitive components. Damage caused by heating shall be corrected at the Contractor's expense.

SECTION 9: INSPECTION

9.1—GENERAL

Inspect and test repaired welds, coatings, and base metal in accordance with this Section. Verify the alignment, profile, and fastening of the erected steel conforms to the Contract Documents.

C9.1

Material quality, damage repair, and conformance to plan dimensions and assembly requirements are subject to the verification inspection of the Owner.

An erection inspection checklist can be found in Appendix C.

9.2—GEOMETRIC CONTROL

The Contractor shall monitor profile and alignment throughout steel erection while considering support conditions and anticipated deflections from subsequent steel placement or support release.

The Contractor shall survey profile and alignment under steel dead load after completion of erection but prior to deck casting. The survey data shall be submitted to the Owner for verification.

C9.2

The Owner should review the survey data to confirm the as-built geometry matches the design intent (e.g., deck can be formed with appropriate haunch dimensions).

Erection practices that may result in improper geometry or difficult fit-up including but not limited to:

a) bearings or temporary supports set to incorrect elevations, locations, levelness, or orientation,
b) cross-frames installed at incorrect locations or orientations,
c) girders erected at incorrect locations or orientations.

Correct steel fabrication, accurate deflection predictions in design, and proper choice of an effective fit condition of the bridge are also examples of factors that affect bridge geometry but are independent of erection means and methods.

9.3—TOLERANCES

Geometric tolerances for erected steel bridges shall be provided in the Contract Plans if required.

C9.3

Special erection tolerances may be appropriate for complex steel bridges, such as arches or trusses, and should be provided in the Contract Plans or mutually agreed between the Owner, Contractor, and Erector.

Editions of this Guide Specification up through 2019 specified tolerances for horizontal alignment, vertical alignment, and web plumbness for I-girder bridges. The tolerances were developed to verify that the erected steel structure matched the intended design geometry, but in practice they were unsuitable because the criteria addressed by the tolerances were associated with some factors that are independent from erection practices. However, the previous tolerances are presented in commentary here because they may be useful for checking erected steel, under steel dead load condition, if there are concerns about the as-built geometry before casting the deck.

a) Horizontal Alignment: ±$^1/_8$ in. × (total length along girder, in feet, between supports)/10. Note this is the same as girder sweep tolerance under D1.5M/D1.5.
b) Vertical Alignment: –0, + ¼ in. × (total length, in feet, from nearest support)/10, but not more than 1½ in. between supports.
c) Web Plumbness: not more than $^1/_8$ in. × web depth (in feet) from the theoretical position.

Further discussion regarding vertical alignment

For typical bridges with top flanges not embedded in the deck or top flanges embedded in the deck haunch, there is no fabrication tolerance in the negative direction, i.e., vertical alignment lower than theoretical. This ensures that the distance between top of flange and top of deck can be maintained, thereby avoiding thickening the haunch (or deck) to suit. Installed locations lower than theoretical may be acceptable upon review by the Owner. For a typical girder bridge, some agencies may choose to control only the elevation of the girder splices and accept vertical alignment between splices (within the tolerance on shop camber). Some of the tolerance on vertical alignment may be "consumed" by the tolerance on shop camber of the fabricated girder.

Since there is no vertical fabrication tolerance below theoretical, Fabricators may elect to slightly increase cambers to ensure tolerances are met during fabrication. The Erection Engineer, Erector, and Contractor should consider the influence of "as-fabricated" cambers when developing Erection Plans and elevations.

Further discussion regarding web plumbness

The location and nature of the measurement for deviation from theoretical web position may vary depending on bridge type. Webs of straight girders in non-skewed bridges should be plumb at all locations under steel dead load and should typically remain plumb after placement of the deck In straight-girder bridges with skewed supports, webs typically deform laterally, both at supports and away from supports, as load is applied; the magnitude and direction of deformation may change along the length of the bridge and from girder to girder. In curved-girder bridges with non-skewed (radial) supports, the webs typically remain plumb at the supports under all loading conditions, but the webs will typically deform laterally as load is applied. In curved-girder bridges with skewed (non-radial) supports, the webs may deform laterally, both at supports and away from supports, as load is applied; again, the magnitude and direction of deformation may change along the length of the bridge and from girder to girder. For other bridge types, measurement positions should be provided by the Owner.

Web position can be affected in the field by conditions not considered by the Design Engineer, beyond the control of the Contractor, or both. Web positions within the tolerance noted here are considered acceptable. Web positions beyond the tolerance noted here may be acceptable; however, they should be evaluated regarding cause and impact on bridge service and approved by the Owner.

Typical considerations include, but may not be limited to:

a) Bearing design (bearings are typically designed to accommodate 0.005 radians of rotational construction tolerance)
b) Girder stresses
c) Cross-frame fit-up and associated locked-in force effects

The actual plumb condition of each girder is influenced by many factors, including:

a) How well the design deflections predict the actual deflections
b) The fit condition chosen for establishing the connections between girders and cross-frames (the “drops”)
c) Fabrication tolerances
d) The erection sequence
e) The deck pouring sequence
f) Support conditions
g) Environmental conditions (sun position, temperature, etc.)

When attached to cross-frames, girders on skewed and curved bridges rotate laterally as the girders deflect from the no-load to the steel dead load and finally the full dead load condition. The condition of plumb in each of these three states depends heavily (but not entirely) on the fit condition chosen for the drops. For example, if a skewed bridge is detailed for steel dead load fit, the girders should be nominally plumb at erection but laying over somewhat in the final condition, or if a skewed bridge is detailed for full dead load fit, the girders will be laying over at erection but should be nominally plumb under full dead load. Therefore, when considering use of a tolerance for girder plumbness in the field, it is important to be mindful of the fit condition used in detailing and fabrication.

9.4—BOLTING

Bolting inspection shall conform to the requirements of the *LRFD Steel Bridge Fabrication Specifications.*

9.5—WELDING

Unless the Owner requires otherwise, visual inspection and NDT shall be performed on field welds in accordance with D1.5M/D1.5. Welds shall be evaluated for acceptance in accordance with D1.5M/D1.5.

Plans or specifications shall indicate “tension or stress reversal areas” so the Contractor knows where to apply tension/stress reversal acceptance criteria under D1.5M/D1.5.

C9.5

Certain nondestructive tests required for welds, especially radiographic (e.g., X-ray) testing, are difficult to perform in the field.

SECTION 10: REPAIR

10.1—DOCUMENTATION

The Contractor is responsible for documenting damage due to handling, removal of erection aids, aligning members and other actions, uncorrected misfits at connections or misalignments exceeding tolerances in erected members, and as-received damage attributable to transport or fabrication.

C10.1

Damage such as minor arc strikes or handling damage to paint may not need extensive documentation, unless it is a recurring problem. Widespread problems such as paint damage throughout several girders, especially if the cause is not apparent, or multiple misaligned girders may require the services of outside expertise.

10.2—IMPLEMENTATION

The Contractor shall propose a method of repair and basis for acceptance for the Owner's review.

10.3—REPAIR PROCEDURES

Submit repair procedures for damaged or misaligned steel in the form of sketches, written procedures, or both as applicable. Information shall provide sufficient detail for the Owner to adequately review the repair application. After repairs are complete, the Contractor shall provide to the Owner as-built detailed drawings, NDT results, and procedures/materials used for inclusion in the project file.

10.4—WELDS

Field or shop welds that are unacceptable shall be repaired in accordance with D1.5M/D1.5. Responsibility for the cost of the repair and subsequent inspection shall be based on the cause.

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REFERENCES

The following list of references is for information only and should be considered as reference text to supplement the commentary provided within this document.

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APPENDIX A:
ERECTION PLAN AND PROCEDURES CHECKLIST

Project:
Bridge:
Location:
Contractor:
Erector:
Erection Engineer:
Reviewer:
Date of Review:
Comments:

√ or N/A	Description
	Plan of Work
	Permanent and temporary structures shown
	All roads, railroads, waterways, clearances, overhead and underground utilities, potential conflicts shown
	Framing plan with member shipping marks (matching those on shop drawings) and field splice locations as applicable
	Erection Sequence
	Step-by-step procedure—figures and narrative dictating work. Written procedure should indicate erection sequence for primary and secondary members (typically cross-frames, diaphragms, etc.), as well as the following: methods of tie down of individual pieces, time and method of connection of diaphragm, lateral bracing, and field splices.
	Delivery location of components shown and member orientation on truck, as applicable
	Crane locations shown
	Temporary supports, hold cranes, blocking, tie-downs shown
	Load restrictions for certain stages (e.g., wind)
	Bracing of girders at supports
	Crane Information
	Crane capacity charts indicating crane type, lifting capacity at given radius and orientation, counterweight requirements, and boom length
	Approximate crane pick points shown
	Crane pick weights shown. Pick weights should include weight of member, rigging, and any other attachments.
	Hold crane loads
	Crane support method: barges, mats, etc.

Continued on next page

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√ or N/A	Description
	Details of Lifting Devices and Special Procedures
	Detail and arrangement of member rigging: showing sizes, capacities, and location of member pick points (or center of gravity)
	Include in the submittal Manufacturer cut sheets for rigging devices: beam clamps, wire rope, shackles, turnbuckles, chains, straps, etc., and pre-engineered falsework, as applicable.
	Bolting Requirements
	Bearing Blocking and Tie-Down Details
	Temporary Supports
	Details of structure shown
	Temporary support details should include capacities and sizes
	Loads and elevations indicated
	Jacking Devices and Procedures
	Coordination Items
	Include in the submittal statements as to the status of coordination with parallel entities requiring review: railroads, Coast Guard, Corps of Engineers, etc.

APPENDIX B: ERECTION CALCULATIONS CHECKLIST

Project:	
Bridge:	
Location:	
Contractor:	
Erector:	
Erection Engineer:	
Reviewer:	
Date of Review:	
Comments:	

√ or N/A	Description
	Complete analysis of erection sequence
	Proper level of analysis used
	Support conditions modeled appropriately at all stages
	Appropriate design criteria employed
	Appropriate loads and load combinations investigated
	Complete checks of structural adequacy of bridge components
	Calculations should substantiate that members do not experience loads greater than their capacities prior to completion of the bridge assembly.
	Complete checks of stability of girder and bridge system
	Calculations should substantiate structural stability of members and sub-assemblies prior to completion of the bridge assembly.
	Girder second-order amplification effects are addressed as needed
	Girder reactions checked for uplift
	Calculations for temporary hold crane loads
	Calculations for temporary support loads
	Calculations for substantiating that bearing capacity and design rotations are not exceeded during steel erection
	Calculations indicating structural integrity of the sub-assembly for cross-frame and bracing placement (adequate bracing strength and stiffness verified)
	Calculations substantiating the stability and structural adequacy of temporary supports and devices
	Falsework towers/temporary support structures and foundations
	Girder tie-downs
	Lifting and/or spreader beams
	Jacking devices
	Calculations of loads
	Calculations of support elevations

Continued on next page

Continued from previous page

√ or N/A	Description
	Calculations for temporary bracing
	Calculations indicating capacity of temporary crane supports
	Calculations to substantiate structural integrity of abutment and retaining walls affected by surcharge from cranes
	Calculations for crane pick locations (center of gravity)
	Calculations indicating structural integrity of any partially bolted primary splices after release of external support system
	Checks of displacements at field splices
	Checks of web layover of erected girders at supports, differential deflection potential at traffic staging, etc. (see Article 9.3)
	Inclusion of crane charts
	Inclusion of cut sheets for pre-engineered components

APPENDIX C:
ERECTION INSPECTION CHECKLIST

(See Article 1.1.7 for definition)

Sheet 1 of 2

PART 1—PRE-ERECTION

☐ Erection Procedure—approved

☐ Site preparation—access roads, crane pads, bearing pedestals, finish & elevation, anchor bolts survey, falsework foundation pads, all obstacles noted

☐ Personnel
- ○ foreman—competent person (as defined by OSHA)
- ○ crane operators—qualified, licensed, training, medical
- ○ welders—certification current, qualified for positions
- ○ any required training & instruction complete

☐ Lifting Equipment
- ○ crane inspection—current, schedule during project
- ○ lifting devices & rigging—certification, inspection

☐ Bolted Connections
- ○ check bolt quality, size & lengths, certifications
- ○ installation procedure, method of tensioning
- ○ Skidmore machine—calibration, certification
- ○ impact wrenches—condition, proper size & capacity
- ○ torque wrenches—calibration

☐ Welded Connections
- ○ welding procedure specifications (WPS)—approved
- ○ welding equipment—sufficient capacity, grounding
- ○ welding consumables—proper storage, drying ovens

☐ Safety/Fall Protection—nets, life-line lanyards, platforms, scaffolds, manlifts, floats, emergency boat

☐ Coordination Items—railroads, local agencies, Coast Guard, emergency services, etc.

PART 2—ERECTOR RESPONSIBILITY

☐ Provide for Inspector, prior to erection
- ○ framing plan, erection procedure
- ○ crane operator qualifications
- ○ welder certifications
- ○ crane inspection certifications
- ○ Skidmore and torque wrench calibration certifications
- ○ bolt Manufacturer certifications
- ○ WPS

☐ Provide for Inspector, during erection
- ○ access to work—ladders, manlift, scaffold or platform
- ○ torque wrench
- ○ Skidmore
- ○ temperature indication crayons

Continued on next page

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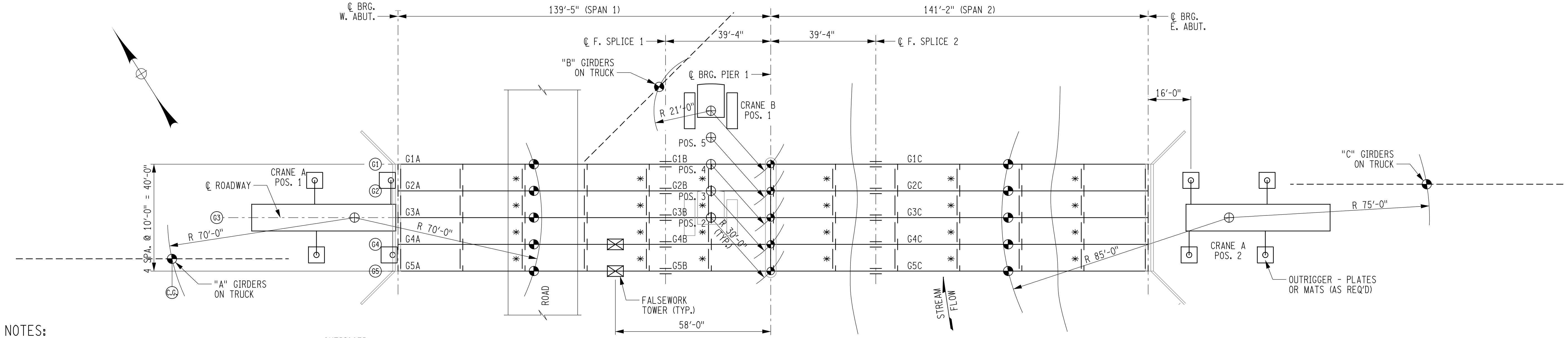
Sheet 2 of 2

PART 3—INSPECTOR RESPONSIBILITY

- [ ] Check all personnel certifications—crane operator, welders, etc.
- [ ] Check all equipment certifications—cranes, etc.
- [ ] Check fall protection—requirements, installation
- [ ] Check crane radii
- [ ] Check temporary supports—installed per erection procedure
- [ ] Check assembly marks—proper location and orientation
- [ ] Check minimum number of bolts and pins installed before release of crane/temporary supports
- [ ] Monitor bolt installation procedure
- [ ] Check field weld size/geometry, consumables, and variables per WPS, and NDT results
- [ ] Check bearing alignment/adjustment

APPENDIX D: SAMPLE ERECTION PLANS

The sets of sample bridge girder erection plans contained in this Appendix are provided to illustrate typical contents of such plans. They are not intended as definitive examples, nor to convey a standard of care for Erection Plan preparation. The actual contents of any specific set of Erection Plans will depend upon the Erector's proposed means and methods, Owner requirements, and the complexity of the bridge. These drawings should be developed in conjunction with Erection Procedures and Erection Engineering Calculations.

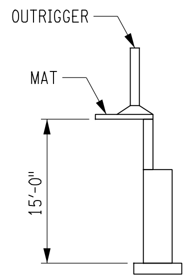


ERECTION PLAN

NOTES:

1. FOR GENERAL NOTES SEE DWG. EP-2.
2. FOR ERECTION DETAILS SEE DWG. EP-2 AND EP-3.
3. SEE FABRICATORS E DRAWING FOR ALL PIECE MARK LOCATIONS AND ORIENTATIONS.
4. TOP OF SPLICE ELEVATIONS PROVIDED BY FABRICATOR.

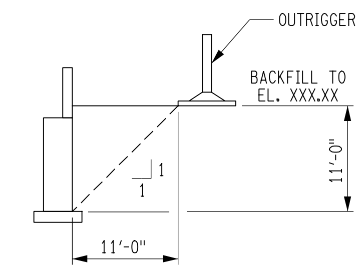
LEGEND	
◐	- INDICATES CENTER OF GRAVITY
⊕	- INDICATES CRANE CENTER PIN
R=XXX	- INDICATES RADIUS FROM CRANE CENTER PIN TO PICK POINT



WEST ABUT.
N.T.S.

WIND LOADING NOTES:

1. ERECTION OF GIRDER G5A (STEP 2), G5B (STEP 7) AND G5C (STEP 20) IS DESIGNED FOR A MAXIMUM WIND SPEED OF XX MPH. CONTRACTOR SHALL PAIR GIRDERS WITHIN A WORK SHIFT. CONTRACTOR SHALL CHECK LOCAL WEATHER REPORTS WHEN SCHEDULING ERECTION OF GIRDERS.



EAST ABUT.
N.T.S.

ERECTION PROCEDURE (CONTINUED):

11. RELEASE TEMPORARY FALSEWORK TOWERS.
12. WITH CRANE-A, LIFT GIRDER G3A INTO ERECTED POSITION AND CONTINUE TO HOLD GIRDER.
13. WITH CRANE-B, LIFT GIRDER G3B AT POSITION 1 AND WALK TO POSITION 4. LIFT GIRDER G3B INTO ERECTED POSITION AND BOLT SPLICE BETWEEN GIRDER G3B AND G3A AS PER GENERAL NOTE (L). CONNECT CROSSFRAMES MARKED (*) ON PLAN BETWEEN GIRDER G3A/G3B AND G4A/G4B PER GENERAL NOTE (K). TIE GIRDER DOWN AT ABUTMENT AND AT PIER PER DETAIL 5. RELEASE CRANE-A AND CRANE-B.
14. HANG CROSSFRAMES MARKED (*) ON PLAN ON BOTH SIDES OF GIRDER G2A AND GIRDER G2B PRIOR TO ERECTING.
15. WITH CRANE-A, LIFT GIRDER G2A INTO ERECTED POSITION AND CONTINUE TO HOLD GIRDER.
16. WITH CRANE-B, LIFT GIRDER G2B AT POSITION 1 AND WALK TO POSITION 5. LIFT G2B INTO ERECTED POSITION SIMILAR TO PREVIOUS STEP 13.
17. WITH CRANE-A, LIFT GIRDER G1A INTO ERECTED POSITION AND CONTINUE TO HOLD GIRDER.
18. WITH CRANE-B, LIFT GIRDER G1B AT POSITION 1 AND INTO ERECTED POSITION SIMILAR TO PREVIOUS STEP 13.
19. MOVE CRANE-A INTO POSITION 2 AS SHOWN ON PLAN WITH 138,800 LBS. COUNTERWEIGHT AND RIGGING DETAIL 3. DELIVER "C" GIRDERS TO THE LOCATION SHOWN ON THE PLAN.
20. LIFT GIRDER G5C INTO ERECTED POSITION AND BOLT SPLICE BETWEEN GIRDER G5C AND G5B AS PER GENERAL NOTE (L). TIE GIRDER DOWN AT ABUTMENT PER DETAIL 4 PRIOR TO RELEASE OF CRANE.
21. HANG CROSSFRAMES MARKED (*) ON PLAN ON BOTH SIDES OF GIRDER G4C PRIOR TO ERECTING.
22. LIFT GIRDER G4C INTO ERECTED POSITION AND BOLT SPLICE BETWEEN GIRDER G4C AND G4B AS PER GENERAL NOTE (L). CONNECT CROSSFRAMES MARKED (*) ON PLAN BETWEEN GIRDER G4C AND G5C PER GENERAL NOTE (K). TIE GIRDER DOWN AT ABUTMENT PER DETAIL 4 PRIOR TO RELEASE OF CRANE.
23. INFILL ALL REMAINING CROSSFRAMES BETWEEN GIRDER LINES 4 AND 5 PER GENERAL NOTE (K).
24. LIFT GIRDER G3C INTO ERECTED POSITION SIMILAR TO PREVIOUS STEP 22.
25. HANG CROSSFRAMES MARKED (*) ON PLAN ON BOTH SIDES OF GIRDER G2C PRIOR TO ERECTING.
26. LIFT GIRDER G2C INTO ERECTED POSITION SIMILAR TO PREVIOUS STEP 22.
27. LIFT GIRDER G1C INTO ERECTED POSITION SIMILAR TO PREVIOUS STEP 22.
28. INFILL ALL REMAINING CROSSFRAMES. COMPLETE ALL BOLTING AND TORQUE ALL BOLTS TO CONTRACT SPECIFICATIONS.
29. VERIFY STEEL PROFILE.

CRANE A POS. 1 (200 TON) LIFTING CAPACITY

RADIUS (FT)	CAPACITY OVER SIDE/360° (lbs.)
20	92,000
25	87,000
30	82,000
35	76,000
40	71,000
45	65,000
50	61,000
55	57,000
60	54,000
65	51,000
70	48,000
75	45,000
80	41,400

CRANE NOTES:

A) GROVE GMK6220 ALL TERRAIN HYDRAULIC CRANE W/ 200 TON CAPACITY AND 136ft. BOOM.

B) ALL CAPACITIES SHOWN ON FULLY EXTENDED OUTRIGGERS W/ 94,700 lbs. COUNTERWEIGHT.

CRANE A POS. 2 (250 TON) LIFTING CAPACITY

RADIUS (FT)	CAPACITY OVER SIDE/360° (lbs.)
20	121,000
25	121,000
30	118,000
35	109,000
40	99,000
45	90,000
50	83,000
55	77,000
60	72,000
65	66,000
70	62,000
75	58,000
80	53,000
85	48,000
90	43,000
95	40,000

CRANE NOTES:

A) GROVE GML6220 ALL TERRAIN HYDRAULIC CRANE W/ 250 TON CAPACITY AND 121ft. BOOM.

B) ALL CAPACITIES SHOWN ON FULLY EXTENDED OUTRIGGERS W/ 138,800 lbs. COUNTERWEIGHT.

CRANE B LIFTING CAPACITY

RADIUS (FT)	CAPACITY OVER SIDE/360° (lbs.)
17	120,000
20	100,800
25	70,425
30	53,750
35	43,250
40	36,025
45	30,725
50	26,700
60	20,975
70	17,075
80	14,275

CRANE NOTES:

A) LIMA 700-HC CRAWLER CRANE W/ 80 TON CAPACITY AND 80ft. BOOM.

B) ALL CAPACITIES SHOWN ON FULLY EXTENDED CRAWLERS W/ 45,800 lbs. COUNTERWEIGHT.

TOP OF SPLICE 1 ELEVATION

GIRDER LINE	NO LOAD ELEV. (FT)	STEEL DL ELEV. (FT)
G1	XXX.XX	XXX.XX
G2	XXX.XX	XXX.XX
G3	XXX.XX	XXX.XX
G4	XXX.XX	XXX.XX
G5	XXX.XX	XXX.XX

TOP OF SPLICE 2 ELEVATION

GIRDER LINE	NO LOAD ELEV. (FT)	STEEL DL ELEV. (FT)
G1	XXX.XX	XXX.XX
G2	XXX.XX	XXX.XX
G3	XXX.XX	XXX.XX
G4	XXX.XX	XXX.XX
G5	XXX.XX	XXX.XX

ERECTION PROCEDURE

1. MOVE CRANE-A INTO POSITION 1 AS SHOWN ON PLAN WITH 94,700 LBS. COUNTERWEIGHT AND RIGGING DETAIL 2. INSTALL TEMPORARY FALSEWORK TOWERS AS SHOWN ON PLAN AND PER DETAIL 5. DELIVER "A" GIRDERS TO THE LOCATION SHOWN ON PLAN.
2. LIFT GIRDER G5A INTO ERECTED POSITION. TIE GIRDER DOWN AT ABUTMENT PER DETAIL 4 AND AT FALSEWORK TOWER PER DETAIL 5 PRIOR TO CRANE RELEASE.
3. HANG CROSSFRAMES MARKED (*) ON PLAN ON BOTH SIDES OF GIRDER G4A PRIOR TO ERECTING.
4. LIFT GIRDER G4A INTO ERECTED POSITION AND CONNECT CROSSFRAMES MARKED (*) ON PLAN BETWEEN GIRDER G4A AND G5A PER GENERAL NOTE (K). TIE GIRDER DOWN AT ABUTMENT PER DETAIL 4 AND AT FALSEWORK TOWER PER DETAIL 5 PRIOR TO CRANE RELEASE.
5. INFILL ALL REMAINING CROSSFRAMES BETWEEN GIRDER LINES 4 AND 5 PER GENERAL NOTE (K).
6. MOVE CRANE-B INTO POSITION 1 AS SHOWN ON PLAN WITH 45,800 LBS. COUNTERWEIGHT AND RIGGING DETAIL 1. DELIVER "B" GIRDERS TO THE LOCATION SHOWN ON PLAN.
7. LIFT GIRDER G5B AND WALK TO POSITION 2. LIFT G5B INTO ERECTED POSITION AND BOLT SPLICE BETWEEN GIRDER G5B AND G5A AS PER GENERAL NOTE (L). TIE GIRDER DOWN AT PIER PER DETAIL 4 PRIOR TO RELEASE OF CRANE.
8. HANG CROSSFRAMES MARKED (*) ON PLAN ON BOTH SIDES OF GIRDER G4B PRIOR TO ERECTING.
9. LIFT GIRDER G4B AT POSITION 1 AND WALK TO POSITION 3. LIFT G4B INTO ERECTED POSITION AND BOLT SPLICE BETWEEN GIRDER G4B AND G4A AS PER GENERAL NOTE (L). CONNECT CROSSFRAMES MARKED (*) ON PLAN BETWEEN GIRDER G4B AND G5B PER GENERAL NOTE (K). TIE GIRDER DOWN AT PIER PER DETAIL 4 PRIOR TO RELEASE OF CRANE.
10. INFILL ALL REMAINING CROSSFRAMES BETWEEN GIRDER LINES 4 AND 5 PER GENERAL NOTE (K).

PICK WEIGHT TABLE

PIECE MARK	CRANE POSITION	PIECE WEIGHT (lbs.)	ATTACHMENTS WEIGHT (lbs.)	BLOCK WEIGHT (lbs.)	RIGGING DETAIL	RIGGING WEIGHT (lbs.)	TOTAL PICK WEIGHT (lbs.)
G1A THRU G5A	A-1	32,120	1,400	2,000	2	2,100	37,620
G1B THRU G5B	B-1 THRU 5	40,150	1,400	2,000	1	2,000	45,550
G1C THRU G5C	A-2	33,230	1,400	2,000	3	4,000	40,630

ALL DIMENSIONS IN ft UNLESS OTHERWISE NOTED

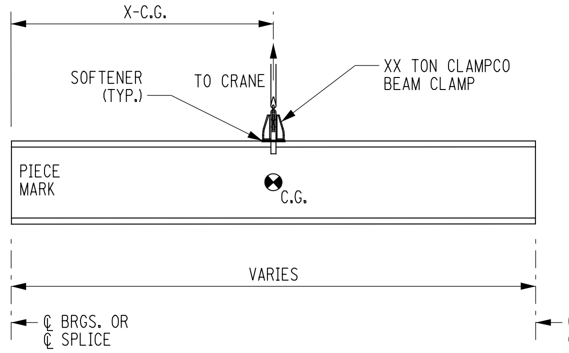
GENERAL BRIDGE ERECTION PLAN

AS SHOWN
SCALE

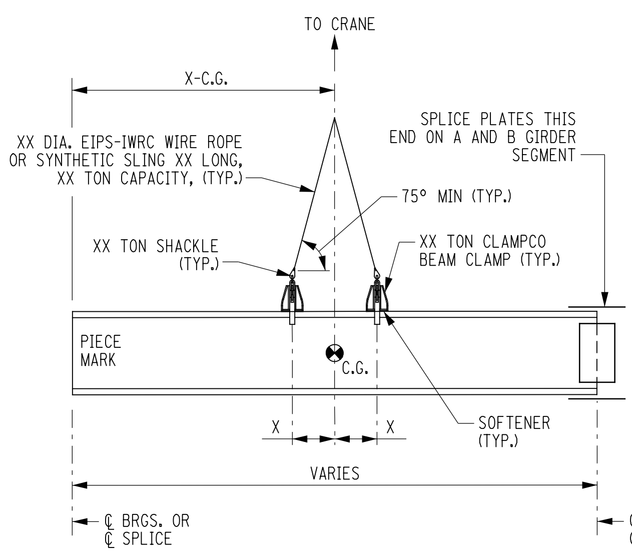
DATE

DRAWING NO. EP-1
SHEET NO.

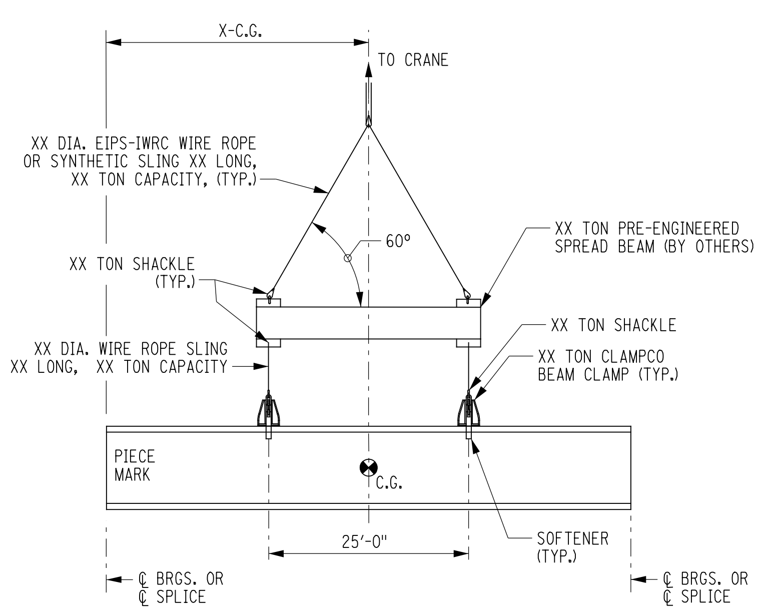
FILE NAME = DGN$SYTIME0123456
DATE/TIME = DGN$USERNAME
USER = DGN$USERNAME



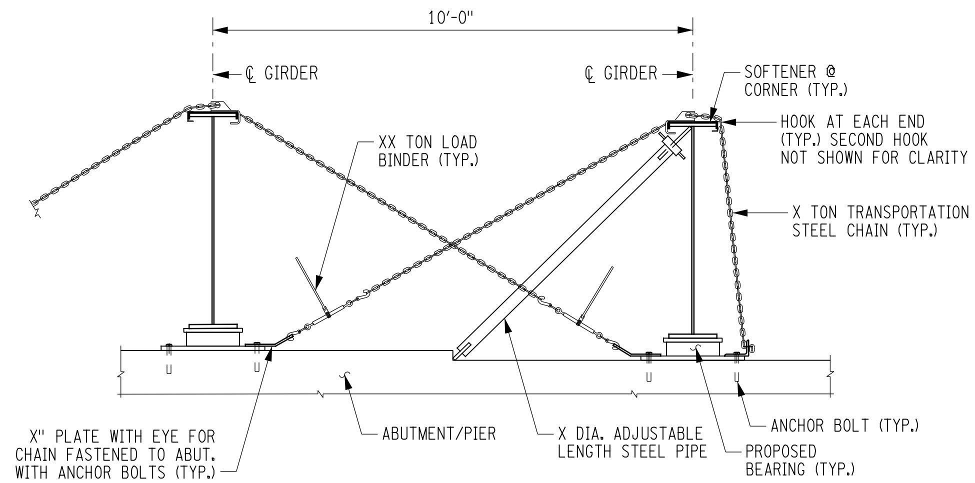
RIGGING DETAIL 1



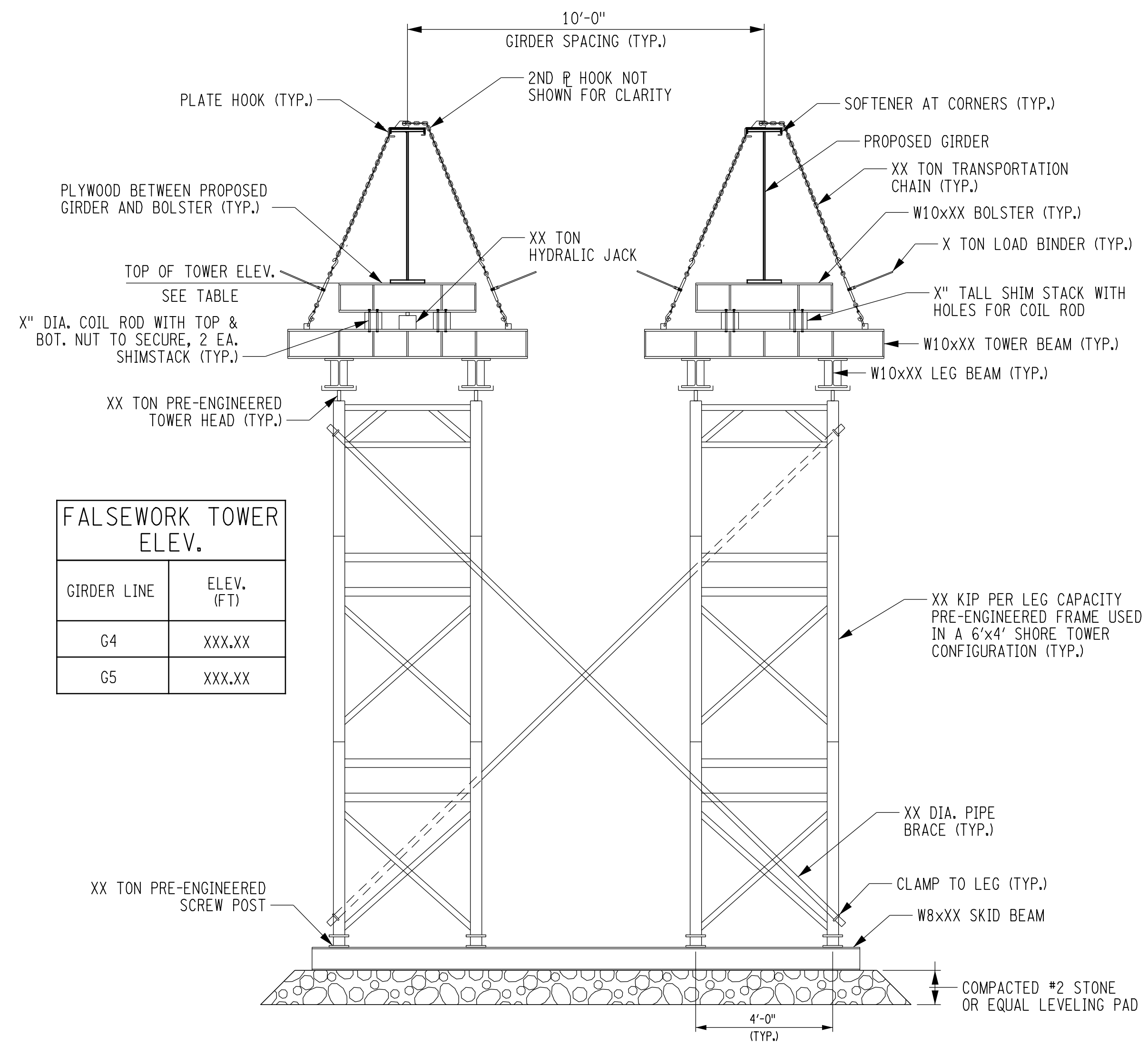
RIGGING DETAIL 2



RIGGING DETAIL 3



GIRDER TIE DOWN DETAIL 4



FALSEWORK TOWER ELEV.

GIRDER LINE	ELEV. (FT)
G4	XXX.XX
G5	XXX.XX

FALSEWORK TOWER DETAIL 5

NOTES:

1. ALL W SHAPES SHALL BE 50 KSI MINIMUM YIELD STRENGTH.
2. ALL ℙ MATERIAL SHALL BE 36 KSI MINIMUM YIELD STRENGTH.
3. ALL WELD ELECTRODE SHALL BE E70XX.
4. ALL PIPE SHALL BE 35 KSI MINIMUM YIELD STRENGTH.
5. ALL BOLTS SHALL BE ASTM A325 HIGH STRENGTH BOLTS.
6. INSTALLATION OF FALSEWORK TOWERS SHALL BE IN ACCORDANCE WITH MANUFACTURES RECOMMENDATIONS.
7. MAXIMUM BEARING PRESSURE BENEATH SKID BEAM IS XXXX PSF.
8. FOR ADDITIONAL ERECTION DETAILS SEE EP-3.
9. TEMPORARY FALSEWORK IS DESIGNED FOR XX MPH MAXIMUM WIND LOAD.

GENERAL ERECTION REQUIREMENTS:

(A) NO CRANE SHALL BE OPERATED IN A MANNER THAT WILL EXCEED ITS RATED CAPACITY AT ANY RADIUS AS SPECIFIED BY THE CRANE MANUFACTURER.

(B) THE CRANE CHART PREPARED BY THE CRANE MANUFACTURER THAT DESCRIBES THE MAXIMUM LIFT AT ALL CONDITIONS OF LOADING SHALL BE POSTED IN EACH CRANE CAB IN CLEAR VIEW OF THE OPERATOR.

(C) CONTRACTOR IS RESPONSIBLE FOR PROVIDING A LEVEL AND STABLE GROUND SURFACE ON WHICH CRANES WILL OPERATE. (SEE OSHA SUB PART R AND CC)

(D) THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE WEIGHT OF EACH LIFT AND FOR INSURING THE STABILITY OF EACH MEMBER DURING ALL PHASES OF ERECTION.

(E) THE CONTRACTOR SHALL TAKE THE NECESSARY PRECAUTIONS TO LOCATE AND PROTECT EXISTING UTILITIES IN THE AREA AS REQUIRED. OVERHEAD POWER LINES ADJACENT TO WORK AREAS ARE TO BE SHUT DOWN DURING ERECTION OPERATIONS WHEN THE CONTRACTOR BELIEVES THEY MAY INTERFERE, OR ARE TO CLOSE TO THE WORK. WHEN POWER LINES IN THE WORK AREA CAN NOT BE DEENERGIZED CONTRACTOR SHALL MAINTAIN A SAFE DISTANCE AS DETERMINED BY THE UTILITY COMPANY. (SEE OSHA SUB PART CC)

(F) CONTROL LINES SHALL BE ATTACHED TO EACH END OF THE GIRDERS BEING LIFTED AND ADEQUATELY MANNED THROUGHOUT THE ERECTION OPERATIONS.

(G) MEMBERS SHALL BE SUBJECT TO ONLY LIGHT DRIFTING IN ORDER TO ALIGN HOLES. ANY DRIFTING THAT RESULTS IN DISTORTION OF THE MEMBER OR DAMAGE TO THE HOLES WILL BE CAUSE FOR REJECTION OF THE MEMBER.

(H) FIELD REAMING OF HOLES WILL NOT BE ALLOWED UNLESS SPECIFICALLY NOTED OTHERWISE IN THE CONTRACT DOCUMENTS OR OTHERWISE APPROVED BY THE OWNER.

(I) INTENTIONALLY LEFT BLANK.

(J) ERECTION WORK SHALL NOT BEGIN WITHOUT THE APPROVAL OF THE OWNER.

(K) BETWEEN THE FIRST TWO LINES OF GIRDERS, EACH DIAPHRAGM OR CROSSFRAME TO GIRDER CONNECTION SHALL BE MADE WITH A MINIMUM OF X APPROVED HIGH STRENGTH BOLTS. THE BOLTS SHALL BE TIGHTENED UNTIL THERE IS NO GAP BETWEEN THE CONNECTING PARTS. AFTER THE FIRST TWO LINES ARE ERECTED AND STABILIZED, DIAPHRAGMS OR CROSSFRAMES INSTALLED BETWEEN SUBSEQUENT LINES OF GIRDERS SHALL HAVE EACH OF THEIR CONNECTIONS MADE WITH A MINIMUM OF TWO HIGH STRENGTH BOLTS IN EACH CONNECTION.

(L) SPLICES OF GIRDERS SHALL BE MADE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH APPROVED HIGH STRENGTH BOLTS AND FULL SIZE ERECTION PINS BEFORE THE EXTERNAL SUPPORT SYSTEMS ARE RELEASED. AT LEAST ONE HALF OF THIS PERCENTAGE SHALL BE BOLTS, TIGHTENED TO SPECIFICATION REQUIREMENTS. THE BOLTS AND PINS SHALL BE INSTALLED UNINFORMLY THROUGHOUT THE CONNECTION EXCEPT THAT ERECTION PINS SHALL BE USED IN THE EXTREME CORNERS OF ALL MAIN SPLICE PLATES. ELEVATION SHOULD BE VERIFIED BEFORE TIGHTENING.

(M) THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING ADEQUACY OF ALL TEMPORARY SUPPORTS.

(N) MAINTENANCE AND PROTECTION OF TRAFFIC SHALL BE APPROVED BY THE OWNER.

(O) DUE TO AVAILABILITY, CONTRACTOR MAY SUBSTITUTE CRANES FOR THOSE SPECIFIED HEREIN PROVIDED THAT THE SUBSTITUTE CRANE CAPACITY AT THE INDICATED RADII MEET OR EXCEED THE LOAD TABLES SPECIFIED AT THE VARIOUS CONDITIONS OF THE PICK. SUBJECT TO APPROVAL OF THE OWNER.

ALL DIMENSIONS IN ft UNLESS OTHERWISE NOTED

GENERAL BRIDGE
ERECTION DETAILS - 1

SCALE	DATE	DRAWING NO. EP-2 SHEET NO.

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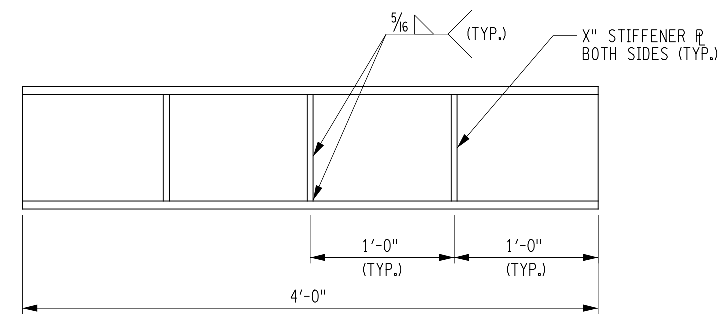
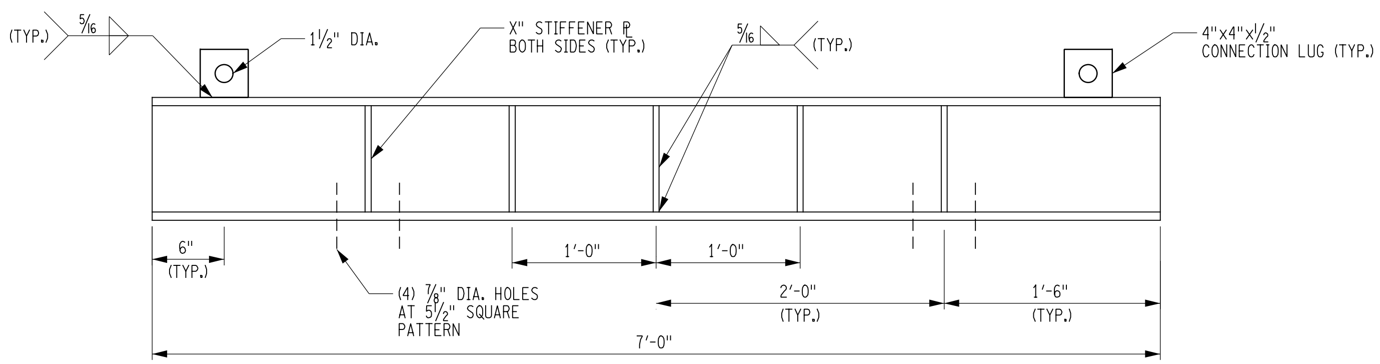
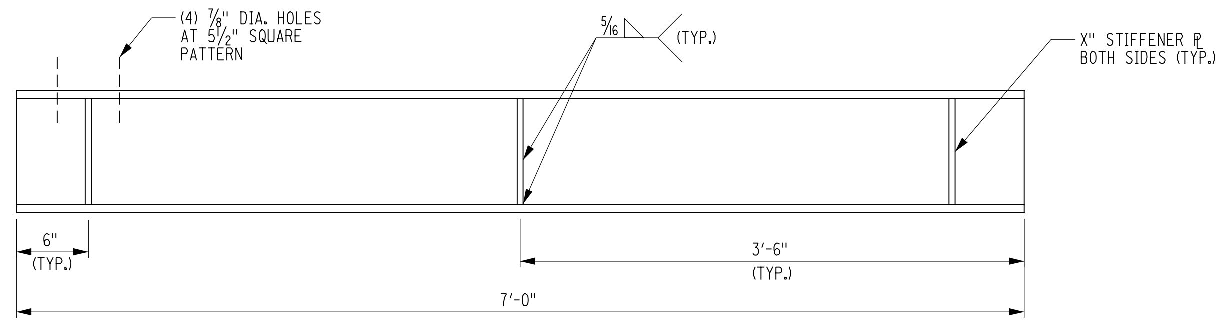
DATE/TIME =
USER = DGN$USERNAME



BOLSTER W10xXX

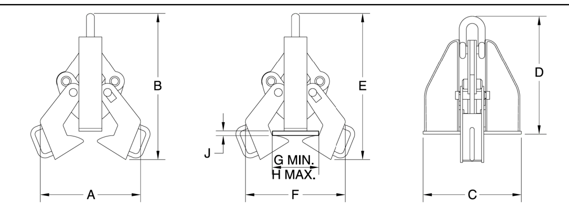


TOWER BEAM W10xXX

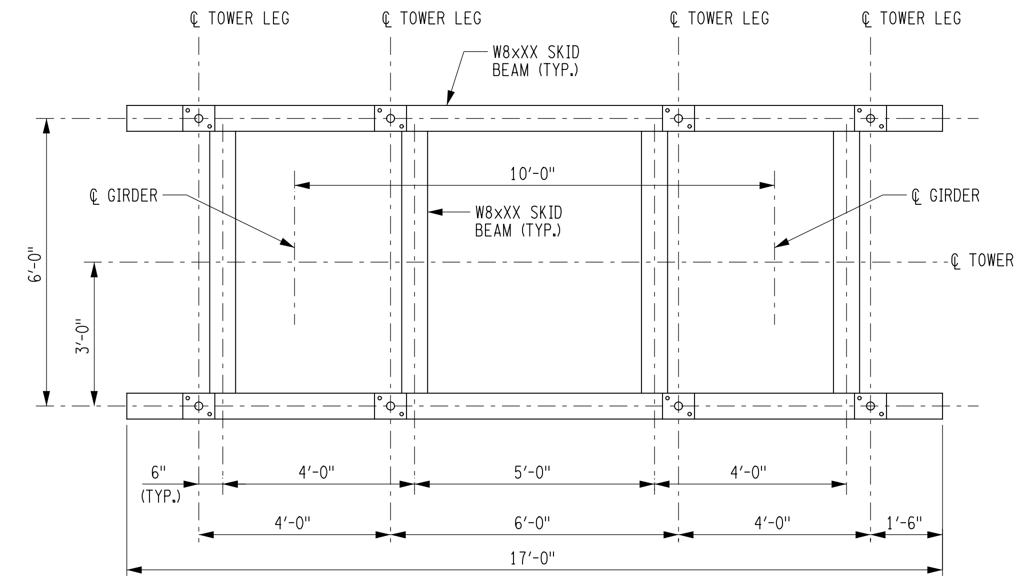


LEG BEAM W10xXX

BEAM CLAMPS



MODEL NO.	WORKING LOADS LIMITS TONS	FLANGEGRIP		WT. LBS	DIMENSIONS (IN.)								
		WIDTH RANGE MIN. MAX. (IN.)	DEPTH (IN.)		A	B	C	D	E	F	G	H	J
F-5	5	4 TO 10	1	51	9 1/2	26	12	20	25 1/2	16 3/4	4	10	1
F-15	15	7 TO 17	2	125	15 1/2	34	17	27	34 1/2	25	7	17	2
NS-15	15	7 TO 17	2	120	15 1/2	34	17	27	34 1/2	25	7	17	2
F-25	25	16 TO 24	3	244	23	48	22 1/4	36	53	37 1/4	16	24	3
NS-25	25	16 TO 24	3	234	23	48	22 1/4	36	53	37 1/4	16	24	3
F-35	35	16 TO 36	4	495	30	64	27 1/2	48	58	53	16	36	4
NS-35	35	16 TO 36	4	484	30	64	27 1/2	48	58	53	16	36	4



SHORING TOWER SKID FRAME (TWO TOWERS)

NOTES:

1. FOR ADDITIONAL ERECTION DETAILS AND NOTES SEE EP-2.

ALL DIMENSIONS IN ft UNLESS OTHERWISE NOTED

GENERAL BRIDGE
ERECTION DETAILS - 2

SCALE	DATE	DRAWING NO. EP-3
		SHEET NO.

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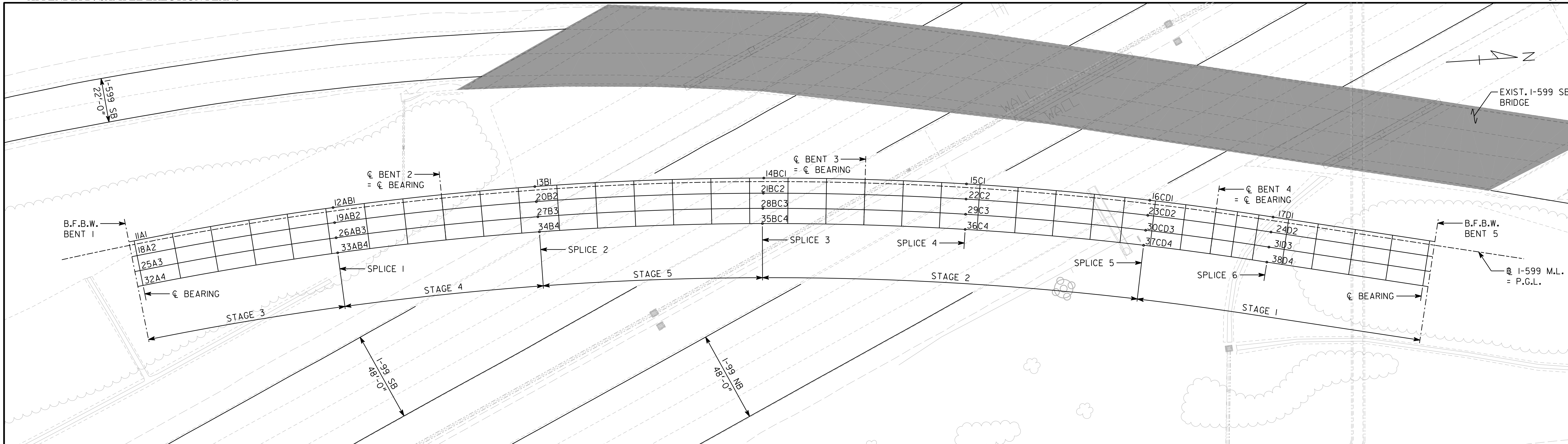
USER = DGN$USERNAME



GENERAL NOTES

1. THESE JACKING, SHORING, AND ERECTION PLANS ARE INTENDED FOR USE AS A SUPPLEMENT TO THE CONTRACT DOCUMENTS FOR THE DOT PROJECT REFERENCED IN THE TITLE BLOCK AND APPLY ONLY TO THIS SPECIFIC APPLICATION.
2. ALL VERTICAL AND HORIZONTAL SHORING INSTALLATIONS SHALL COMPLY WITH SAFE PRACTICE AND WITH THE REQUIREMENTS OF GOVERNMENTAL REGULATIONS, CODES AND ORDINANCES AND RECOMMENDATIONS PUBLISHED BY THE SCAFFOLDING, SHORING AND FORMING INSTITUTE.
3. IMPOSED SHORING LOADS ARE COMPUTED AS APPLIED CONCENTRICALLY TO THEIR VERTICAL SUPPORT MEMBERS. ALL BEAMS AND GIRDERS SHALL BE CENTERED LATERALLY AND BUTTED OR LAPPED CENTRALLY OVER VERTICAL SUPPORT MEMBERS.
4. ELEVATION "A" RECOMMENDED FOR TOP OF SHORING REPRESENTS THE THEORETICAL GEOMETRY OF THE COMPLETED STEEL UNIT AFTER DEFLECTION DUE TO STEEL SELF WEIGHT. CONTRACTOR SHALL USE BEST JUDGEMENT AT THE TIME OF INSTALLING THE TOP CRIBBING AND ADJACENT SHIMS TO BEST FIT THE STEEL TO THE TEMPORARY AND PERMANENT SUPPORTS.
5. SHORING SHALL BE WACO 100 KIP/LEG SHORING ERECTED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS. ALL COMPONENTS SHALL BE PINNED OR BOLTED TOGETHER PER MANUFACTURER'S DETAILS.
6. ALL LEDGERS OR JOISTS SHALL BE SECURED TO SHORE HEADS WITH ¾" Ø BOLTS, UNLESS NOTED OTHERWISE. ALL SHORE BASES SHALL BE SECURED TO HP SILLS WITH 2-¾" Ø BOLTS EACH OR 3" OF 5⁄16" FILLET WELD ON OPPOSITE SIDES OF BASE PLATE (6" TOTAL).
7. UNLESS SHOWN OTHERWISE ON THESE PLANS, ALL STEEL JOISTS, JACKING BEAMS, BLOCKING BEAMS AND BLOCKING SHALL BE SECURED TO EACH OTHER BY A MINIMUM OF 3" OF 5⁄16" FILLET WELD EACH OR EQUIVALENT WELD OR ONE ¾" Ø BOLT.
8. ALL SHORING, BEAMS, BLOCKING, ETC., EQUIPMENT SHALL BE ERECTED PLUMB AND LEVEL, UNLESS OTHERWISE INDICATED ON THESE PLANS.
9. SHORING FOUNDATIONS ARE DESIGNED FOR A MAXIMUM SOIL BEARING PRESSURE OF 2500 PSF. CONTRACTOR SHALL VERIFY ADEQUATE BEARING CAPACITY PRIOR TO PLACING SHORING.
10. CONTRACTOR SHALL PROTECT SHORING FOUNDATIONS FROM SLOPE FAILURE, SCOUR, AND OTHER UNDERMINING.
11. ALL STEEL SHIMS SHALL BE ASTM A-36 OR A572.
12. ALL STEEL ROLLED SHAPES AND PLATES USED FOR SHORING SHALL BE ASTM A-36 OR HIGHER STRENGTH, EXCEPT ALL HP SHAPES SHALL BE ASTM A572, GRADE 50.
13. ALL TIMBER BLOCKING AND CRIBBING SHALL BE OAK (EXCLUDING PLYWOOD SHIMS).
14. PLYWOOD SHIMS SHALL BE APA STRUCTURAL I RATED SHEATHING EXTERIOR.
15. SAND JACKS SHALL BE ALUMA SYSTEMS PART NO. 231113 OR CONTRACTOR'S EQUIVALENT. CONTRACTOR SHALL PROVIDE SAND JACK FOR A SAFE WORKING LOAD GREATER THAN OR EQUAL TO 200 KIPS. CONTRACTOR SHALL PROVIDE DETAILS FOR PROTECTING SAND FROM WEATHER AND ACCIDENTAL RELEASE.
16. CABLES SHALL BE 6X19 EIP IWRC WIRE ROPE OR BETTER.

GENERAL NOTES (CONT'D.)

17. FIELD WELDERS SHALL BE PREQUALIFIED ACCORDING TO THE STANDARD QUALIFICATION PROCEDURE OF THE APPLICABLE AWS SPECIFICATIONS AND AMENDMENTS THERETO AS NOTED IN THE STATE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS CONSTRUCTION OF TRANSPORTATION SYSTEMS SUBARTICLE 501.3.01(B). FIELD WELDERS MUST HAVE CURRENT QUALIFICATION CARD ON HIS PERSON AT ALL TIMES THAT HE IS DOING FIELD WELDING. USE ONLY E70XX (EXCLUDING E7014 AND E7024) LOW HYDROGEN ELECTRODES FOR MANUAL SHIELD ARC WELDING.
18. CRANE LOCATIONS SHOWN ARE APPROXIMATE. CONTRACTOR SHALL ADJUST CRANE LOCATIONS AS NEEDED TO AVOID OBSTACLES AND TO SATISFY CRANE OPERATING REQUIREMENTS. NO CRANE SHALL BE OPERATED IN A MANNER THAT WILL EXCEED ITS RATED CAPACITY AT ANY RADIUS AS SPECIFIED BY THE CRANE MANUFACTURER.
19. THE CRANE CHART PREPARED BY THE CRANE MANUFACTURER THAT DESCRIBES THE MAXIMUM LIFT AT ALL CONDITIONS OF LOADING SHALL BE POSTED IN EACH CRANE CAB IN CLEAR VIEW OF THE OPERATOR. OPERATOR SHALL HAVE THE LOAD OF EACH SECTION HE IS TO LIFT.
20. CRANES SHALL BE OPERATED ON LEVEL AND STABLE GROUND SURFACES. CONTOURS SHOWN ARE APPROXIMATE EXISTING GRADE. CONTRACTOR SHALL MODIFY GRADES AS NEEDED TO SATISFY CRANE OPERATING REQUIREMENTS.
21. CONTRACTOR SHALL CONFIRM GROUND BEARING CAPACITY ADEQUATE TO SUPPORT ALL CRANE PICKS AS SHOWN.
22. CONTRACTOR SHALL CONFIRM THE ADEQUACY OF ALL BURIED UTILITIES TO RESIST ALL CRANE LOADINGS SHOWN OR ASSOCIATED WITH THESE ERECTION PLANS.
23. CONTROL LINES SHALL BE ATTACHED TO EACH END OF ALL PIECES PICKED AND ADEQUATELY MANNED THROUGHOUT ERECTION OPERATIONS.
24. PICK POINTS AND PICK WEIGHTS PROVIDED IN THESE PLANS ARE ESTIMATES. CONTRACTOR SHALL TEST PICK ALL PIECES TO VERIFY THAT THEY FLY LEVEL. CONTACT ENGINEER IF PICK POINTS MUST BE SHIFTED BY MORE THAN 2 FT, IF PICK LOADS EXCEED THOSE SHOWN OR IF PICKED PIECE APPEARS UNSTABLE.
25. CONTRACTOR SHALL NOT PICK GIRDERS IN WINDS OR ANTICIPATED WINDS THAT EXCEED XX MPH.
26. TEMPORARY SHORING AND BRACING IS DESIGNED FOR A XX MPH MAXIMUM WIND LOAD.
27. DURING THE FIT-UP OF GIRDER SPLICES AND CROSS FRAMES, AT LEAST HALF OF THE HOLES SHALL BE FILLED. THIS MAY BE ACHIEVED WITH EITHER SNUG-TIGHT ERECTION BOLTS OR FULL-SIZE ERECTION PINS, BUT AT LEAST HALF (ONE QUARTER OF TOTAL HOLES) SHALL BE BOLTS. PRIMARY MEMBER CONNECTIONS MADE ON THE GROUND PRIOR TO ERECTION SHALL BE 100 PERCENT COMPLETE.
28. GIRDER AND CROSS FRAME LABELS ARE TAKEN FROM SHOP DRAWING PIECE MARKS.
29. THE CONTRACTOR SHALL HAVE THE CRANE ANNUAL INSPECTION REPORTS ON SITE AND AVAILABLE FOR REVIEW.
30. THE MAKE AND MODEL OF THE CRANES AND COMPONENTS IN THE FIELD SHALL NOT DIFFER FROM WHAT IS SHOWN ON THE FINAL PLAN WITHOUT PRIOR REVIEW AND APPROVAL BY THE ENGINEER.
31. THE CONTRACTOR SHALL HAVE FINAL APPROVED PLANS ON SITE DURING THE PROPOSED WORK.
32. FALL PROTECTION SHALL BE WORN BY ALL WORKERS WHEN WORKING ABOVE THE HEIGHTS REQUIRED BY OSHA. CONTRACTOR IS RESPONSIBLE FOR PROVIDING A SAFE SITE IN ACCORDANCE WITH ALL APPLICABLE REGULATIONS.
33. CONTRACTOR SHALL PROTECT ALL SHORING COMPONENTS, INCLUDING BRACING AND DEAD MEN FROM TRAFFIC.

SEQUENCE OF OPERATIONS

1. PLACE SHORING AS SHOWN ON SHORING LAYOUT.
2. ERECT STAGES 1-5 IN ORDER.
3. COMPLETE FINAL BOLTING.
4. REMOVE ALL SHORING.
5. WELD BEARINGS AND PLACE AND GROUT ANCHOR RODS.
6. REMOVE RESTRAINTS.
7. POUR DECK (SEQUENCE, DETAILS AND STABILITY CHECKS BY OTHERS).

DATE | REVISIONS | BY

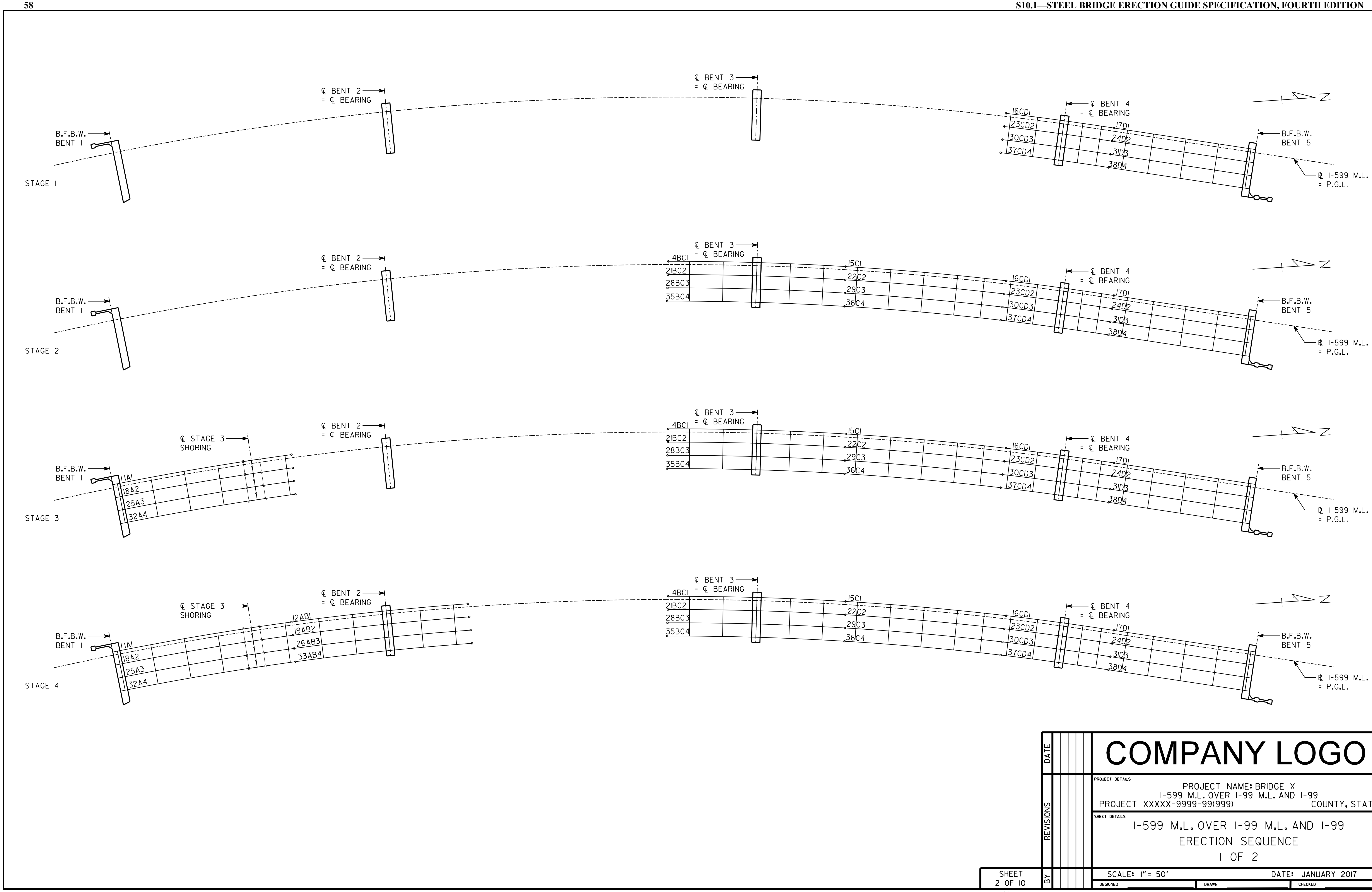
COMPANY LOGO

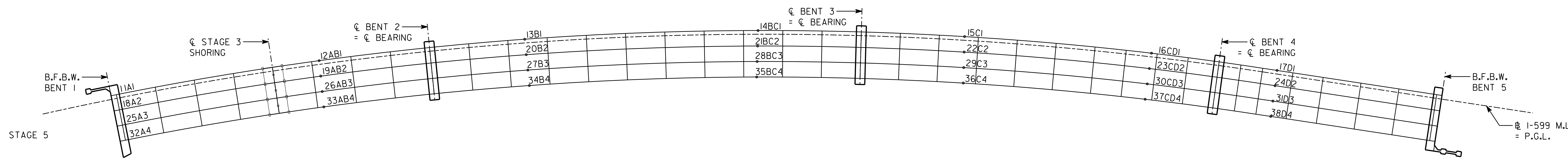
PROJECT DETAILS
PROJECT NAME: BRIDGE X
I-599 M.L. OVER I-99 M.L. AND I-99
PROJECT XXXXX-9999-99(999) COUNTY, STATE

SHEET DETAILS
I-599 M.L. OVER I-99 M.L. AND I-99
STEEL GIRDER ERECTION
STAGING PLAN AND GENERAL NOTES

SHEET 1 OF 10 | SCALE: 1" = 50' | DATE: JANUARY 2017
DESIGNED | DRAWN | CHECKED

½ INCH WHEN PRINTED 11X17

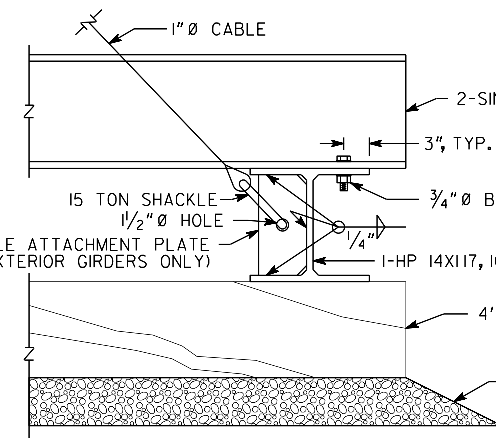

STAGE 1
STAGE 2
STAGE 3
STAGE 4
B.F.B.W. BENT 1
℄ BENT 2 = ℄ BEARING
℄ BENT 3 = ℄ BEARING
℄ BENT 4 = ℄ BEARING
B.F.B.W. BENT 5
℄ I-599 M.L. = P.G.L.
℄ STAGE 3 SHORING
16CD1
23CD2
30CD3
37CD4
17D1
24D2
31D3
38D4
14BC1
21BC2
28BC3
35BC4
15C1
22C2
29C3
36C4
11A1
18A2
25A3
32A4
12AB1
19AB2
26AB3
33AB4
N
DATE
REVISIONS
BY
SHEET 2 OF 10
COMPANY LOGO
PROJECT DETAILS
PROJECT NAME: BRIDGE X
I-599 M.L. OVER I-99 M.L. AND I-99
PROJECT XXXXX-9999-99(999)
COUNTY, STATE
SHEET DETAILS
I-599 M.L. OVER I-99 M.L. AND I-99
ERECTION SEQUENCE
1 OF 2
SCALE: 1"= 50'
DATE: JANUARY 2017
DESIGNED
DRAWN
CHECKED
1/2 INCH WHEN PRINTED 11X17



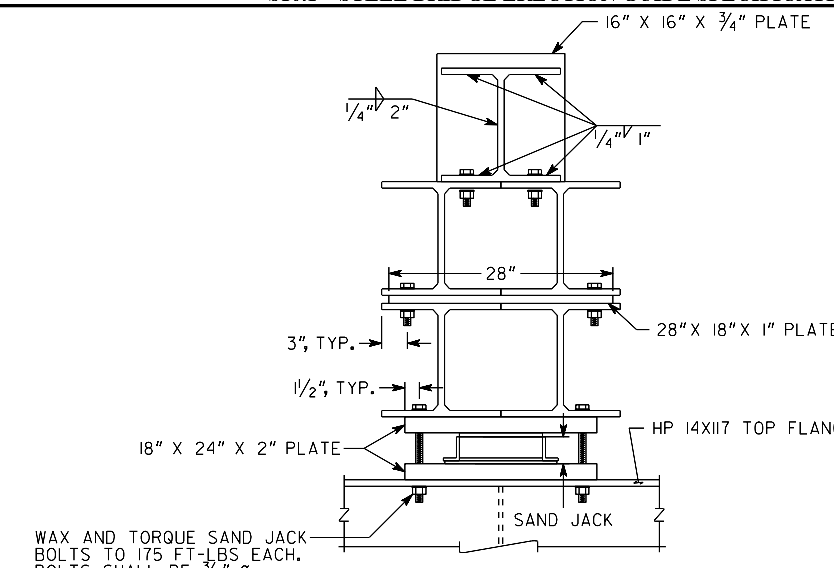
DATE	COMPANY LOGO
REVISIONS	PROJECT DETAILS PROJECT NAME: BRIDGE X I-599 M.L. OVER I-99 M.L. AND I-99 PROJECT XXXXX-9999-99(999) COUNTY, STATE
	SHEET DETAILS I-599 M.L. OVER I-99 M.L. AND I-99 ERECTION SEQUENCE 2 OF 2
SHEET 3 OF 10 / BY	SCALE: 1" = 50' DATE: JANUARY 2017 DESIGNED DRAWN CHECKED

1/2 INCH WHEN PRINTED 11X17

STATION	GIRDER	EL. A
7020+27.25	11A1	1064.40
	18A2	1063.97
	25A3	1063.49
	32A4	1062.89

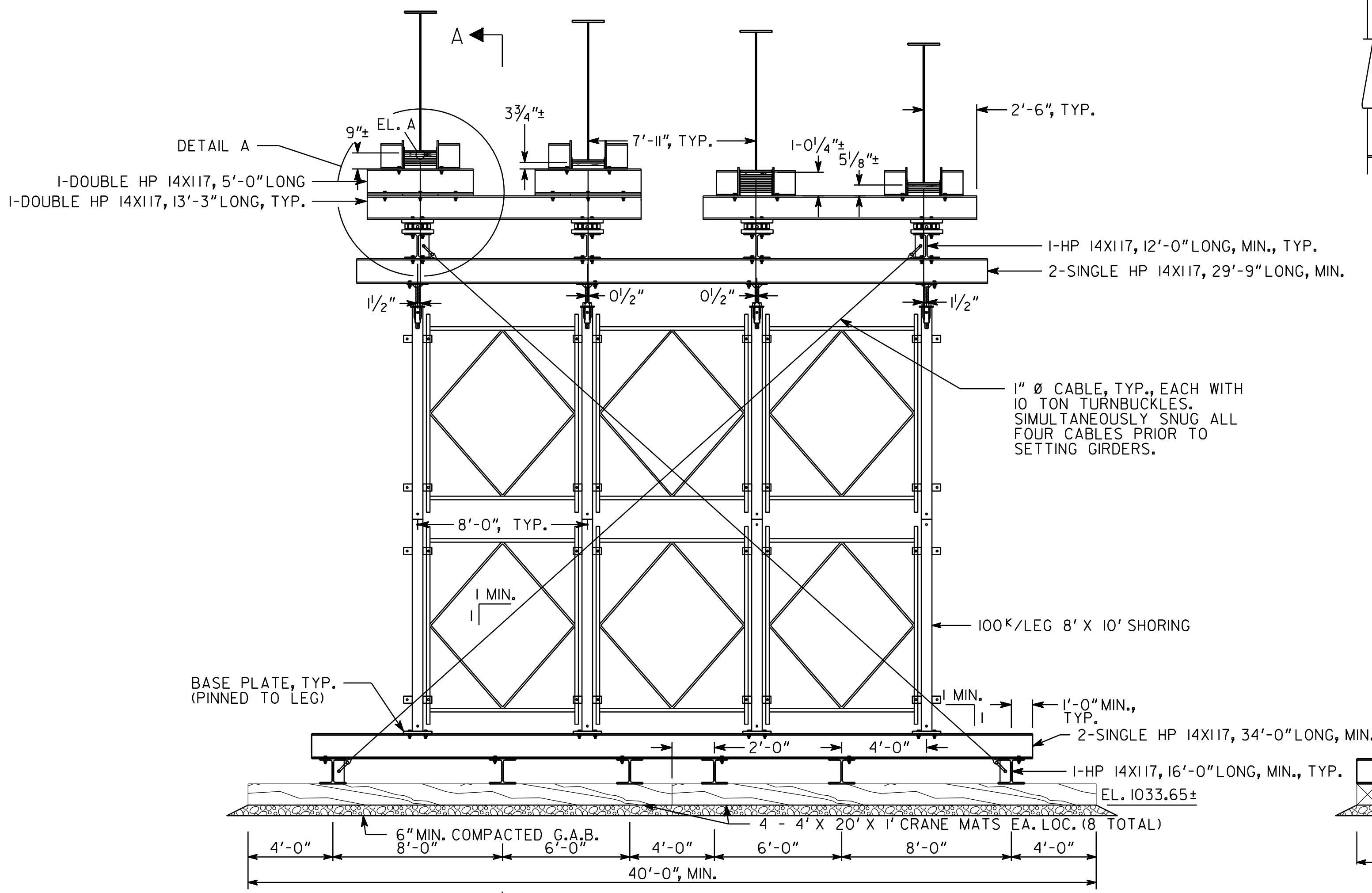


DETAIL B
½" = 1'-0"

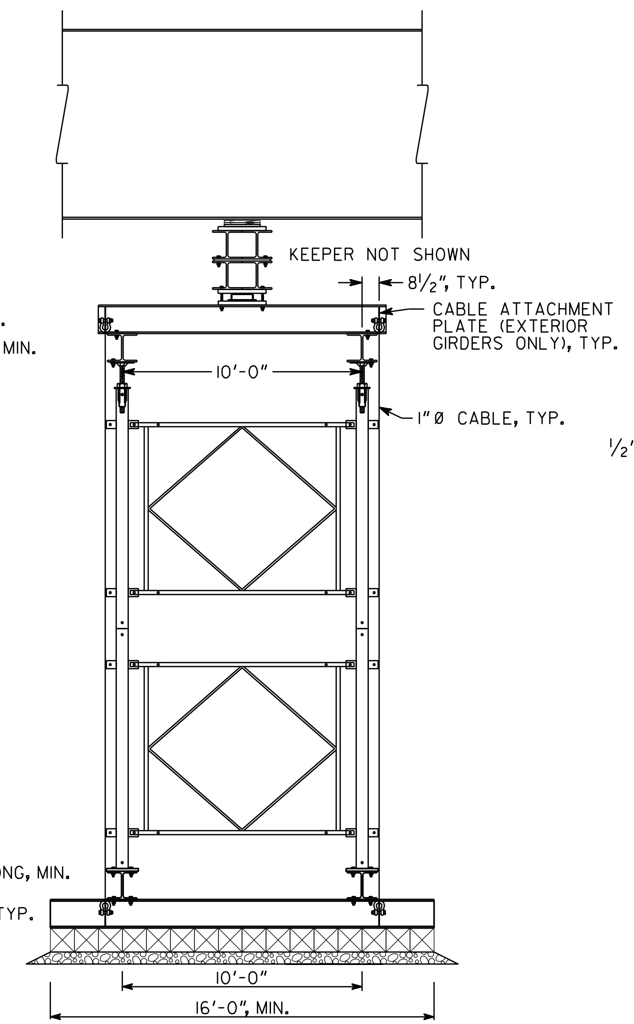


SECTION B-B
½" = 1'-0"

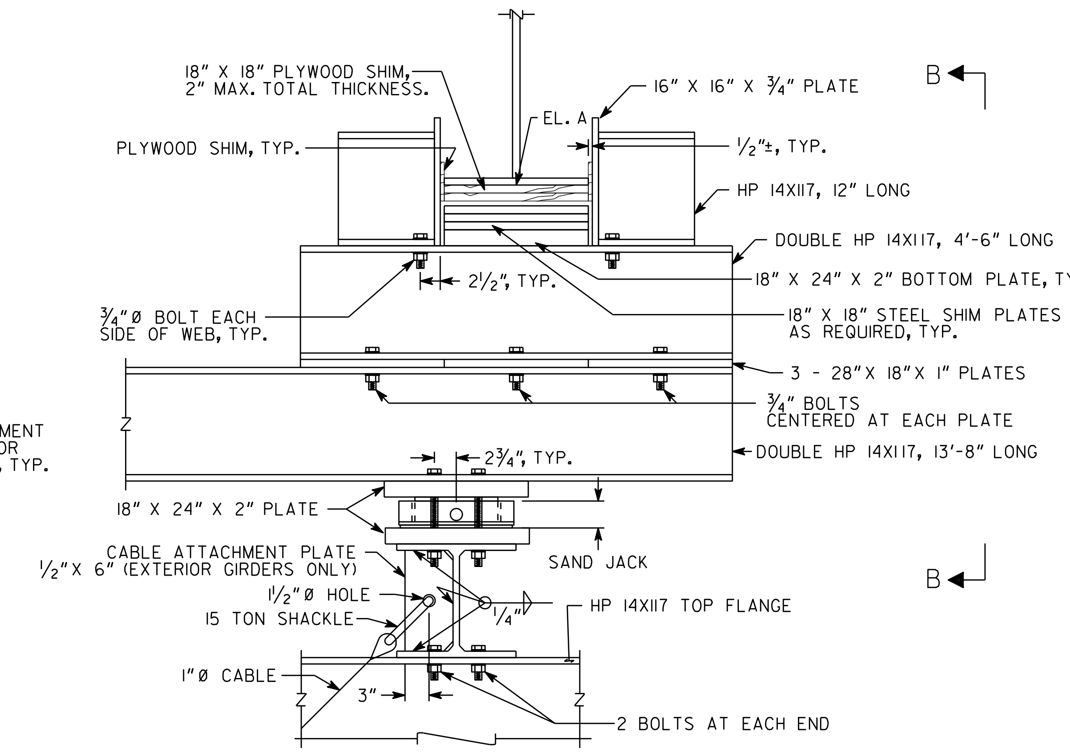
NOTE:
CROSS FRAMES NOT SHOWN FOR CLARITY.



SECTION THROUGH BRIDGE AT SHORING
LOOKING AHEAD



SECTION A-A

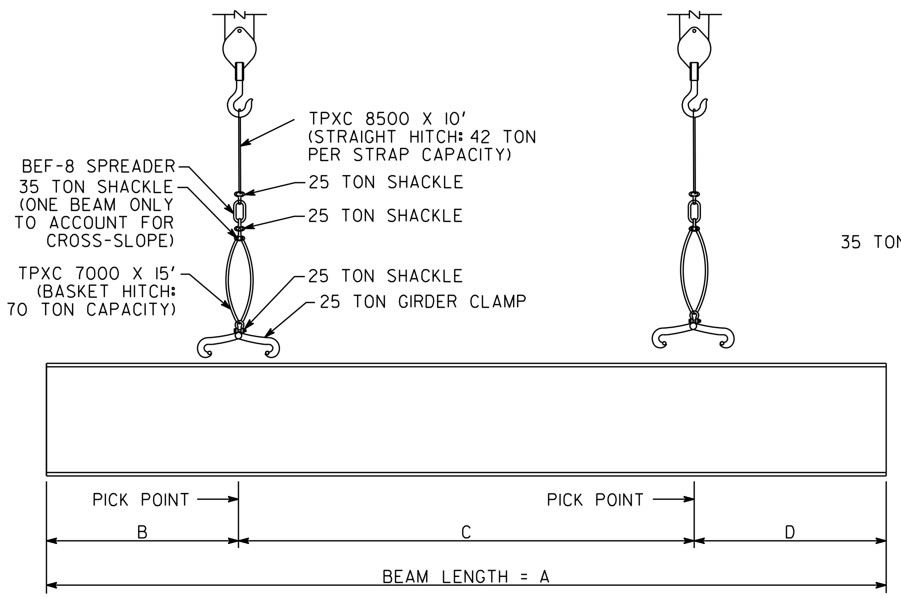


DETAIL A
½" = 1'-0"
DETAILS AT OTHER GIRDERS ARE SIMILAR.

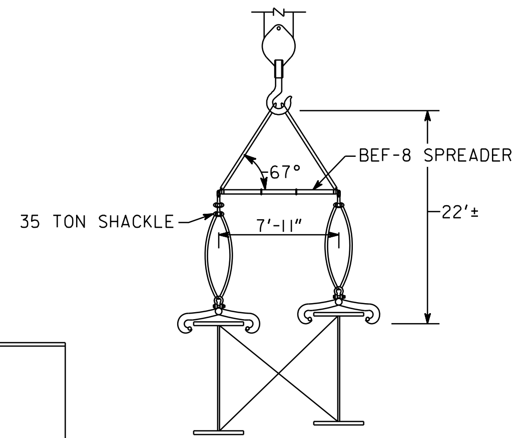
DATE / REVISIONS / BY	
	COMPANY LOGO
	PROJECT DETAILS PROJECT NAME: BRIDGE X I-599 M.L. OVER I-99 M.L. AND I-99 PROJECT XXXXX-9999-99(999) COUNTY, STATE
	SHEET DETAILS I-599 M.L. OVER I-99 M.L. AND I-99 SHORING DETAILS STAGE 3
SHEET 4 OF 10	SCALE: ⅛" = 1'-0" DATE: JANUARY 2017 DESIGNED DRAWN CHECKED

½ INCH WHEN PRINTED 11X17

PIECE	WEIGHT (EA)	QUANT.	TOTAL WT.
TPXC 8500 X 10'	17 LB	2	34 LB
25TN SHACKLE	28 LB	6	168 LB
BEF-8 SPREADER	313 LB	1	313 LB
TPXC 7000 X 15'	25 LB	2	50 LB
35TN SHACKLE	45 LB	1	45 LB
25TN GIRDER CLAMP	340 LB	2	680 LB
TOTAL RIGGING WEIGHT PER CRANE			1290 LB

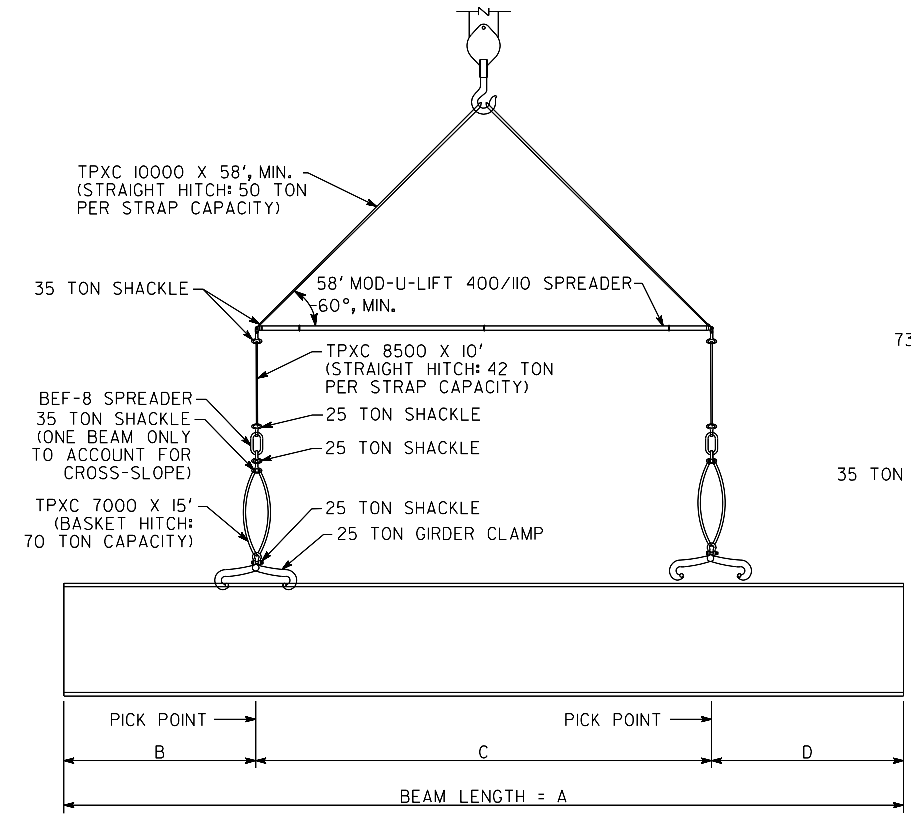


ELEVATION



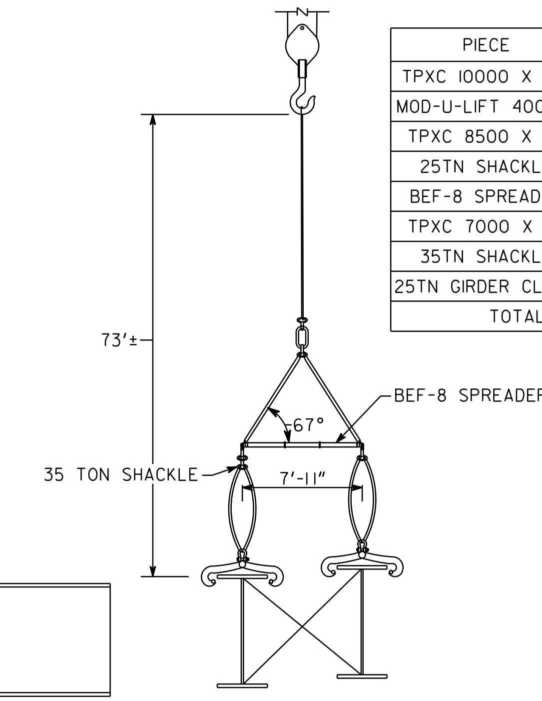
SECTION

RIGGING - PICK DETAIL A



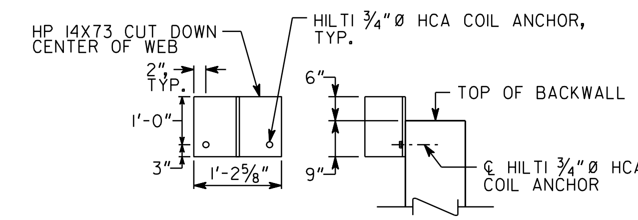
ELEVATION

RIGGING - PICK DETAIL C

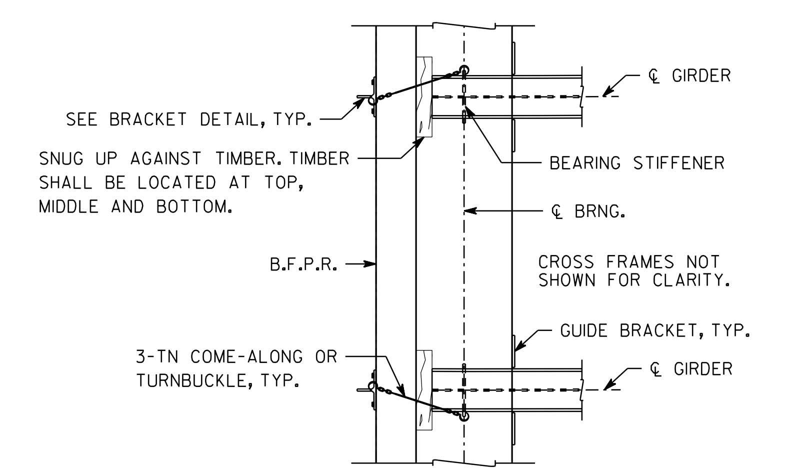


SECTION

PIECE	WEIGHT (EA)	QUANT.	TOTAL WT.
TPXC 10000 X 45'	128 LB	2	256 LB
MOD-U-LIFT 400/110	10108 LB	1	10108 LB
TPXC 8500 X 10'	17 LB	4	68 LB
25TN SHACKLE	28 LB	12	336 LB
BEF-8 SPREADER	313 LB	2	626 LB
TPXC 7000 X 15'	25 LB	4	100 LB
35TN SHACKLE	45 LB	6	270 LB
25TN GIRDER CLAMP	340 LB	4	1360 LB
TOTAL RIGGING WEIGHT PER CRANE			13124 LB

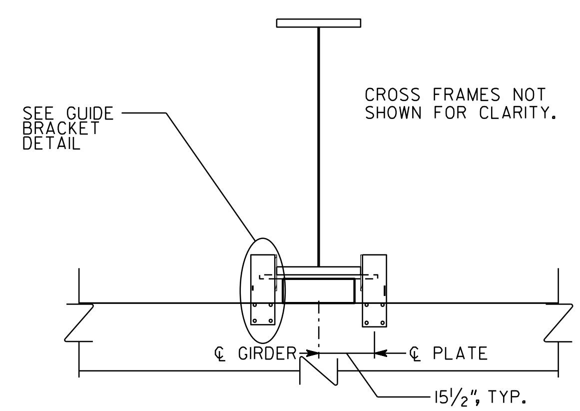


BRACKET DETAIL

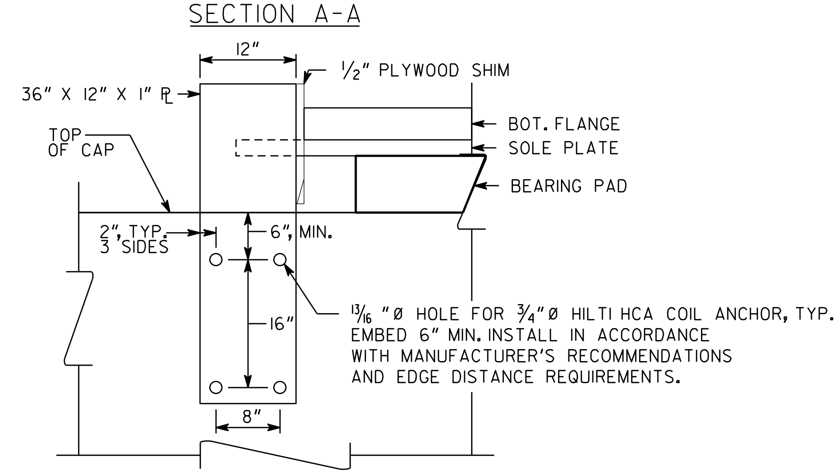


LONGITUDINAL RESTRAINT - DETAIL E END BENTS 1 & 5

¼" = 1'-0"



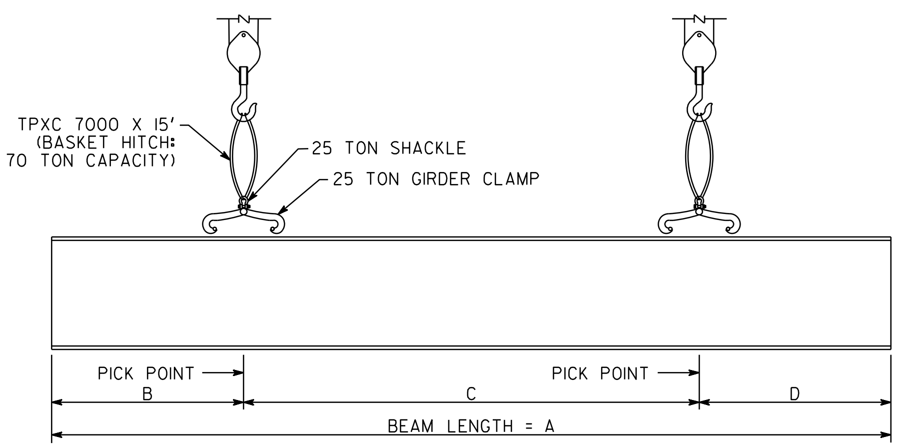
SECTION A-A



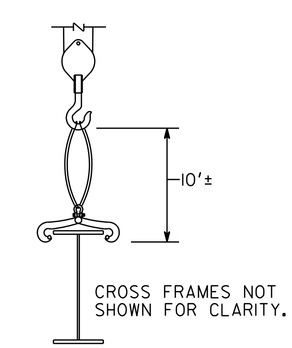
GUIDE BRACKET DETAIL

BRACING - DETAIL D - GIRDER AT BENT

PIECE	WEIGHT (EA)	QUANT.	TOTAL WT.
TPXC 7000 X 15'	25 LB	1	25 LB
25TN SHACKLE	28 LB	1	28 LB
25TN GIRDER CLAMP	340 LB	1	340 LB
TOTAL RIGGING WEIGHT PER CRANE			393 LB



ELEVATION



SECTION

RIGGING - PICK DETAIL B

DATE	COMPANY LOGO
REVISIONS	PROJECT DETAILS: PROJECT NAME: BRIDGE X I-599 M.L. OVER I-99 M.L. AND I-99 PROJECT XXXXX-9999-99(999) COUNTY, STATE
	SHEET DETAILS: I-599 M.L. OVER I-99 M.L. AND I-99 MISCELLANEOUS DETAILS
BY	SCALE: NONE DATE: JANUARY 2017
SHEET 5 OF 10	DESIGNED / DRAWN / CHECKED

½ INCH WHEN PRINTED 11X17

ERECTION PROCEDURE

1. PLACE CRANES IN POSITIONS 1 AND 2.
2. DELIVER GIRDERS 17D1 AND 24D2 TO UNLOAD POSITION.
3. PAIR GIRDERS BY CONNECTING ALL CROSS FRAMES.
4. DELIVER GIRDER 23CD2 TO UNLOAD POSITION. COMPLETE SPLICE WITH GIRDER 24D2.
5. DELIVER GIRDER 16CD1 TO UNLOAD POSITION. COMPLETE SPLICE WITH GIRDER 17D1.
6. COMPLETE PAIRING OF GIRDERS BY CONNECTING CROSS FRAMES BETWEEN GIRDERS 16CD1 AND 23CD2.
7. PICK PAIRED GIRDERS AND SWING GIRDERS INTO PLACE ON TO BENTS 4 AND 5, AND THEN HOLD.
8. SECURE GIRDERS AT BENT 4 AS PER DETAIL D AND ON BENT 5 AS PER DETAIL D AND DETAIL E, AS SHOWN ON SHEET 5.
9. TRANSFER LOAD TO PERMANENT BEARINGS AND RELEASE GIRDERS FROM CRANES.
10. DELIVER GIRDER 31D3 TO UNLOAD POSITION AND ATTACH CROSS FRAMES TO BOTH SIDES OF GIRDER.
11. DELIVER GIRDER 30CD3 TO UNLOAD POSITION AND ATTACH CROSS FRAMES TO BOTH SIDES OF GIRDER. COMPLETE SPLICE WITH GIRDER 31D3.
12. PICK GIRDERS AND SWING INTO PLACE ON TO BENTS 4 AND 5, AND THEN HOLD.
13. SECURE GIRDERS AT BENT 4 AS PER DETAIL D AND ON BENT 5 AS PER DETAIL E, AS SHOWN ON SHEET 5.
14. ATTACH CROSS FRAMES BETWEEN GIRDERS 23CD2 AND 30CD3 AND BETWEEN GIRDERS 24D2 AND 31D3.
15. TRANSFER LOAD TO PERMANENT BEARINGS AND RELEASE GIRDER FROM CRANES.
16. DELIVER GIRDER 38D4 TO UNLOAD POSITION.
17. DELIVER GIRDER 37CD4 TO UNLOAD POSITION. COMPLETE SPLICE WITH GIRDER 38D4.
18. PICK GIRDERS AND SWING INTO PLACE ON TO BENTS 4 AND 5, AND THEN HOLD.
19. SECURE GIRDERS AT BENT 4 AS PER DETAIL D AND ON BENT 5 AS PER DETAIL E, AS SHOWN ON SHEET 5.
20. ATTACH CROSS FRAMES BETWEEN GIRDERS 30CD3 AND 37CD4 AND BETWEEN GIRDERS 31D3 AND 38D4.
21. TRANSFER LOAD TO PERMANENT BEARINGS AND RELEASE GIRDERS FROM CRANES.

ERECTION SEQUENCE

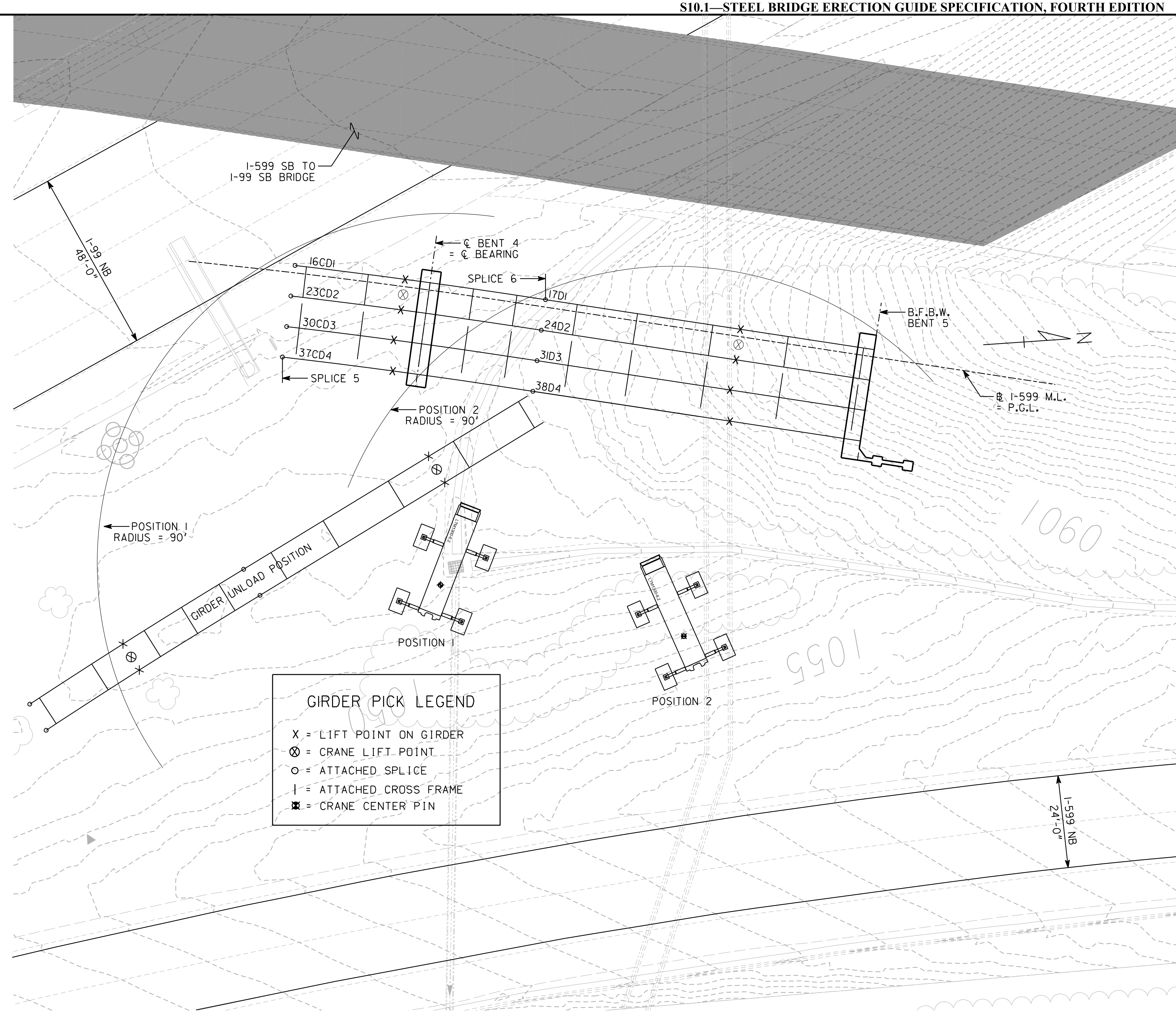
1. 16CD1/17D1 - 23CD2/24D2 PAIR
2. 30CD3/31D3
3. 37CD4/38D4

LTM1300 - 75% OF 360° CHART CAPACITY	
RADIUS	CAPACITY
85′	61,200 LB
90′	56,600 LB
95′	52,500 LB
110′	42,500 LB
115′	39,500 LB
120′	27,200 LB

CRANE NOTES:

1. LIEBHERR LTM 1300-6.2 CRANE WITH 128′ BOOM.
2. ALL CAPACITIES SHOWN WITH 211,600 LB. COUNTERWEIGHT.

STAGE 1 TRAFFIC:
-THERE ARE NO LANE CLOSURES DURING STAGE 1 STEEL ERECTION.



PIECE MARK	PICK DETAIL	LIFT POINT LOCATIONS A ARC	A CHORD	B ARC	B CHORD	C ARC	C CHORD	D ARC	D CHORD	PICK WEIGHTS (LB) PIECE WEIGHT	SPLICE PLATES WEIGHT	CROSS FRAME WEIGHT	RIGGING WEIGHT (EACH)	HOOK BLOCK CRANE 1	HOOK BLOCK CRANE 2	TOTAL PICK WEIGHT	LTM1300 RADIUS	LTM1300 PICK WT.	LTM1300 RADIUS	LTM1300 PICK WT.
16CD1/17D1	A	149.32′	149.27′	28.55′	28.55′	87.19′	87.18′	33.58′	33.58′	81,100	3,200	4,000	1,290	3,530	3,530	97,940	95′, MAX.	48,970	95′, MAX.	48,970
23CD2/24D2		149.23′	149.19′	28.53′	28.53′	87.13′	87.12′	33.58′	33.58′											
30CD3/31D3	B	149.16′	149.11′	27.78′	27.78′	87.44′	87.43′	33.94′	33.94′	41,200	1,600	7,900	400	3,530	3,530	58,560	115′, MAX.	29,280	115′, MAX.	29,280
37CD4/38D4	B	149.07′	149.02′	28.59′	28.59′	87.62′	87.61′	32.86′	32.86′	39,700	1,600	0	400	3,530	3,530	49,160	120′, MAX.	24,580	120′, MAX.	24,580

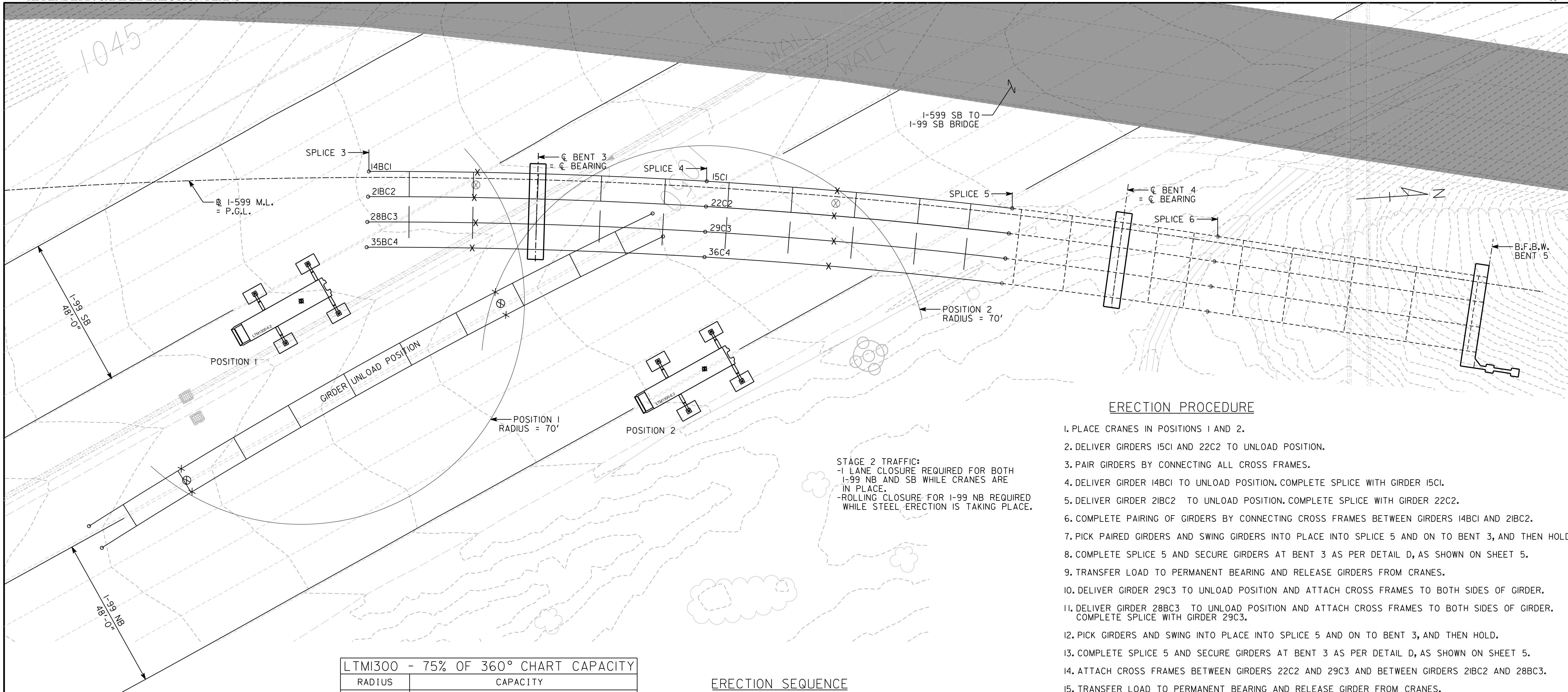
DATE
REVISIONS
BY

COMPANY LOGO

PROJECT DETAILS
PROJECT NAME: BRIDGE X
I-599 M.L. OVER I-99 M.L. AND I-99
PROJECT XXXXX-9999-99(999) COUNTY, STATE

SHEET DETAILS
I-599 M.L. OVER I-99 M.L. AND I-99
LIFTING PLAN
STAGE 1

SHEET 6 OF 10
SCALE: 1″= 30′
DATE: JANUARY 2017
DESIGNED DRAWN CHECKED
1/2 INCH WHEN PRINTED 11X17



ERECTION PROCEDURE

1. PLACE CRANES IN POSITIONS 1 AND 2.
2. DELIVER GIRDERS 15C1 AND 22C2 TO UNLOAD POSITION.
3. PAIR GIRDERS BY CONNECTING ALL CROSS FRAMES.
4. DELIVER GIRDER 14BC1 TO UNLOAD POSITION. COMPLETE SPLICE WITH GIRDER 15C1.
5. DELIVER GIRDER 21BC2 TO UNLOAD POSITION. COMPLETE SPLICE WITH GIRDER 22C2.
6. COMPLETE PAIRING OF GIRDERS BY CONNECTING CROSS FRAMES BETWEEN GIRDERS 14BC1 AND 21BC2.
7. PICK PAIRED GIRDERS AND SWING GIRDERS INTO PLACE INTO SPLICE 5 AND ON TO BENT 3, AND THEN HOLD.
8. COMPLETE SPLICE 5 AND SECURE GIRDERS AT BENT 3 AS PER DETAIL D, AS SHOWN ON SHEET 5.
9. TRANSFER LOAD TO PERMANENT BEARING AND RELEASE GIRDERS FROM CRANES.
10. DELIVER GIRDER 29C3 TO UNLOAD POSITION AND ATTACH CROSS FRAMES TO BOTH SIDES OF GIRDER.
11. DELIVER GIRDER 28BC3 TO UNLOAD POSITION AND ATTACH CROSS FRAMES TO BOTH SIDES OF GIRDER. COMPLETE SPLICE WITH GIRDER 29C3.
12. PICK GIRDERS AND SWING INTO PLACE INTO SPLICE 5 AND ON TO BENT 3, AND THEN HOLD.
13. COMPLETE SPLICE 5 AND SECURE GIRDERS AT BENT 3 AS PER DETAIL D, AS SHOWN ON SHEET 5.
14. ATTACH CROSS FRAMES BETWEEN GIRDERS 22C2 AND 29C3 AND BETWEEN GIRDERS 21BC2 AND 28BC3.
15. TRANSFER LOAD TO PERMANENT BEARING AND RELEASE GIRDER FROM CRANES.
16. DELIVER GIRDER 36C4 TO UNLOAD POSITION.
17. DELIVER GIRDER 35BC4 TO UNLOAD POSITION. COMPLETE SPLICE WITH GIRDER 36C4.
18. PICK GIRDERS AND SWING INTO PLACE INTO SPLICE 5 AND ON TO BENT 3, AND THEN HOLD.
19. COMPLETE SPLICE 5 AND SECURE GIRDERS AT BENT 4 AS PER DETAIL D, AS SHOWN ON SHEET 5.
20. ATTACH CROSS FRAMES BETWEEN GIRDERS 29C3 AND 36C4 AND BETWEEN GIRDERS 28BC3 AND 35BC4.
21. TRANSFER LOAD TO PERMANENT BEARING AND RELEASE GIRDERS FROM CRANES.

ERECTION SEQUENCE

1. 14BC1/15C1 - 21BC2/22C2 PAIR
2. 28BC3/29C3
3. 35BC4/36C4

LTM1300 - 75% OF 360° CHART CAPACITY

RADIUS	CAPACITY
60'	96,100 LB
65'	86,900 LB
70'	79,100 LB
105'	45,500 LB
110'	42,500 LB
115'	39,500 LB

CRANE NOTES:

1. LIEBHERR LTM 1300-6.2 CRANE WITH 128' BOOM.
2. ALL CAPACITIES SHOWN WITH 211,600 LB. COUNTERWEIGHT.

GIRDER PICK LEGEND

- X = LIFT POINT ON GIRDER
- ⊗ = CRANE LIFT POINT
- O = ATTACHED SPLICE
- | = ATTACHED CROSS FRAME
- ⌧ = CRANE CENTER PIN

		LIFT POINT LOCATIONS								PICK WEIGHTS (LB)										
PIECE MARK	PICK DETAIL	A		B		C		D		PIECE WEIGHT	SPLICE PLATES WEIGHT	CROSS FRAME WEIGHT	RIGGING WEIGHT (EACH)	HOOK BLOCK CRANE 1	HOOK BLOCK CRANE 2	TOTAL PICK WEIGHT	LTM1300		LTM1300	
		ARC	CHORD	ARC	CHORD	ARC	CHORD	ARC	CHORD								RADIUS	PICK WT.	RADIUS	PICK WT.
14BC1/15C1	A	202.32'	202.20'	34.05'	34.05'	113.00'	112.98'	55.27'	55.26'	133,800	3,200	4,000	1,290	3,530	3,530	150,640	70', MAX.	75,320	70', MAX.	75,320
21BC2/22C2		201.45'	201.33'	33.96'	33.96'	112.46'	112.44'	55.03'	55.03'											
28BC3/29C3	B	200.58'	200.46'	34.48'	34.48'	112.10'	112.08'	54.00'	54.00'	67,200	1,600	7,900	400	3,530	3,530	84,560	110', MAX.	42,280	110', MAX.	42,280
35BC4/36C4	B	199.71'	199.60'	33.10'	33.10'	111.90'	111.88'	54.72'	54.71'	65,600	1,600	0	400	3,530	3,530	75,060	115', MAX.	37,530	115', MAX.	37,530

DATE | REVISIONS | BY

COMPANY LOGO

PROJECT DETAILS
PROJECT NAME: BRIDGE X
I-599 M.L. OVER I-99 M.L. AND I-99
PROJECT XXXXX-9999-99(999) COUNTY, STATE

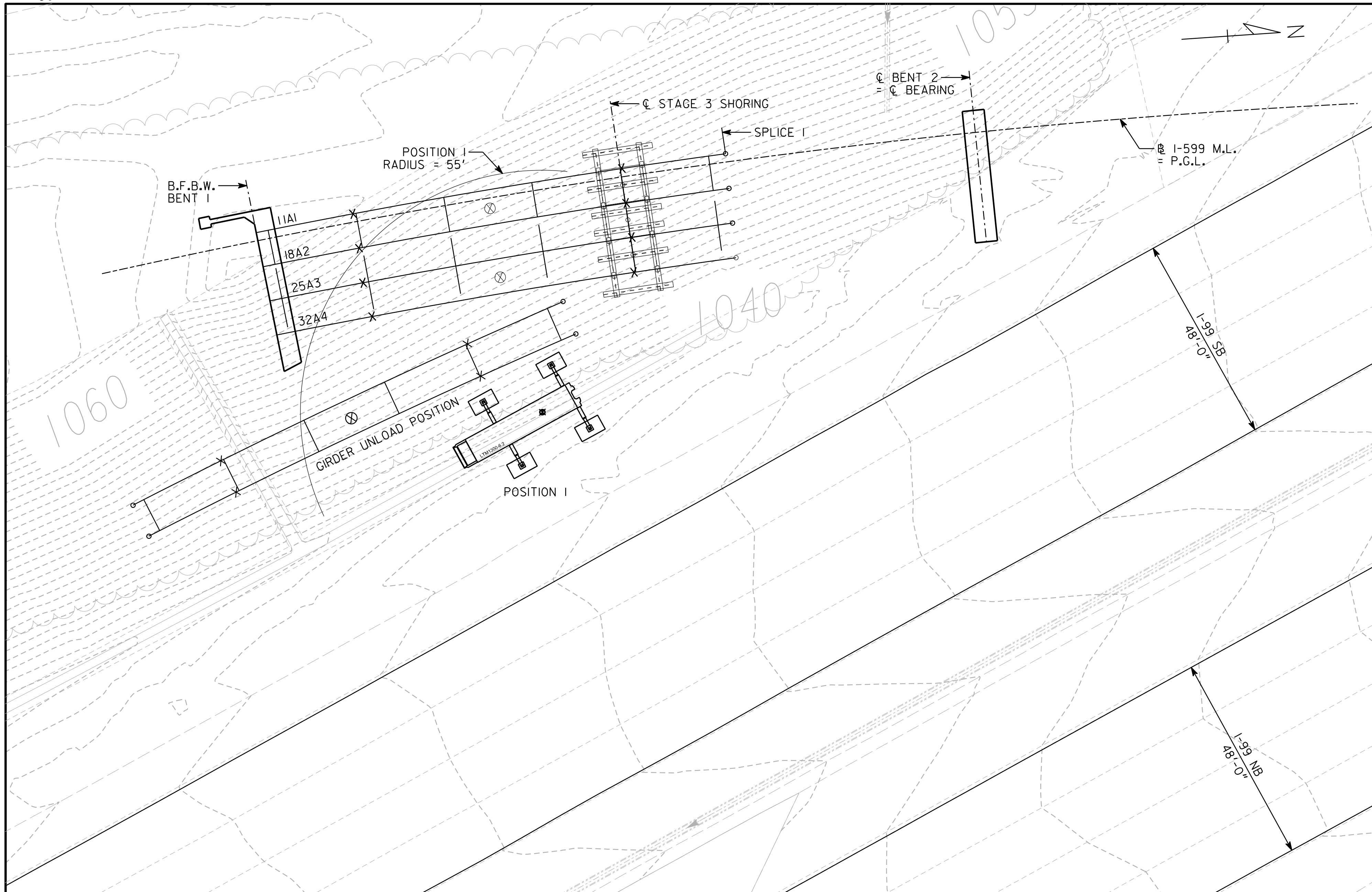
SHEET DETAILS
I-599 M.L. OVER I-99 M.L. AND I-99
LIFTING PLAN
STAGE 2

SHEET 7 OF 10

SCALE: 1"= 30'   DATE: JANUARY 2017

DESIGNED | DRAWN | CHECKED

1/2 INCH WHEN PRINTED 11X17



ERECTION PROCEDURE

1. INSTALL SHORING, TOP CRIBBING AND SHIMS AS SHOWN ON SHEET 4. ADJUST TOPS OF SHIMS TO ELEVATION "A."
2. PLACE CRANE IN POSITION 1.
3. DELIVER GIRDERS 11A1 AND 18A2 TO UNLOAD POSITION.
4. PAIR GIRDERS BY CONNECTING ALL CROSS FRAMES.
5. PICK GIRDERS AND SWING INTO PLACE ON TO BENT 1 AND SHORING TOWER, AND THEN HOLD.
6. SECURE GIRDERS AT BENT 1 AS PER DETAIL D AND AS PER DETAIL E, AS SHOWN ON SHEET 5.
7. TRANSFER LOAD TO SHORING AND PERMANENT BEARING, AND RELEASE GIRDERS FROM CRANES.
8. DELIVER GIRDER 25A3 TO UNLOAD POSITION AND ATTACH CROSS FRAMES TO BOTH SIDES OF GIRDER.
9. PICK GIRDER AND SWING INTO PLACE ON TO BENT 1 AND SHORING TOWER, AND THEN HOLD.
10. SECURE GIRDER AT BENT 1 AS PER DETAIL D AND AS PER DETAIL E, AS SHOWN ON SHEET 5.
11. ATTACH CROSS FRAMES BETWEEN GIRDERS 18A2 AND 25A3.
12. TRANSFER LOAD TO SHORING AND PERMANENT BEARING, AND RELEASE GIRDER FROM CRANES.
13. DELIVER GIRDER 32A4 TO UNLOAD POSITION.
14. PICK GIRDER AND SWING INTO PLACE ON TO BENT 1 AND SHORING TOWER, AND THEN HOLD.
15. SECURE GIRDER AT BENT 1 AS PER DETAIL D AND AS PER DETAIL E, AS SHOWN ON SHEET 5.
16. ATTACH CROSS FRAMES BETWEEN GIRDERS 25A3 AND 32A4.
17. TRANSFER LOAD TO SHORING AND PERMANENT BEARING, AND RELEASE GIRDER FROM CRANES.

STAGE 3 TRAFFIC:
-THERE ARE NO LANE CLOSURES DURING STAGE 3 STEEL ERECTION.

LTM1300 - 75% OF 360° CHART CAPACITY	
RADIUS	CAPACITY
45′	110,300 LB
50′	96,200 LB
55′	83,700 LB

CRANE NOTES:

1. LIEBHERR LTM 1300-6.2 CRANE WITH 128′ BOOM.
2. ALL CAPACITIES SHOWN WITH 123,500 LB. COUNTERWEIGHT.

GIRDER PICK LEGEND

X = LIFT POINT ON GIRDER
⊗ = CRANE LIFT POINT
O = ATTACHED SPLICE
| = ATTACHED CROSS FRAME
⌧ = CRANE CENTER PIN

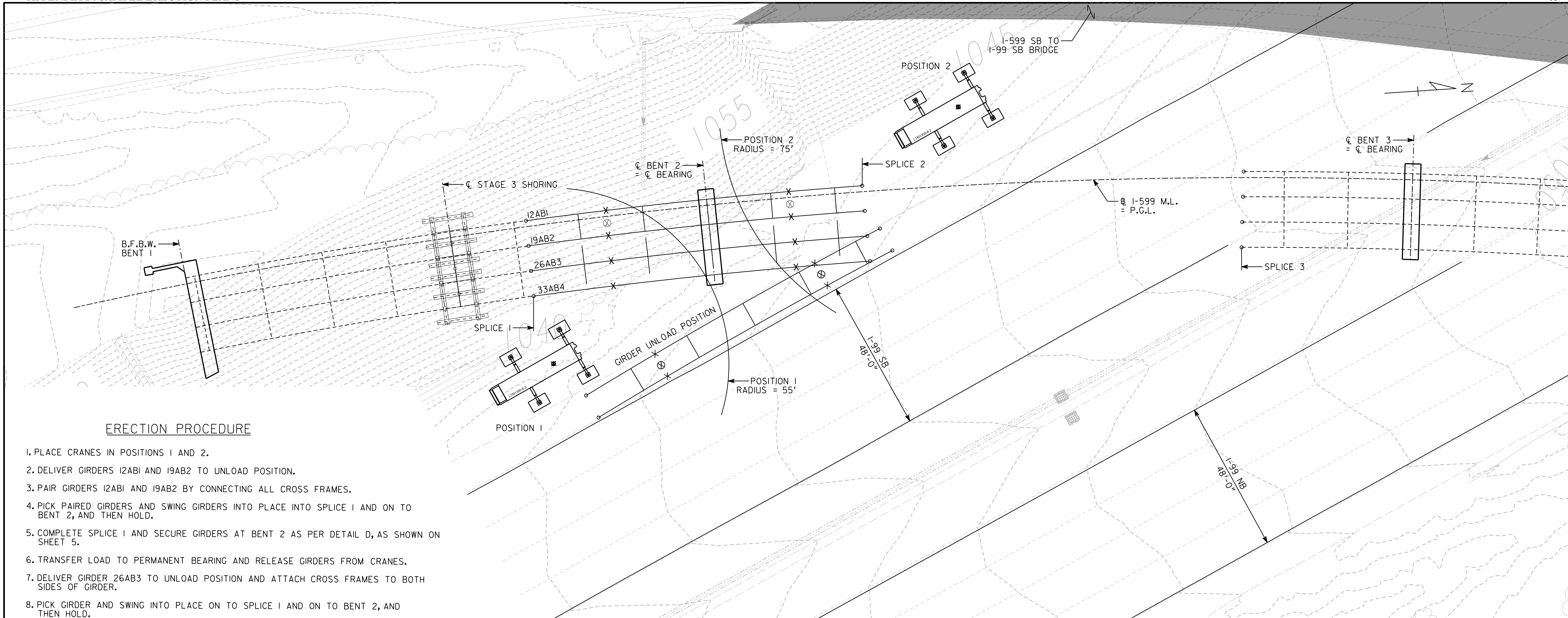
ERECTION SEQUENCE

1. 11A1 - 18A2 PAIR
2. 25A3 - 32A4 PAIR

		LIFT POINT LOCATIONS								PICK WEIGHTS (LB)								
PIECE MARK	PICK DETAIL	A		B		C		D		PIECE WEIGHT	SPLICE PLATES WEIGHT	CROSS FRAME WEIGHT	RIGGING WEIGHT (EACH)	HOOK BLOCK CRANE 1	HOOK BLOCK CRANE 2	TOTAL PICK WEIGHT	LTM1300	
		ARC	CHORD	ARC	CHORD	ARC	CHORD	ARC	CHORD								RADIUS	PICK WT.
11A1	C	106.97′	106.96′	24.38′	24.38′	58.00′	58.00′	24.59′	24.59′	57,200	0	2,400	13,130	3,530	N/A	76,260	55′, MAX.	76,260
18A2		106.21′	106.19′	24.00′	24.00′	58.00′	58.00′	24.21′	24.21′									
25A3	C	105.44′	105.42′	23.62′	23.62′	58.00′	58.00′	23.81′	23.81′	56,500	0	2,400	13,130	3,530	N/A	75,560	55′, MAX.	75,560
32A4		104.67′	104.65′	23.25′	23.25′	58.00′	58.00′	23.42′	23.42′									

DATE	COMPANY LOGO
REVISIONS	PROJECT DETAILS PROJECT NAME: BRIDGE X I-599 M.L. OVER I-99 M.L. AND I-99 PROJECT XXXXX-9999-99(999) COUNTY, STATE
	SHEET DETAILS I-599 M.L. OVER I-99 M.L. AND I-99 LIFTING PLAN STAGE 3
BY	SCALE: 1″= 30′ DATE: JANUARY 2017
SHEET 8 OF 10	DESIGNED DRAWN CHECKED

1/2 INCH WHEN PRINTED 11X17



ERECTION PROCEDURE

1. PLACE CRANES IN POSITIONS 1 AND 2.
2. DELIVER GIRDERS 12AB1 AND 19AB2 TO UNLOAD POSITION.
3. PAIR GIRDERS 12AB1 AND 19AB2 BY CONNECTING ALL CROSS FRAMES.
4. PICK PAIRED GIRDERS AND SWING GIRDERS INTO PLACE INTO SPLICE 1 AND ON TO BENT 2, AND THEN HOLD.
5. COMPLETE SPLICE 1 AND SECURE GIRDERS AT BENT 2 AS PER DETAIL D, AS SHOWN ON SHEET 5.
6. TRANSFER LOAD TO PERMANENT BEARING AND RELEASE GIRDERS FROM CRANES.
7. DELIVER GIRDER 26AB3 TO UNLOAD POSITION AND ATTACH CROSS FRAMES TO BOTH SIDES OF GIRDER.
8. PICK GIRDER AND SWING INTO PLACE ON TO SPLICE 1 AND ON TO BENT 2, AND THEN HOLD.
9. COMPLETE SPLICE 1 AND SECURE GIRDER AT BENT 2 AS PER DETAIL D, AS SHOWN ON SHEET 5.
10. ATTACH CROSS FRAMES BETWEEN GIRDERS 19AB2 AND 26AB3.
11. TRANSFER LOAD TO PERMANENT BEARING AND RELEASE GIRDER FROM CRANES.
12. DELIVER GIRDER 33AB4 TO UNLOAD POSITION.
13. PICK GIRDER AND SWING INTO PLACE INTO SPLICE 1 AND ON TO BENT 2, AND THEN HOLD.
14. COMPLETE SPLICE 1 AND SECURE GIRDER AT BENT 2 AS PER DETAIL D, AS SHOWN ON SHEET 5.
15. ATTACH CROSS FRAMES BETWEEN GIRDERS 26AB3 AND 33AB4.
16. TRANSFER LOAD TO PERMANENT BEARING AND RELEASE GIRDER FROM CRANES.

LTM1300 - 75% OF 360° CHART CAPACITY	
RADIUS	CAPACITY
70'	56,500 LB
75'	50,300 LB
100'	33,700 LB
105'	31,000 LB
110'	28,600 LB
115'	26,500 LB

CRANE NOTES:

1. LIEBHERR LTM 1300-6.2 CRANE WITH 128' BOOM.
2. ALL CAPACITIES SHOWN WITH 123,500 LB. COUNTERWEIGHT.

ERECTION SEQUENCE

1. 12AB1-19AB2 PAIR
2. 26AB3
3. 33AB4

GIRDER PICK LEGEND

X = LIFT POINT ON GIRDER
⊗ = CRANE LIFT POINT
○ = ATTACHED SPLICE
| = ATTACHED CROSS FRAME
⊠ = CRANE CENTER PIN

STAGE 4 TRAFFIC:
-THERE ARE NO LANE CLOSURES DURING STAGE 4 STEEL ERECTION

PIECE MARK	PICK DETAIL	LIFT POINT LOCATIONS A ARC	A CHORD	B ARC	B CHORD	C ARC	C CHORD	D ARC	D CHORD	PICK WEIGHTS (LB) PIECE WEIGHT	SPLICE PLATES WEIGHT	CROSS FRAME WEIGHT	RIGGING WEIGHT (EACH)	HOOK BLOCK CRANE 1	HOOK BLOCK CRANE 2	TOTAL PICK WEIGHT	LTM1300 RADIUS	LTM1300 PICK WT.	LTM1300 RADIUS	LTM1300 PICK WT.
12AB1	A	106.10'	106.09'	25.23'	25.23'	57.63'	57.62'	23.24'	23.24'	84,100	3200	2000	1,290	3,530	3,530	98,940	75', MAX.	49,470	75', MAX.	49,470
19AB2		106.10'	106.09'	25.24'	25.24'	57.62'	57.62'	23.25'	23.25'											
26AB3	B	106.10'	106.09'	25.36'	25.36'	57.92'	57.91'	22.83'	22.83'	42,400	1600	4000	400	3,530	3,530	55,860	110', MAX.	27,930	110', MAX.	27,930
33AB4	B	106.10'	106.09'	25.17'	25.17'	57.63'	57.63'	23.30'	23.30'	41,700	1600	0	400	3,530	3,530	51,160	115', MAX.	25,580	115', MAX.	25,580

SHEET
9 OF 10

DATE | REVISIONS | BY

COMPANY LOGO

PROJECT DETAILS
PROJECT NAME: BRIDGE X
I-599 M.L. OVER I-99 M.L. AND I-99
PROJECT XXXXX-9999-99(999) COUNTY, STATE

SHEET DETAILS
I-599 M.L. OVER I-99 M.L. AND I-99
LIFTING PLAN
STAGE 4

SCALE: 1"= 30' DATE: JANUARY 2017
DESIGNED | DRAWN | CHECKED

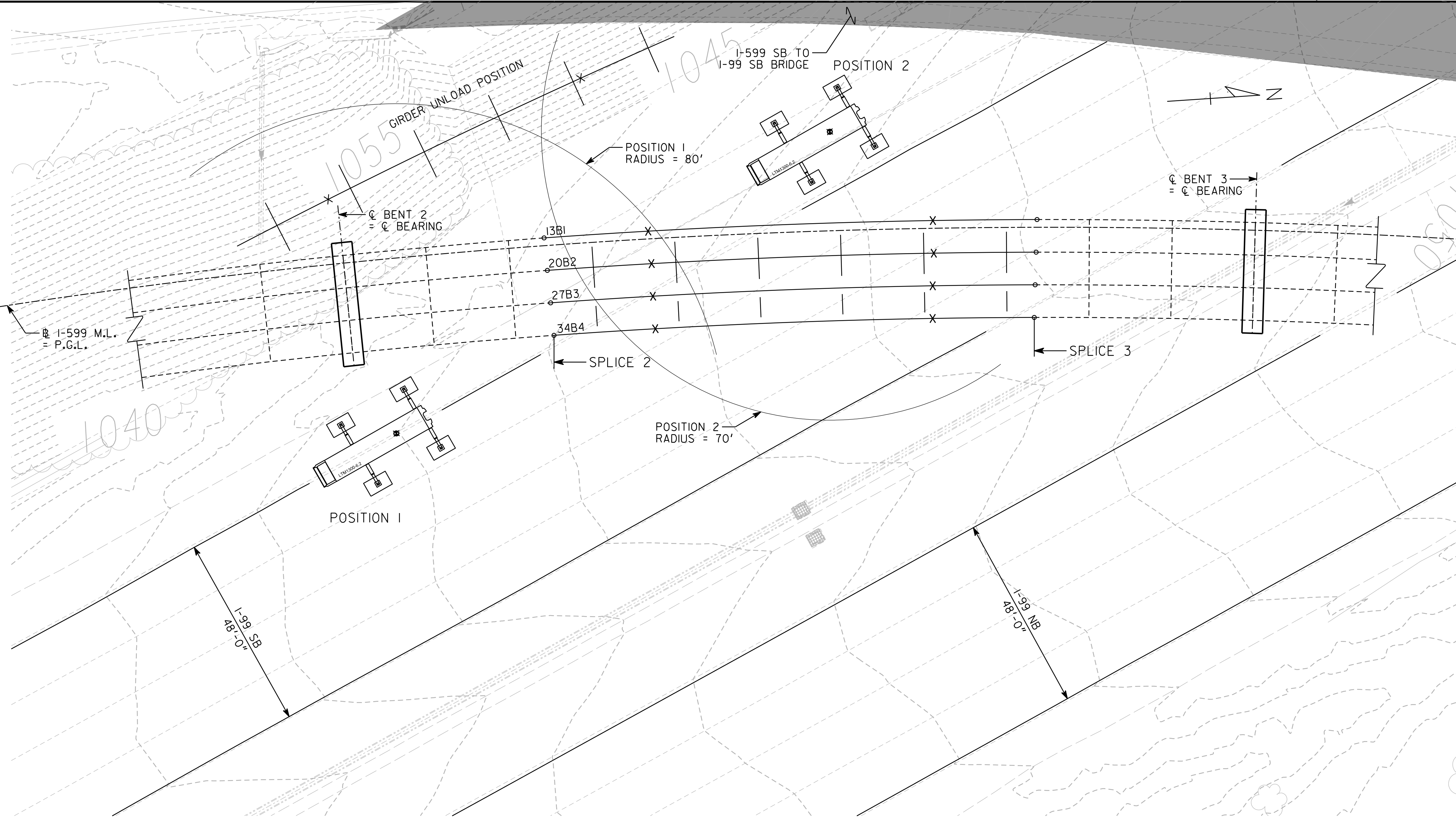
1/2 INCH WHEN PRINTED 11X17

ERECTION PROCEDURE

1. PLACE CRANES IN POSITION 1 AND 2.
2. DELIVER GIRDER 13B1 TO UNLOAD POSITION.
3. PICK GIRDER AND SWING GIRDER INTO PLACE INTO SPLICE 2 AND 3, AND THEN HOLD.
4. COMPLETE SPLICE 2 AND RELEASE FROM CRANE 1.
5. COMPLETE SPLICE 3 AND RELEASE FROM CRANE 2.
6. DELIVER GIRDER 20B2 TO UNLOAD POSITION AND ATTACH CROSS FRAMES TO BOTH SIDES OF GIRDER.
7. PICK GIRDER AND SWING INTO PLACE INTO SPLICE 2 AND 3, AND THEN HOLD.
8. COMPLETE SPLICE 2 AND RELEASE FROM CRANE 1.
9. ATTACH CROSS FRAMES BETWEEN GIRDERS 13B1 AND 20B2.
10. COMPLETE SPLICE 3 AND RELEASE FROM CRANE 2.
11. DELIVER GIRDER 27B3 TO UNLOAD POSITION.
12. PICK GIRDER AND SWING INTO PLACE INTO SPLICE 2 AND 3, AND THEN HOLD.
13. COMPLETE SPLICE 2 AND RELEASE FROM CRANE 1.
14. ATTACH CROSS FRAMES BETWEEN GIRDERS 20B2 AND 27B3.
15. COMPLETE SPLICE 3 AND RELEASE FROM CRANE 2.
16. DELIVER GIRDER 34B4 TO UNLOAD POSITION.
17. PICK GIRDER AND SWING INTO PLACE INTO SPLICE 2 AND 3, AND THEN HOLD.
18. COMPLETE SPLICE 2 AND RELEASE FROM CRANE 1.
19. ATTACH CROSS FRAMES BETWEEN GIRDERS 27B3 AND 34B4.
20. COMPLETE SPLICE 3 AND RELEASE FROM CRANE 2.

NOTE:
GIRDER 20B2 SHALL BE PLACED WITHIN 24 HOURS OF PLACING GIRDER 13B1. NEITHER SHALL BE PLACED IF WINDS ARE EXPECTED TO EXCEED 10 MPH IN THE FOLLOWING 48 HOURS.

STAGE 5 TRAFFIC:
-1 LANE CLOSURE REQUIRED FOR I-99 SB WHILE CRANES ARE IN PLACE.
-ROLLING CLOSURE FOR I-99 SB REQUIRED WHILE STEEL ERECTION IS TAKING PLACE.



LTM1300 - 75% OF 360° CHART CAPACITY	
RADIUS	CAPACITY
70'	56,500 LB
80'	46,800 LB
90'	40,000 LB
120'	24,700 LB

CRANE NOTES:

1. LIEBHERR LTM 1300-6.2 CRANE WITH 128' BOOM.
2. ALL CAPACITIES SHOWN WITH 123,500 LB. COUNTERWEIGHT.

ERECTION SEQUENCE

1. 13B1
2. 20B2
3. 27B3
4. 34B4

GIRDER PICK LEGEND

X = LIFT POINT ON GIRDER
⊗ = CRANE LIFT POINT
○ = ATTACHED SPLICE
| = ATTACHED CROSS FRAME
⊠ = CRANE CENTER PIN

PIECE MARK	PICK DETAIL	LIFT POINT LOCATIONS								PICK WEIGHTS (LB)										
		A		B		C		D		PIECE WEIGHT	SPLICE PLATES WEIGHT	CROSS FRAME WEIGHT	RIGGING WEIGHT (EACH)	HOOK BLOCK CRANE 1	HOOK BLOCK CRANE 2	TOTAL PICK WEIGHT	LTM1300		LTM1300	
		ARC	CHORD	ARC	CHORD	ARC	CHORD	ARC	CHORD								RADIUS	PICK WT.	RADIUS	PICK WT.
13B1	B	119.93'	119.91'	25.30'	25.30'	69.13'	69.13'	25.50'	25.50'	33,200	0	0	400	3,530	3,530	41,060	120', MAX.	20,530	120', MAX.	20,530
20B2	B	118.90'	118.88'	25.32'	25.32'	68.55'	68.55'	25.03'	25.03'	33,600	0	4,800	400	3,530	3,530	46,260	120', MAX.	23,130	120', MAX.	23,130
27B3	B	117.87'	117.85'	24.87'	24.87'	67.94'	67.94'	25.06'	25.06'	33,400	0	0	400	3,530	3,530	41,260	120', MAX.	20,630	120', MAX.	20,630
34B4	B	116.84'	116.81'	24.65'	24.65'	67.35'	67.34'	24.84'	24.84'	32,400	0	0	400	3,530	3,530	40,260	120', MAX.	20,130	120', MAX.	20,130

SHEET
10 OF 10

DATE
REVISIONS
BY

COMPANY LOGO

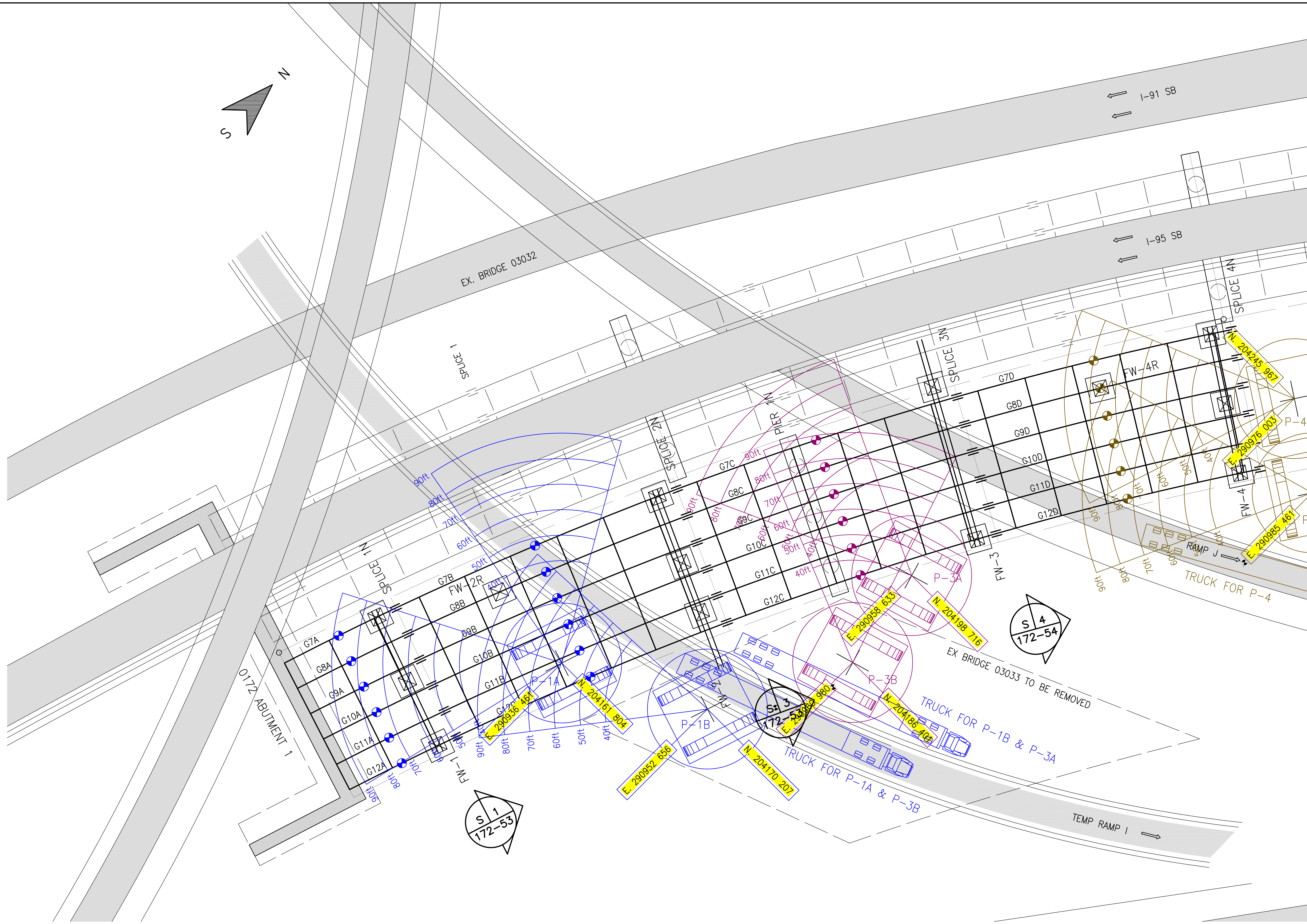
PROJECT DETAILS
PROJECT NAME: BRIDGE X
I-599 M.L. OVER I-99 M.L. AND I-99
PROJECT XXXXX-9999-99(999) COUNTY, STATE

SHEET DETAILS
I-599 M.L. OVER I-99 M.L. AND I-99
LIFTING PLAN
STAGE 5

SCALE: 1" = 30'
DATE: JANUARY 2017
DESIGNED
DRAWN
CHECKED

1/2 INCH WHEN PRINTED 11X17


I-91 SB
I-95 SB
EX. BRIDGE 03032
SPLICE 1
SPLICE 1N
SPLICE 2N
SPLICE 3N
SPLICE 4N
SPLICE 5N
SPLICE 6N
PIER 1N
PIER 2N
PIER 3N
FW-1
FW-2
FW-3
FW-4
FW-5
FW-2R
FW-4R
FW-5R
0172 ABUTMENT 1
WP3
WP5
WP22
WP23
WP24
WP25
RAMP J
TEMP RAMP I
EX BRIDGE 03033 TO BE REMOVED
I-91 NB
STREET
46'-9½"
114'-11¼"
45'-8¾"
65'-5"
106'-4¼"
67'-1¼"
47'-9"
114'-9¼"
73'-2½"
N.B. ERECTION KEY PLAN
SCALE: 1:350
2 REVISE AND RESUBMIT 12-10-15
1 PRELIMINARY 10-16-15
DESCRIPTION
DATE
BRIDGE 00172 ERECTION PLAN
DWN: D.C.
DES: D.C.
CHK: R.J.
SCALE AS SHOWN
DWG. NO. 0172-45
REVISION --
SHEET 1 OF 14



ERECTION PLAN 1 OF 2

SCALE: 1:250

REV.	DESCRIPTION	BY	DATE
2	REVISE AND RESUBMIT		12-10-15
1	PRELIMINARY		10-16-15

BRIDGE 00172 ERECTION PLAN

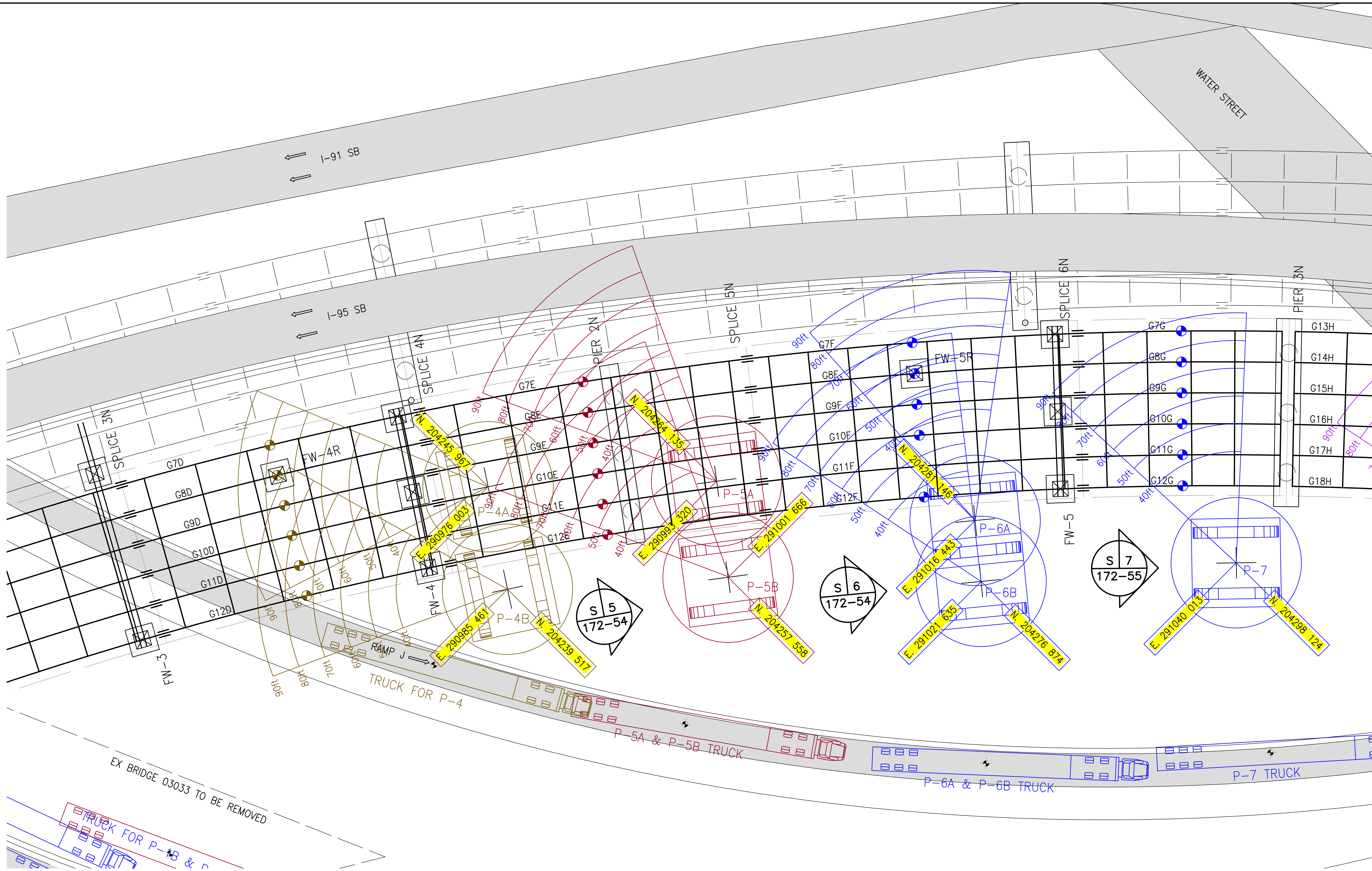
DWN: D.C.
DES: D.C.
CHK: R.J.

SCALE: AS SHOWN

DWG. NO. 0172-46

SHEET 2 OF 14

REVISION --



ERECTION PLAN 2 OF 2

SCALE: 1:250

REV	DESCRIPTION	BY	DATE
3	RELOCATE CRANE POSITION P-4		2-29-16
2	REVISE AND RESUBMIT		12-10-15
1	PRELIMINARY		10-16-15

BRIDGE 00172 ERECTION PLAN

DWN: D.C.
DES: D.C.
CHK: R.J.

SCALE AS SHOWN

REVISION --

DWG. NO. 0172-47

SHEET 3 OF 14

Bridge 00172 North Bound (Abutment 1 to Pier 3N)

Lifting sequence	Load Length (ft)	Weight of Girder (kg)	Weight of Girder (kips)	Weight of Diaphragm (kg)	Weight of Diaphragm (kips)	spreader+ block+rope (kips)	Total Pick Load (kips)	Boom Length (ft)	Max Crane Radius (ft)	Crane Capacity (kips)	capacity/load ratio
			(A)		(B)	(C)	(A)+(B)+(C)				
Manitowoc M-250 Series 2 Crawler, 207k crane CWT + 60k carbody CWT, No 44 boom with heavy-lift top											
Crane position 1A											
G8A with diaphragms	47.0	16,470	36.32	1,436	2.94	10.70	49.96		80	92.70	1.86
G7A		16,226	35.78		0.00	10.70	46.48		90	78.40	1.69
G9A		16,202	35.73		0.00	10.70	46.43		70	111.80	2.41
G10A with diaphragms		16,101	35.50	1,436	2.94	10.70	49.15		60	138.90	2.83
G11A		15,987	35.25		0.00	10.70	45.95		50	179.90	3.92
G12A		15,538	34.26		0.00	10.70	44.96		50	179.90	4.00
G8B with diaphragms	115.0	35,798	78.93	4,308	8.83	14.00	101.77	170	65	124.10	1.22
G7B		35,004	77.18		0.00	14.00	91.18		75	101.50	1.11
G9B		33,658	74.22		0.00	14.00	88.22		55	157.10	1.78
G10B with diaphragms		33,408	73.66	4,308	8.83	14.00	96.50		46	203.00	2.10
G11B		33,159	73.12		0.00	14.00	87.12		46	203.00	2.33
Crane position 1B											
G12B	115.0	31,852	70.23		0.00	14.00	84.23	170	65	124.10	1.47
Crane position 3A											
G8C with diaphragms	112.0	45,197	99.66	3,950	8.10	14.00	121.76	170	55	157.10	1.29
G7C		44,619	98.38		0.00	14.00	112.38		65	124.10	1.10
G9C		41,731	92.02		0.00	14.00	106.02		50	179.90	1.70
Crane position 3B											
G10C with diaphragms	112.0	41,457	91.41	3,950	8.10	14.00	113.51		60	138.90	1.22
G11C		41,245	90.95		0.00	14.00	104.95		50	179.90	1.71
G12C		40,097	88.41		0.00	14.00	102.41		50	179.90	1.76
Crane position 4A											
G8D with diaphragms	107.0	32,938	72.63	4,308	8.83	14.00	95.46	170	75	101.50	1.06
G7D		32,116	70.82		0.00	14.00	84.82		80	92.70	1.09
G9D		31,531	69.53		0.00	14.00	83.53		75	101.50	1.22
Crane position 4B											
G10D	107.0	31,303	69.02		0.00	14.00	83.02		80	92.70	1.12
G11D with diaphragms		31,075	68.52	4,308	8.83	14.00	91.35		75	101.50	1.11
G12D		29,787	65.68		0.00	14.00	79.68		75	101.50	1.27

Bridge 00172 North Bound (Abutment 1 to Pier 3N)

Lifting sequence	Load Length (ft)	Weight of Girder (kg)	Weight of Girder (kips)	Weight of Diaphragm (kg)	Weight of Diaphragm (kips)	spreader+ block+rope (kips)	Total Pick Load (kips)	Boom Length (ft)	Max Crane Radius (ft)	Crane Capacity (kips)	capacity/load ratio
			(A)		(B)	(C)	(A)+(B)+(C)				
Manitowoc M-250 Series 2 Crawler, 207k crane CWT + 60k carbody CWT, No 44 boom with heavy-lift top											
Crane position 5A											
G8E with diaphragms	115.0	54,668	120.54	4,668	9.57	14.00	144.11	170	55	157.10	1.09
G7E		53,971	119.01		0.00	14.00	133.01		60	138.90	1.04
G9E		47,249	104.18		0.00	14.00	118.18		50	179.90	1.52
Crane position 5B											
G10E with diaphragms	115.0	46,899	103.41	4,668	9.57	14.00	126.98		60	138.90	1.09
G11E		46,555	102.65		0.00	14.00	116.65		55	157.10	1.35
G12E		45,195	99.65		0.00	14.00	113.65		50	179.90	1.58
Crane position 6A											
G8F with diaphragms	115.0	39,433	86.95	5,744	11.78	14.00	112.72	170	60	138.90	1.23
G7F		38,306	84.46		0.00	14.00	98.46		70	111.80	1.14
G9F		34,433	75.92		0.00	14.00	89.92		50	179.90	2.00
Crane position 6B											
G10F with diaphragms	115.0	34,187	75.38	5,744	11.78	14.00	101.16		60	138.90	1.37
G11F		33,939	74.84		0.00	14.00	88.84		50	179.90	2.03
G12F		32,280	71.18		0.00	14.00	85.18		50	179.90	2.11
Crane position 7											
G8G with diaphragms	73.0	25,617	56.49	3,232	6.63	10.70	73.81	170	75	101.50	1.38
G7G		25,143	55.44		0.00	10.70	66.14		85	85.00	1.29
G9G		23,239	51.24		0.00	10.70	61.94		65	124.10	2.00
G10G with diaphragms		23,081	50.89	3,232	6.63	10.70	68.22		55	157.10	2.30
G11G		22,899	50.49		0.00	10.70	61.19		55	157.10	2.57
G12G		22,044	48.61		0.00	10.70	59.31		55	157.10	2.65

PICK SCHEDULE

SCALE: 1:N.T.S.

REV.	DESCRIPTION	BY	DATE
3	RELOCATE CRANE POSITION P-4		2-29-16
2	REVISE AND RESUBMIT		12-10-15
1	PRELIMINARY		10-16-15

BRIDGE 00172 ERECTION PLAN

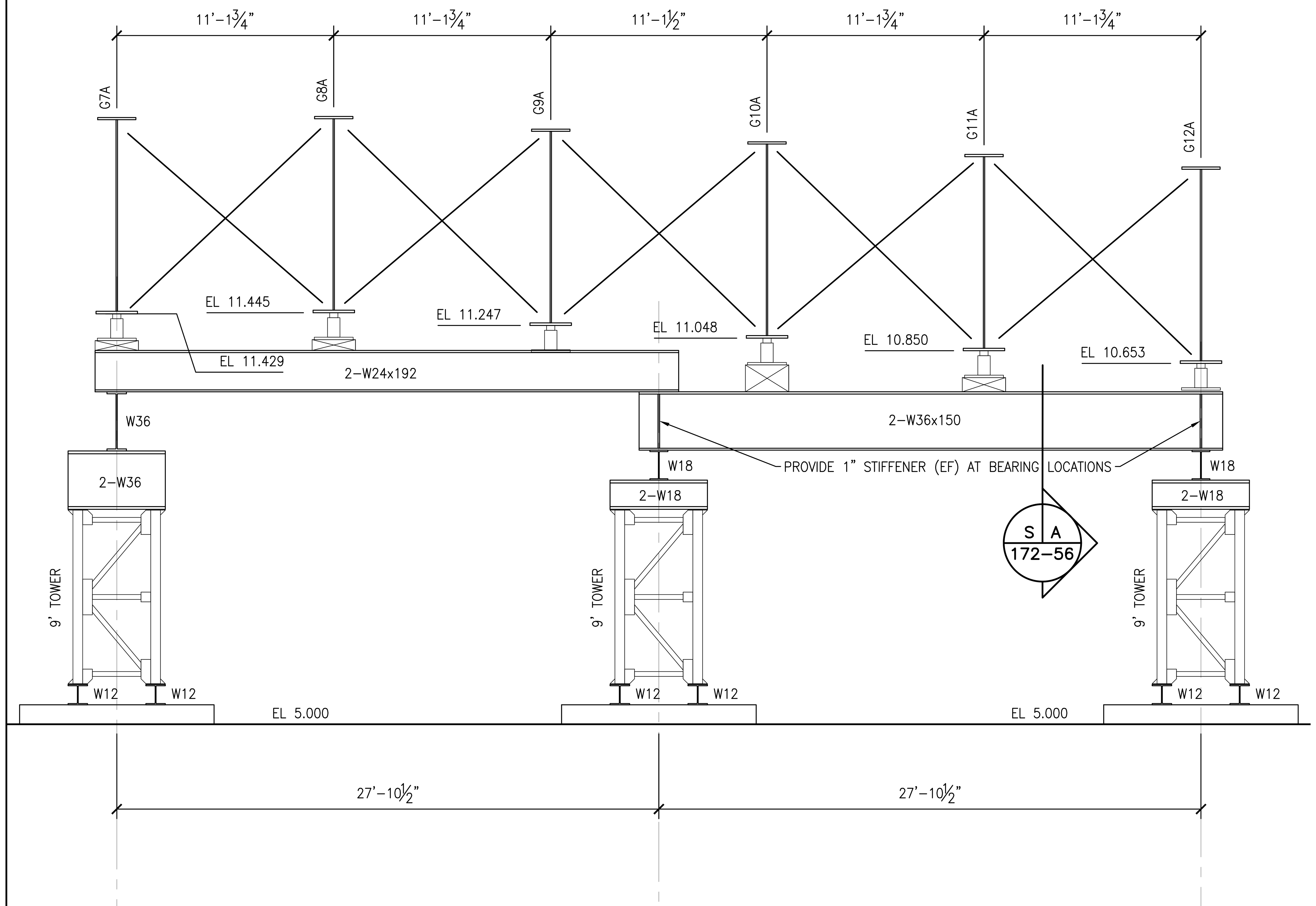
DWN: D.C.
DES: D.C.
CHK: R.J.

SCALE: AS SHOWN

REVISION: --

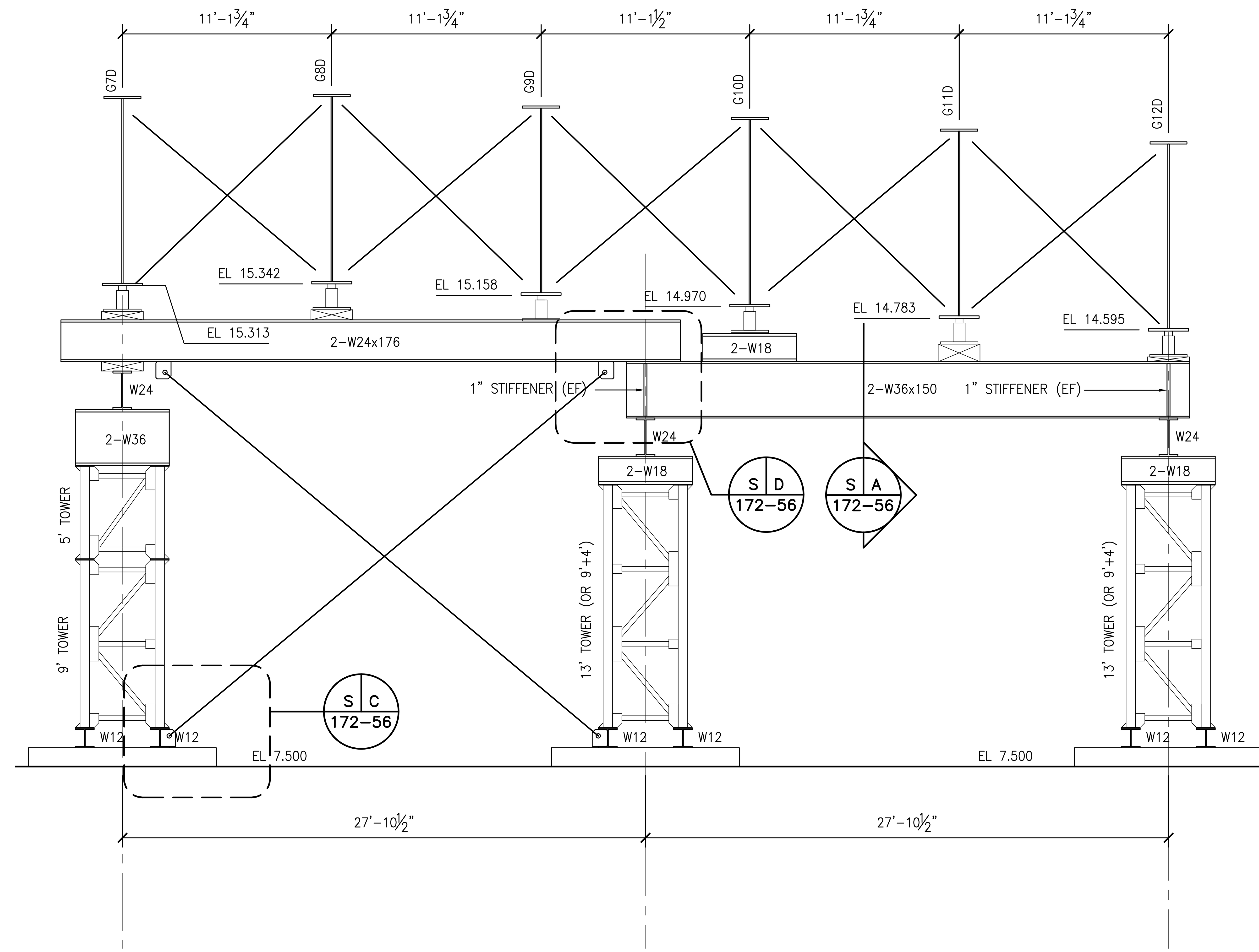
DWG. NO. 0172-48

SHEET 4 OF 14



FW-I ELEVATION

SCALE: 1:50



FW-4 ELEVATION

SCALE: 1:50

REV	DESCRIPTION	BY	DATE
3	RAISE B.O.S. @ FW4 PER FIELD CONDITION		3-2-16
2	REVISE AND RESUBMIT		12-10-15
1	PRELIMINARY		10-16-15

BRIDGE 00172 ERECTION PLAN

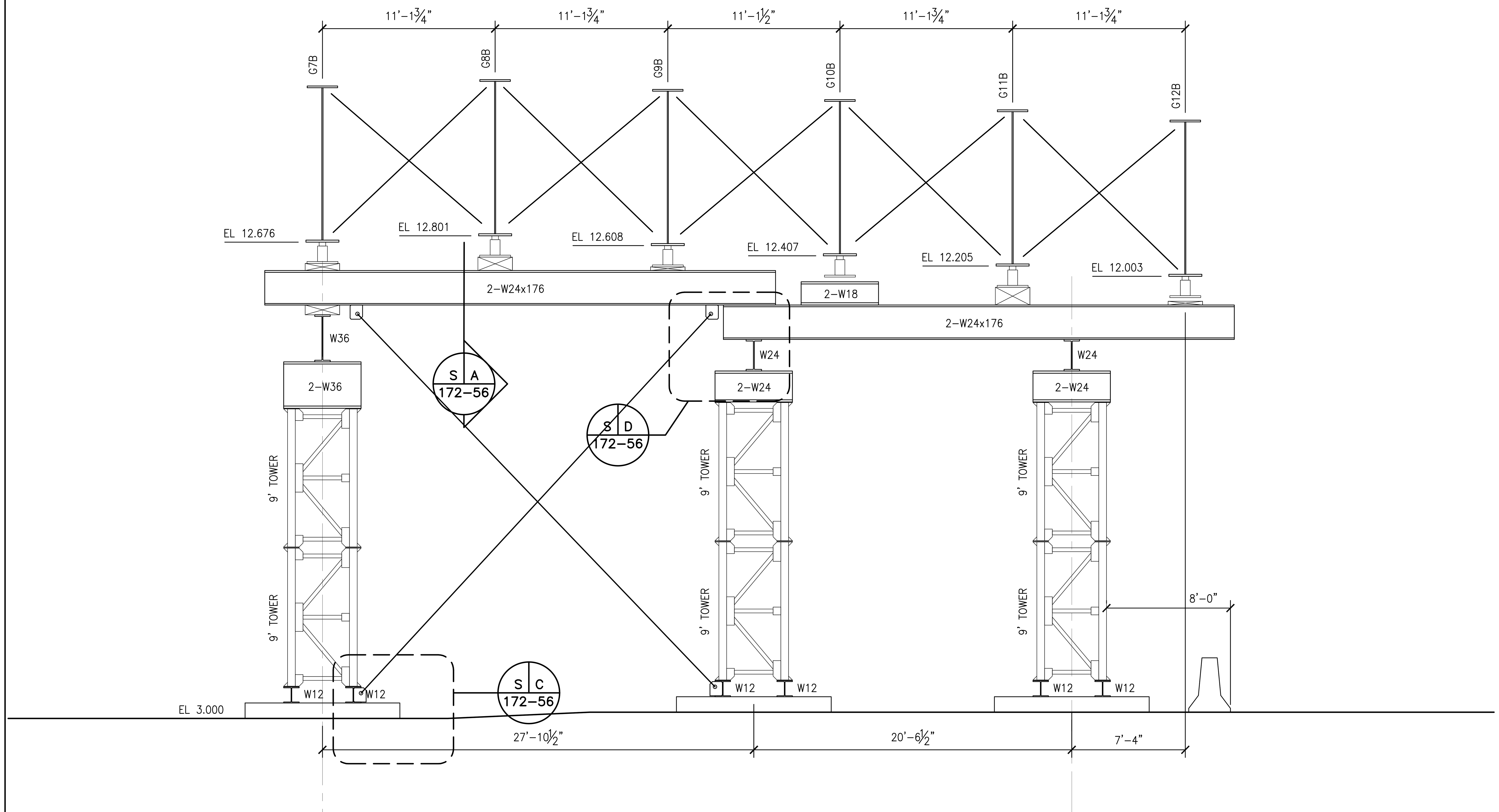
DWN: D.C.
DES: D.C.
CHK: R.J.

SCALE: AS SHOWN

REVISION: --

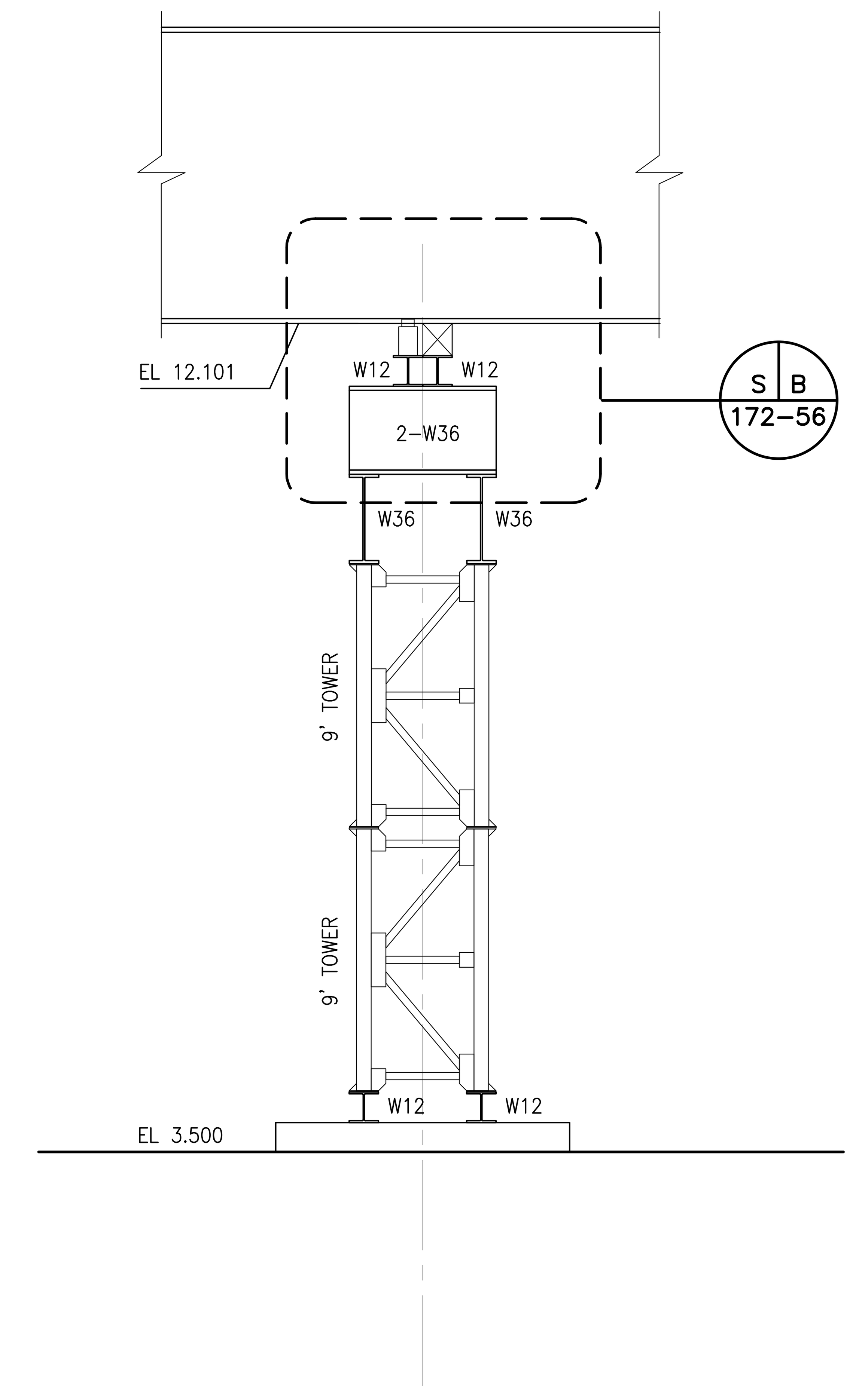
DWG. NO. 0172-49

SHEET 5 OF 14



FW-2 ELEVATION

SCALE: 1:50



FW-2R ELEVATION

SCALE: 1:50

REV	DESCRIPTION	BY	DATE
2	REVISE AND RESUBMIT		12-10-15
1	PRELIMINARY		10-16-15

BRIDGE 00172 ERECTION PLAN

DWN: D.C.
DES: D.C.
CHK: R.J.

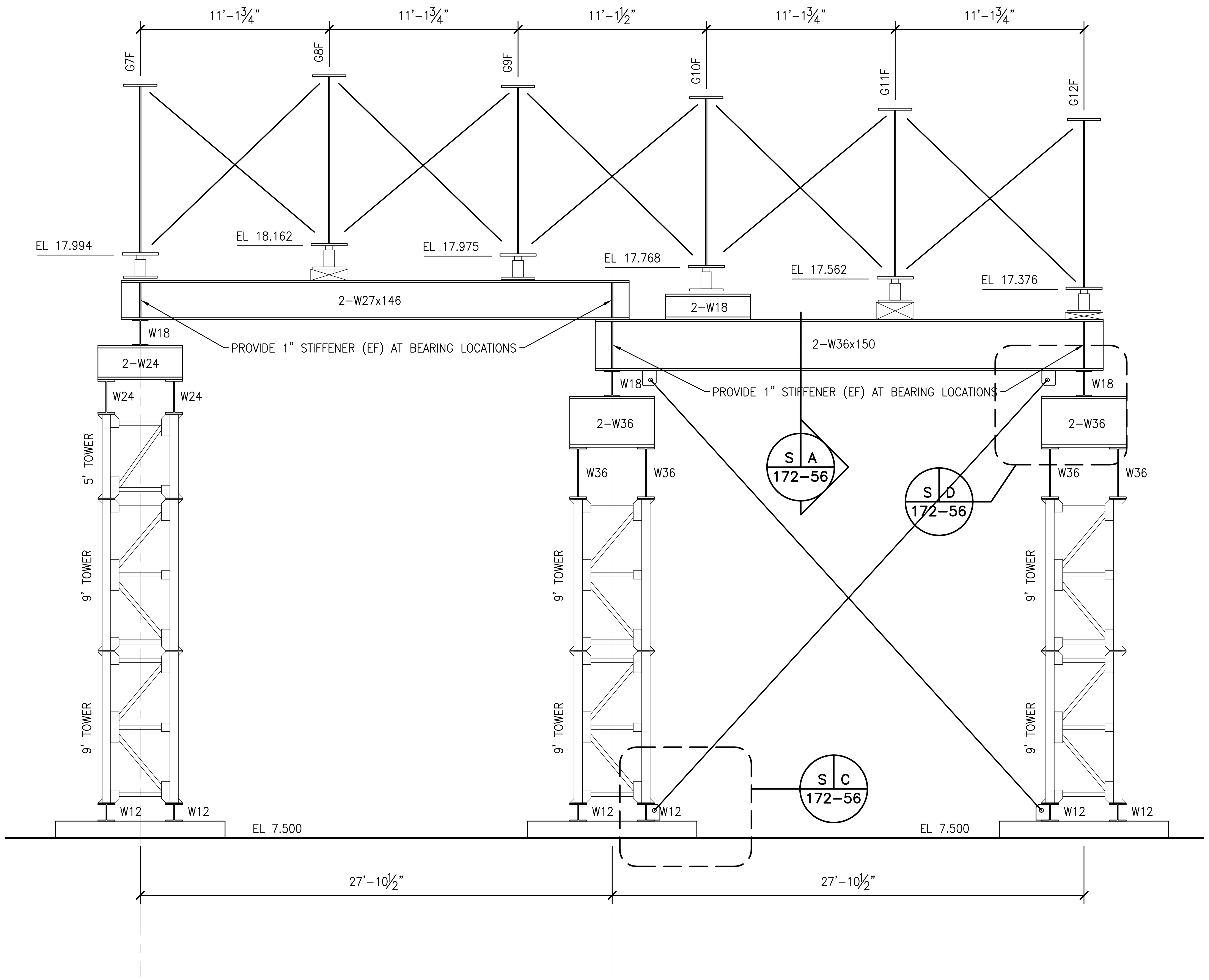
SCALE AS SHOWN

DWG. NO. 0172-50

REVISION --

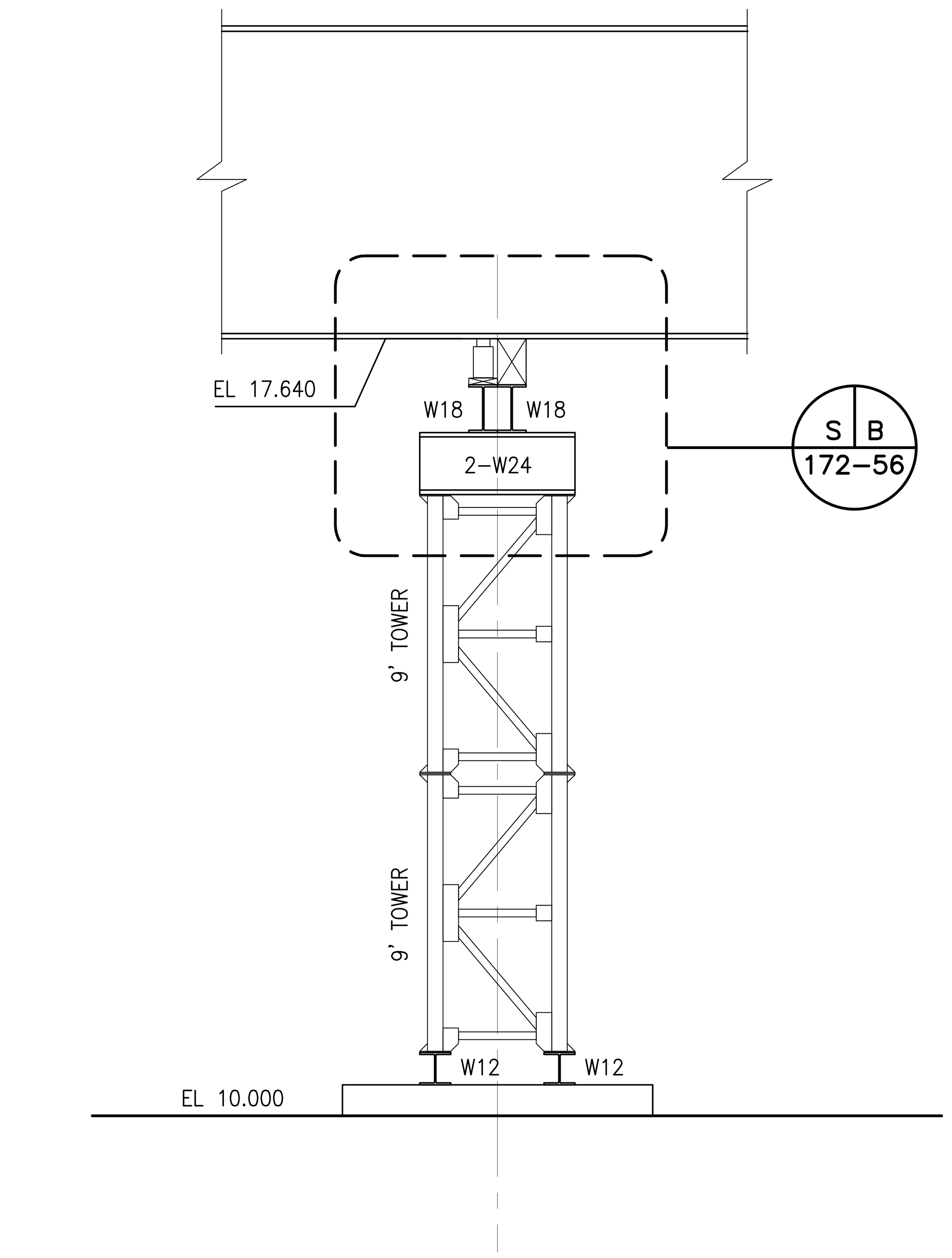
SHEET 6 OF 14


6'-4"
11'-1¾"
11'-1¾"
11'-1½"
11'-1¾"
11'-1¾"
G7C
G8C
G9C
G10C
G11C
G12C
EL 13.869
EL 14.023
EL 13.843
EL 13.654
EL 13.466
EL 13.276
2-W18
STRADDLE BEAM 1: 2-W36X330
W24
5' TOWER
9' TOWER
W12
8'-0"MIN
8'-0" MIN
EL 6.000
S A
172-56
PL 1X8X8 WITH 2" HOLE
NET EDGE DISTANCE 2" MIN
5⁄16
17T SHACKLE
9/16" MIN EIP IWRC WIRE ROPE
WITH 3 CABLE CLAMPS AT EACH END
17T SHACKLE AND EQUALIZER
1 3/4X18 HG-228
JAW-JAW TURN BUCKLE
(2) 3'x3'x5' DEADMEN AND
(4) 5'X10'X10" CONCRETE PLANKS
WITH EDGE CHANNELS WELDED
TOGETHER,
TOTAL WT=38,400 LBS
TIE BLOCK TO PLANKS WITH CABLES
DEADMAN ASSEMBLY SAME AS OTHER END
62'-1"
FW-3 ELEVATION
SCALE: 1:50
EL 14.785
W14
W14
S B
172-56
2-W36
9' TOWER
9' TOWER
W12
W12
EL 7.000
FW-4R ELEVATION
SCALE: 1:50
2 REVISE AND RESUBMIT 12-10-15
1 PRELIMINARY 10-16-15
REV DESCRIPTION BY DATE
BRIDGE 00172 ERECTION PLAN
DWN: D.C.
DES: D.C.
CHK: R.J.
SCALE
AS SHOWN
DWG. NO.
0172-51
REVISION
--
SHEET 7 OF 14



FW-5 ELEVATION

SCALE: 1:50



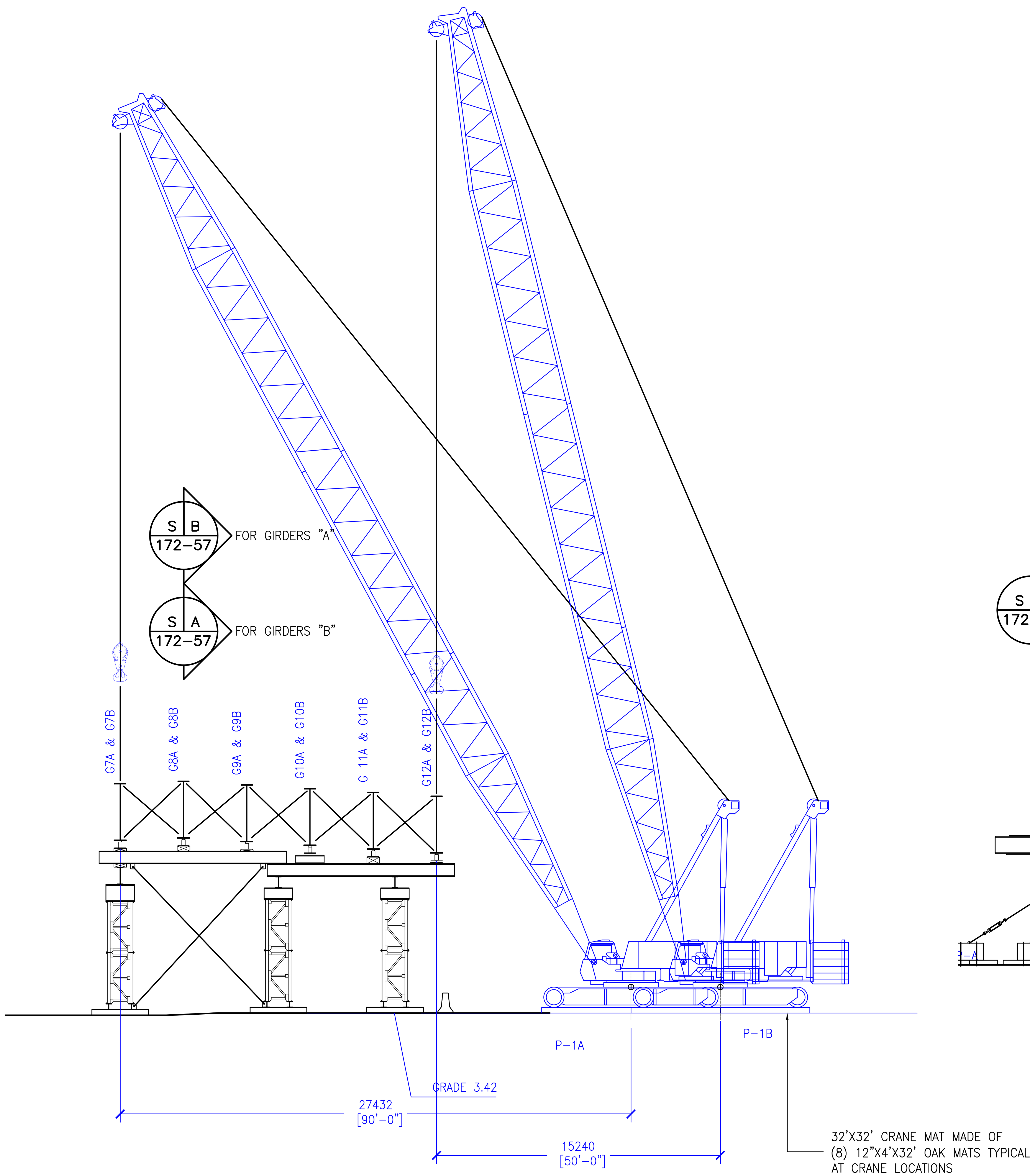
FW-5R ELEVATION

SCALE: 1:50

REV	DESCRIPTION	BY	DATE
2	REVISE AND RESUBMIT		12-10-15
1	PRELIMINARY		10-16-15

BRIDGE 00172 ERECTION PLAN

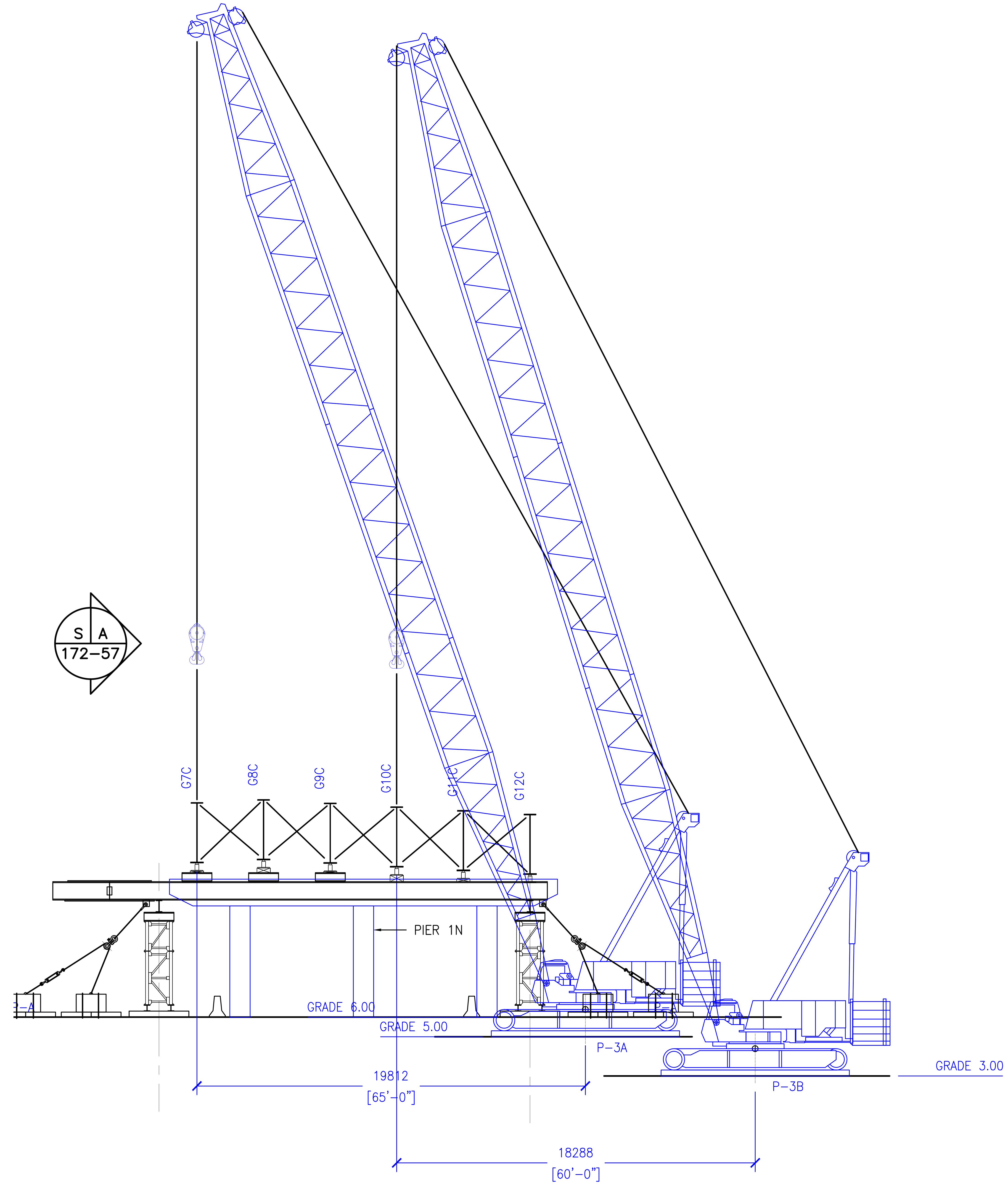
DWN: D.C. DES: D.C. CHK: R.J.	SCALE AS SHOWN	DWG. NO. 0172-52
SHEET 8 OF 14	REVISION --	



S 1
172–46

CRANE P-IA & P-IB ELEVATION

SCALE: 1:150



S 3
172–46

CRANE P-3A & P-3B ELEVATION

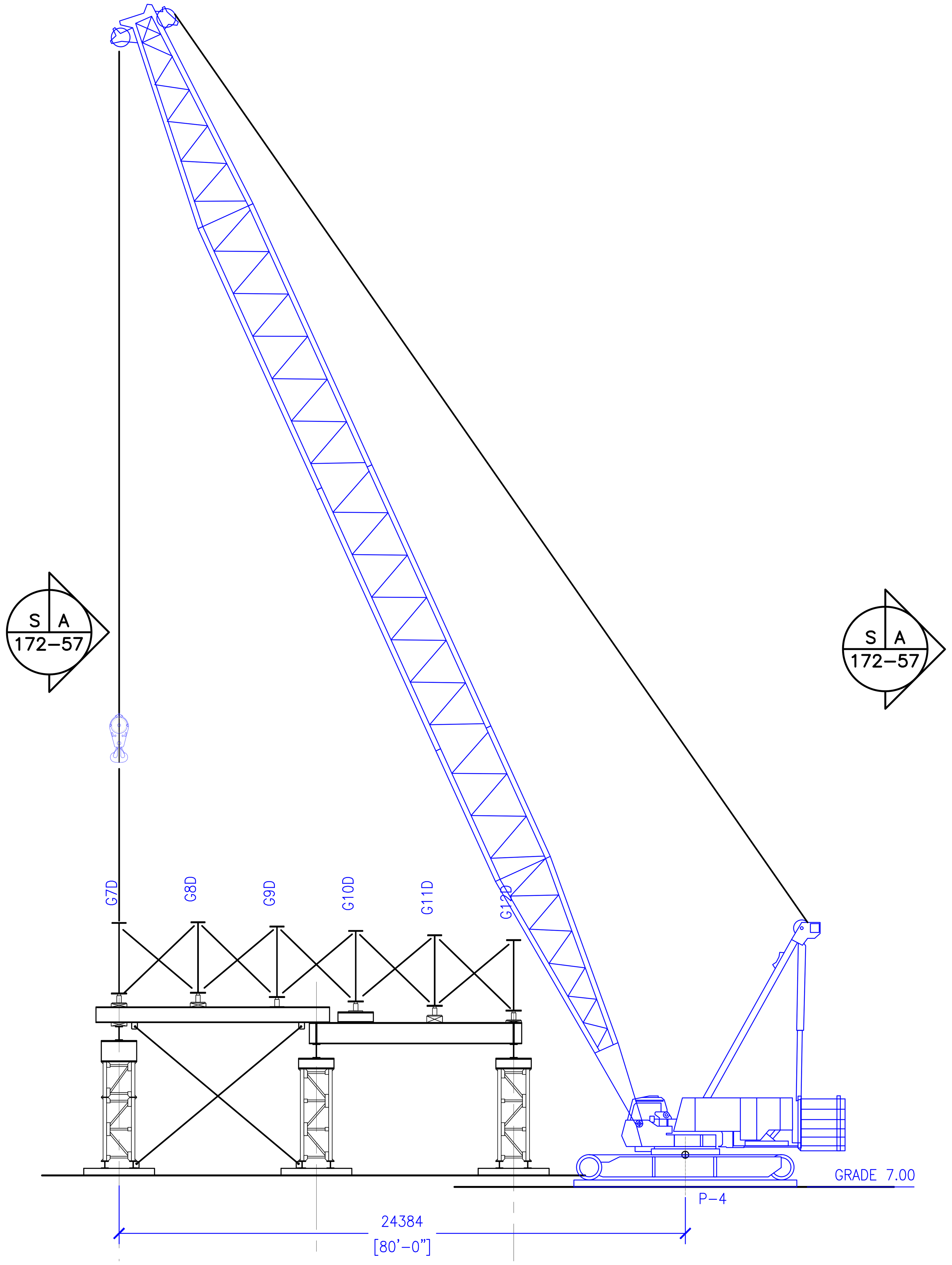
SCALE: 1:150

REV.	DESCRIPTION	BY	DATE
2	REVISE AND RESUBMIT		12–10–15
1	PRELIMINARY		10–16–15

BRIDGE 00172 ERECTION PLAN

DWN: D.C.
DES: D.C.
CHK: R.J.

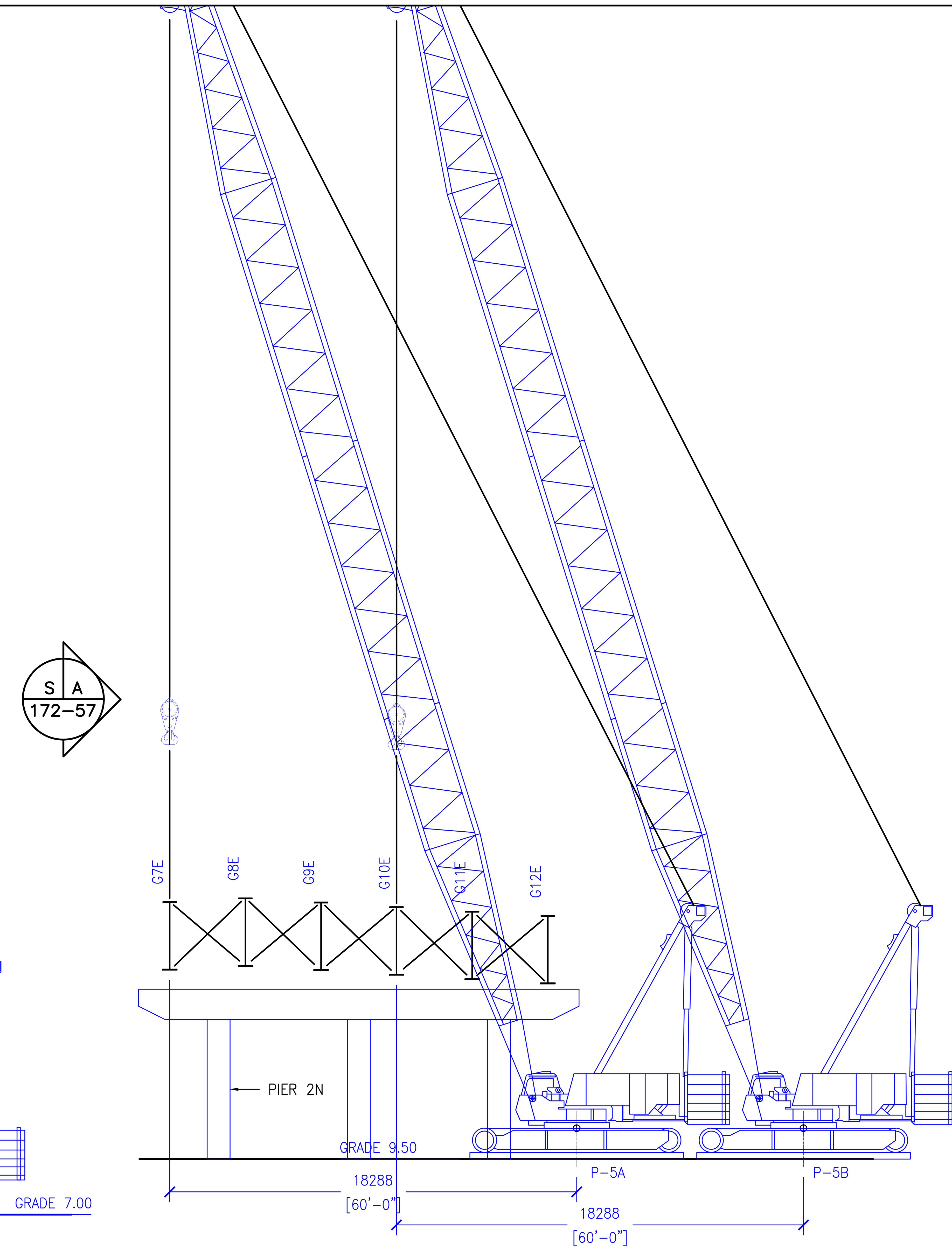
SCALE: AS SHOWN
REVISION: --
DWG. NO. 0172-53
SHEET 9 OF 14



S 4
172–46

CRANE P-4 ELEVATION

SCALE: 1:150



S 5
172–47

CRANE P-5A & P-5B ELEVATION

SCALE: 1:150

REV	DESCRIPTION	BY	DATE
2	REVISE AND RESUBMIT		12–10–15
1	PRELIMINARY		10–16–15

BRIDGE 00172 ERECTION PLAN

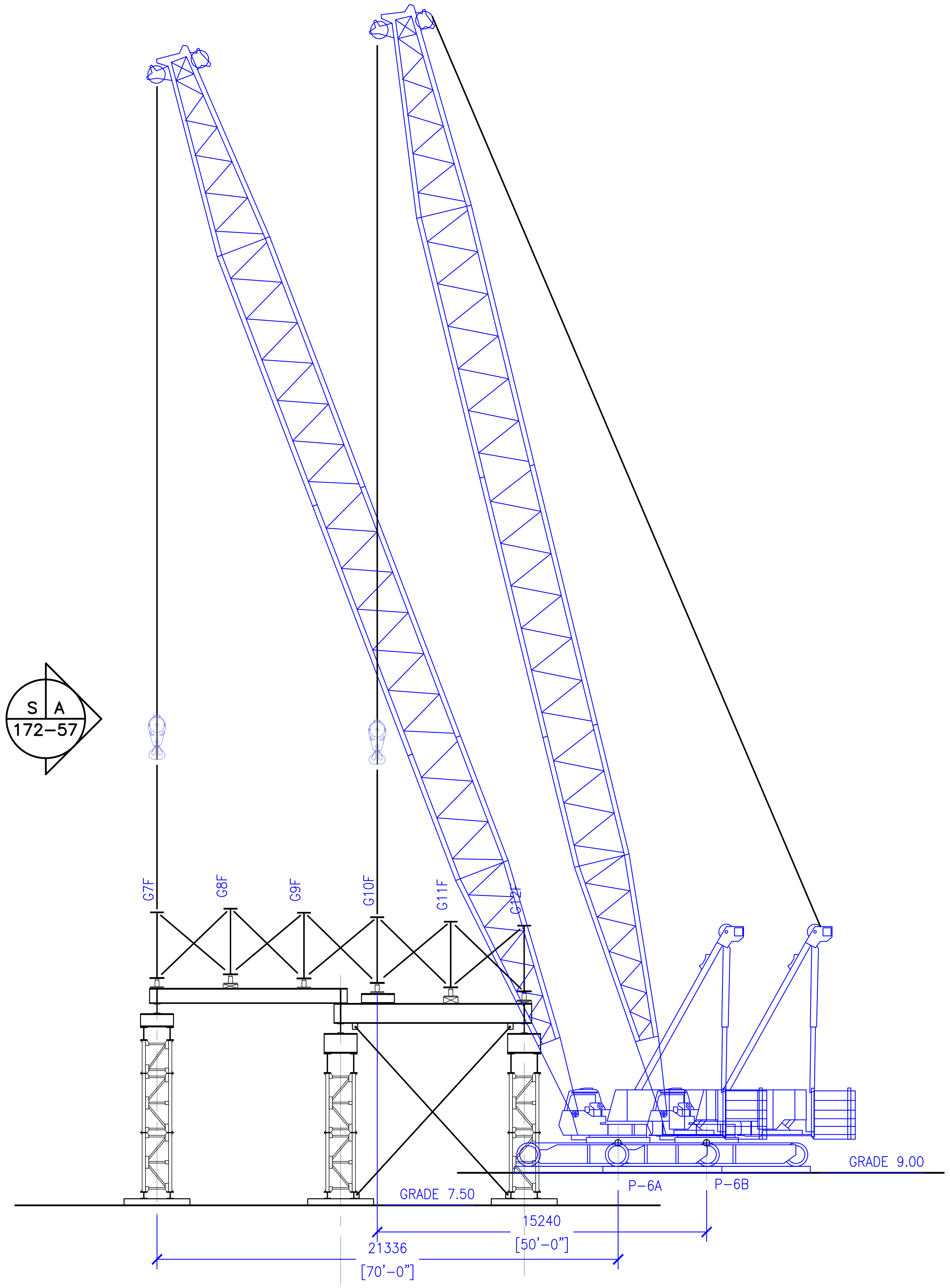
DWN: D.C.
DES: D.C.
CHK: R.J.

SCALE: AS SHOWN

DWG. NO. 0172-54

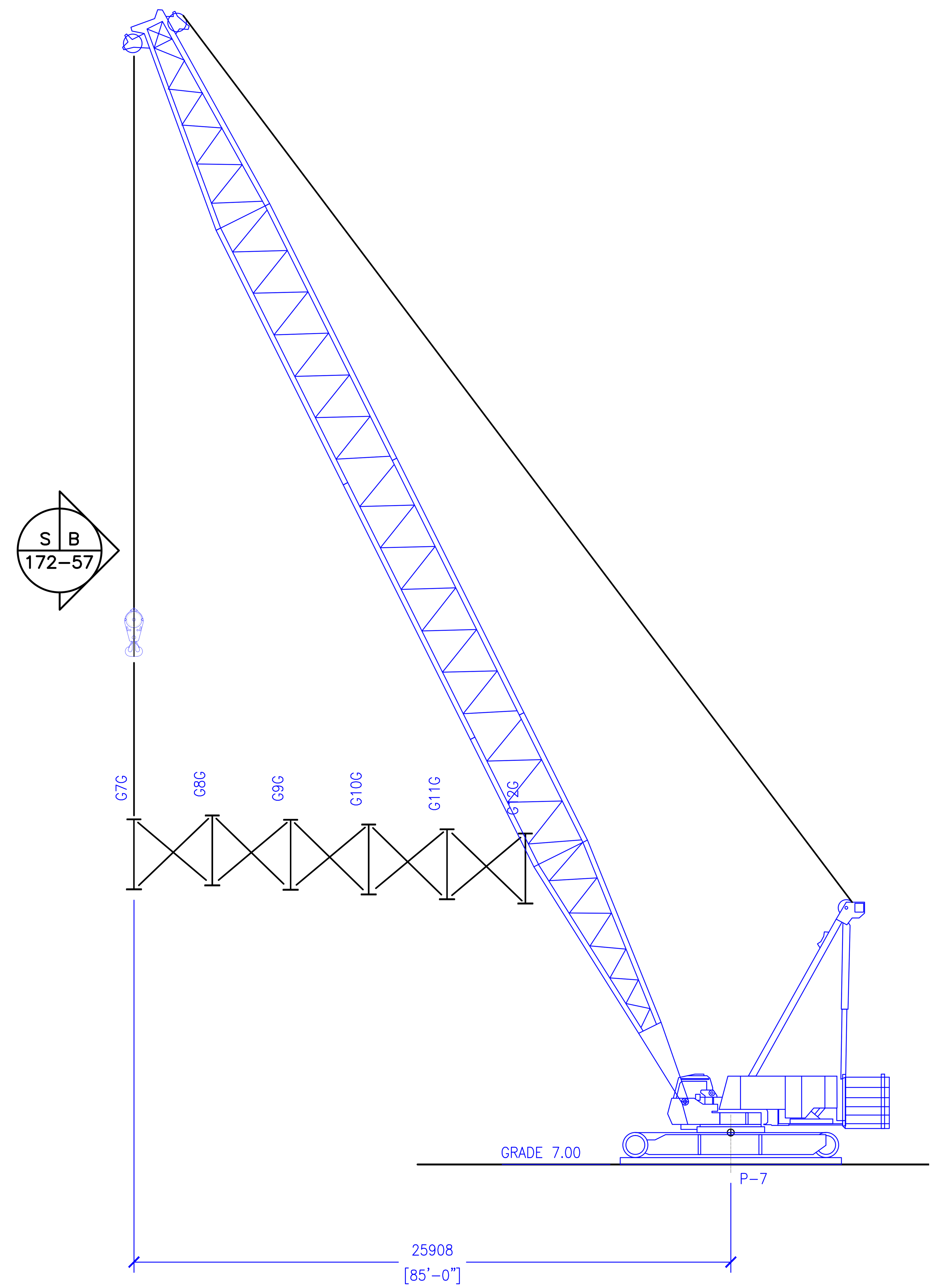
REVISION --

SHEET 10 OF 14



S 6 / 172–43 **CRANE P-6A & P-6B ELEVATION**

SCALE: 1:150



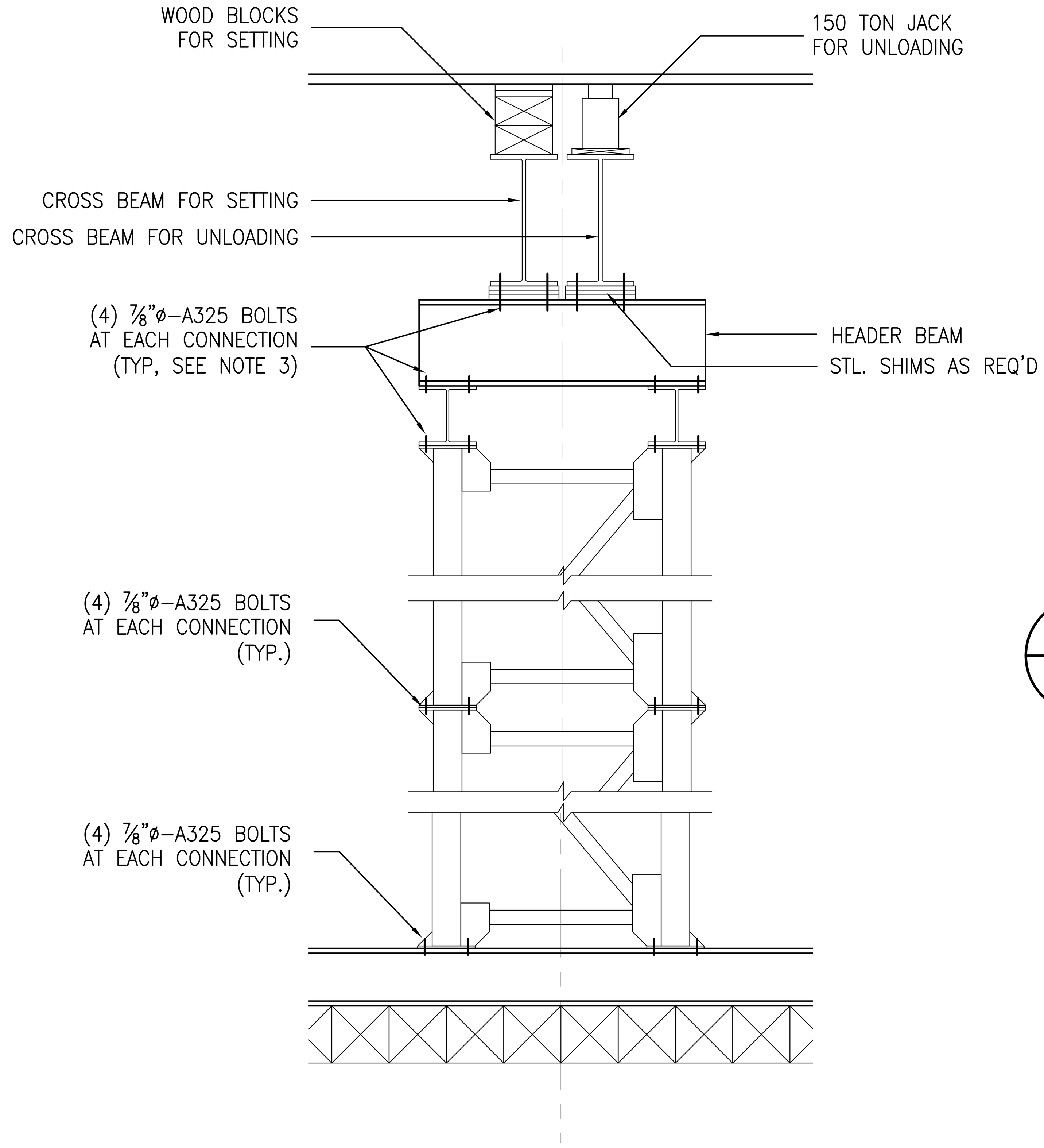
S 7 / 172–43 **CRANE P-7 ELEVATION**

SCALE: 1:150

REV.	DESCRIPTION	BY	DATE
2	REVISE AND RESUBMIT		12–10–15
1	PRELIMINARY		10–16–15

BRIDGE 00172 ERECTION PLAN

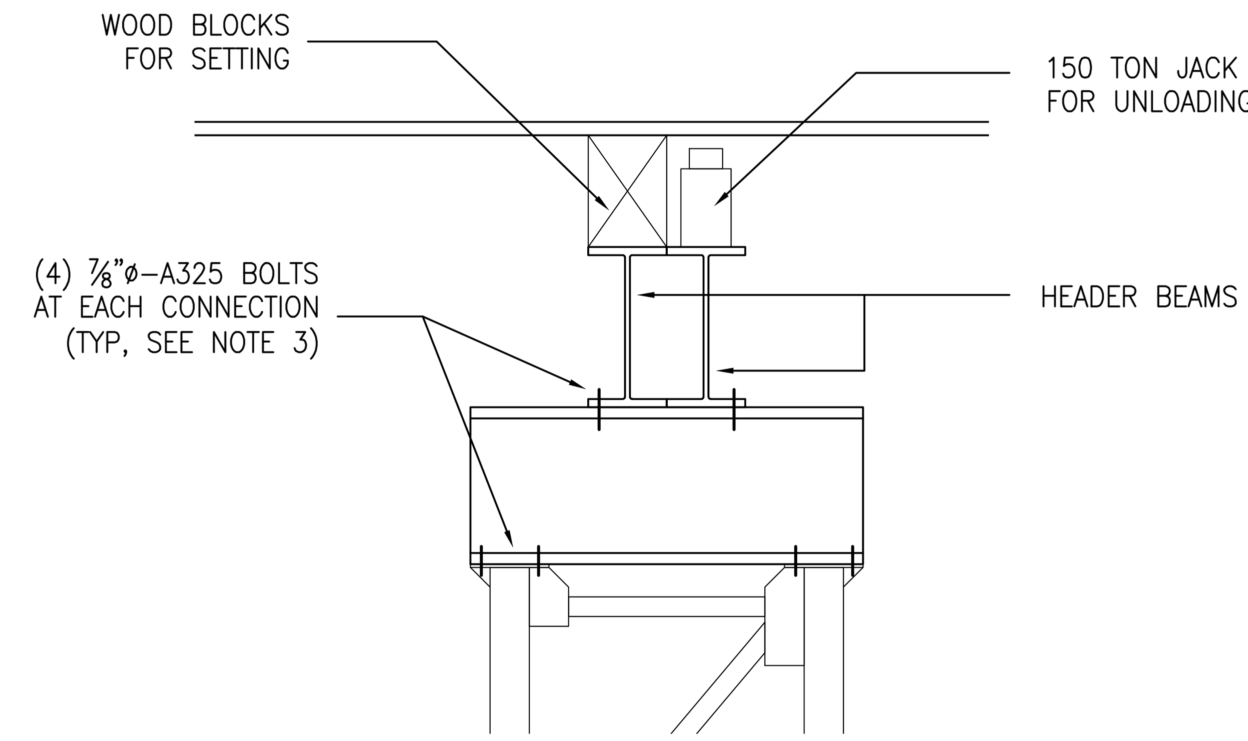
DWN: D.C. DES: D.C. CHK: R.J.	SCALE AS SHOWN	DWG. NO. 0172-55
SHEET 11 OF 14	REVISION --	



S | A

TYP. JACKING & CONNECTION

SCALE: 1:25



S | B

JACKING & CONNECTION FOR SINGLE TOWER

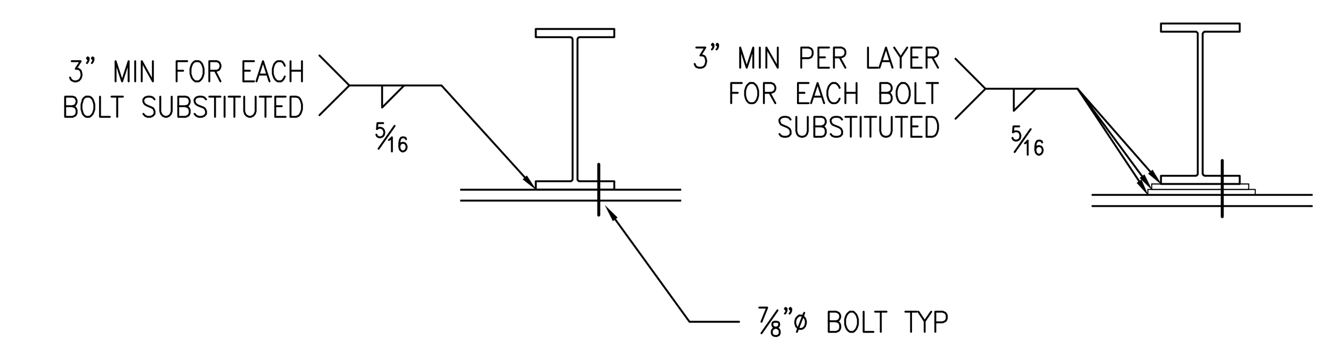
SCALE: 1:25

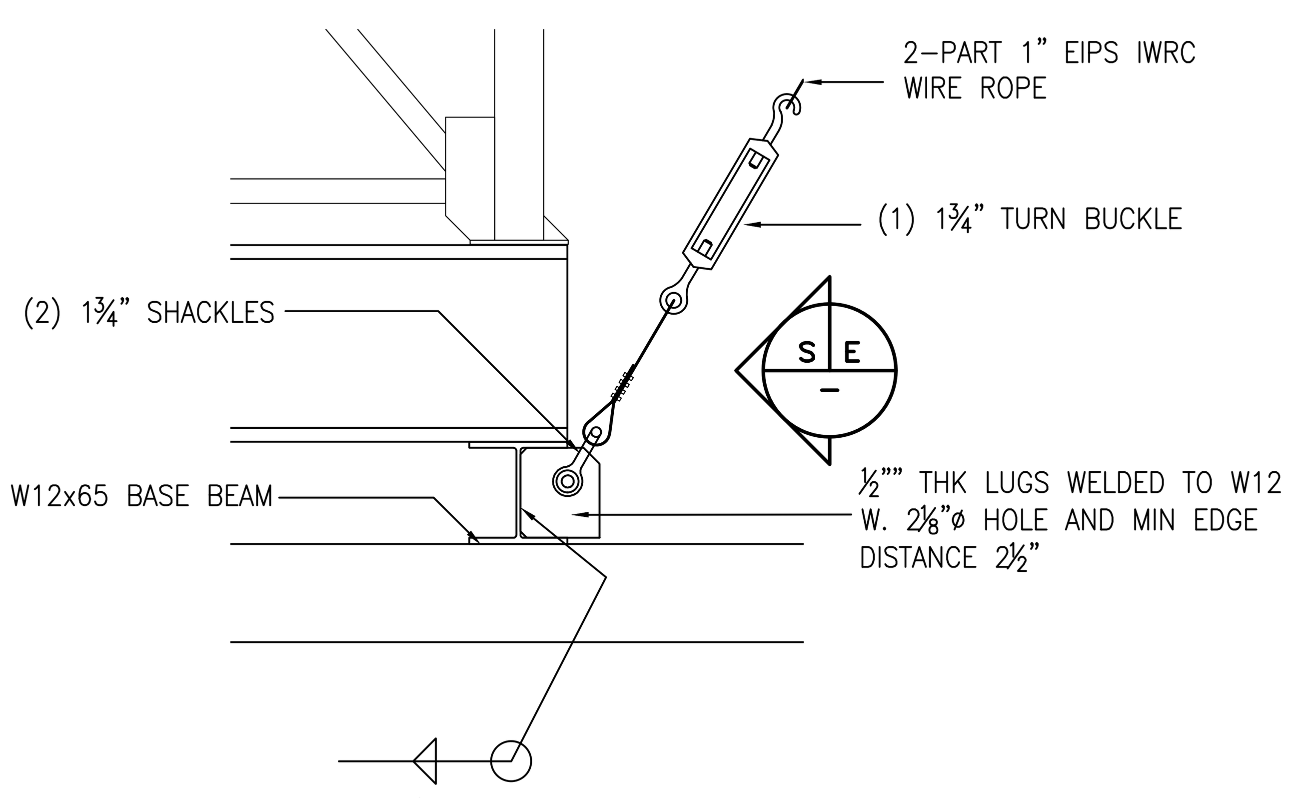
NOTES:

1) ALL TOWERS SHALL BE SET PLUMB. STEEL SHIMS MAY BE USED FOR ADJUSTMENT.

2) ALL FALSEWORK TOWER SEGMENTS, HEADERS, GRILLAGE BEAMS SHALL BE CONNECTED BY (4) ⅞"ø HIGH STRENGTH BOLTS AT ALL LOCATIONS.

3) ABOVE BOLT CONNECTION CAN BE SUBSTITUTED WITH WELDING METHOD SHOWN BELOW:

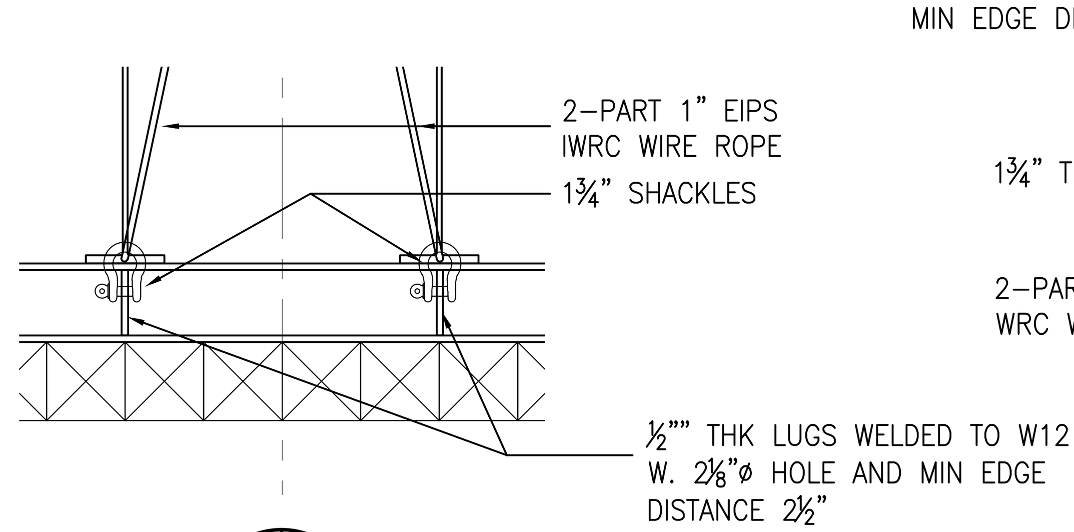




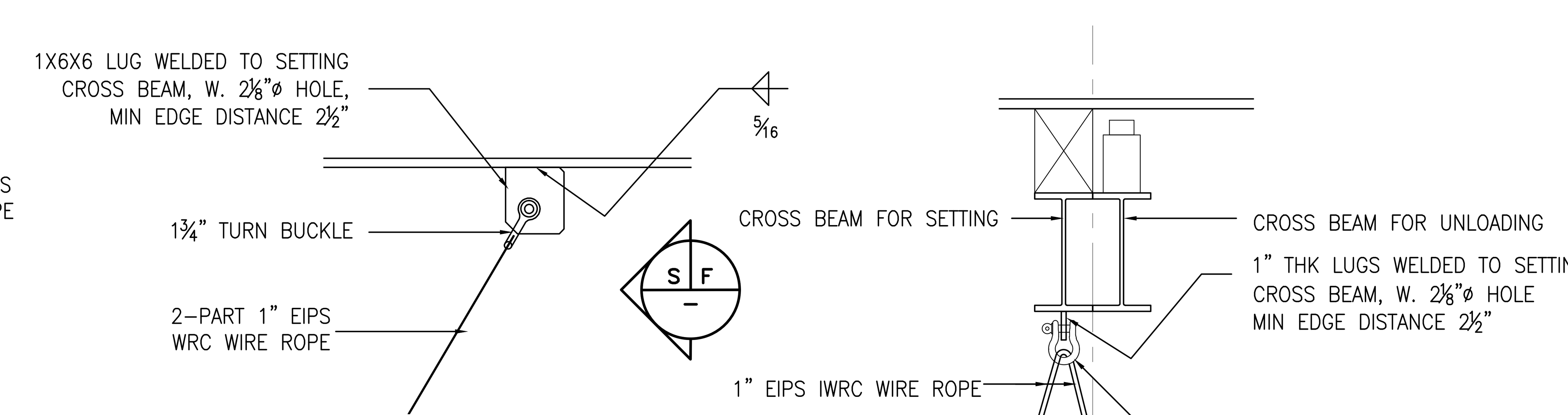
S | C

CABLE BRACING DETAIL

SCALE: 1:20



S | E



S | F

S | D

CABLE BRACING DETAIL

SCALE: 1:20

2	REVISE AND RESUBMIT		12–10–15
1	PRELIMINARY		10–16–15
	DESCRIPTION	BY	DATE

BRIDGE 00172 ERECTION PLAN

DWN: D.C.
DES: D.C.
CHK: R.J.
SCALE: AS SHOWN
DWG. NO. 0172-56
REVISION --
SHEET 12 OF 14

QTY	RIGGING COMPONENTS	WEIGHT (K)
2	35T GIRDER CLAMP	1.04
4	35T SHACKLE	0.21
2	55T SHACKLE	0.20
2	36' SPREADER	5.33
2	55T SHACLE	0.20
2	2"X50' EIPS SLING	0.78
2	35T SHACKLE	0.10
2	2"X20' EIPS SLING	0.36
	SUBTOTAL RIGGING	8.22
	CRANE BLOCK -100T	3.90
	CRANE ROPE -2.70 lb/ft	1.89
	RIGGING, BLOCK & ROPE	14.01

QTY	RIGGING COMPONENTS	WEIGHT (K)
2	35T GIRDER CLAMP	1.04
6	35T SHACKLE	0.30
1	36' SPREADER	2.67
2	35T SHACKLE	0.10
2	2"X50' EIPS SLING	0.78
	SUBTOTAL RIGGING	4.89
	CRANE BLOCK -100T	3.90
	CRANE ROPE -2.70 lb/ft	1.89
	RIGGING, BLOCK & ROPE	10.68

GENERAL NOTES:

1. CRANES SHALL BE OPERATED IN ACCORDANCE WITH THE CONNECTICUT DEPARTMENT OF PUBLIC SAFETY REGULATIONS.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE WEIGHT OF EACH LIFT AND FOR INSURING THE STABILITY OF EACH MEMBER DURING ALL PHASES OF ERECTION.
3. MEMBERS SHALL BE SUBJECT TO ONLY LIGHT DRIFTING TO ALIGN HOLES. ANY DRIFTING THAT RESULTING IN DISTORTION OF THE MEMBER OR DAMAGE TO THE HOLES WILL BE CAUSE FOR REJECTING THE MEMBER.
4. FIELD REAMING OF HOLES SHALL NOT BE PERFORMED UNLESS REQUIRED BY THE CONTRACT DRAWINGS OR APPROVED BY THE ENGINEER.
5. CRANE SHALL BE SET LEVEL AND CRANE OPERATIONS IN ACCORDANCE WITH APPLICABLE A.N.S.I. AND O.S.H.A. SPECIFICATIONS.
6. CRANE POSITIONS ARE APPROXIMATE DUE TO UNKNOWN SITE CONDITIONS AT TIME OF ERECTION. CRANE POSITIONS MAY VARY SLIGHTLY FROM THOSE SHOWN ON THE DRAWINGS. HOWEVER ALL PICKS SHALL BE WITHIN LIMITATIONS SET FORTH IN PICK SCHEDULES.
7. MAXIMUM ALLOWABLE GROUND BEARING PRESSURE IS 4.0 K.S.F.
8. RIGGING NOTES: A. ALL WIRE ROPE SLINGS TO BE 6X19 OR 6X17 EXTRA IMPROVED PLOW STEEL WITH MECHANICALLY SPLICED EYES AT EACH END. UNLESS OTHERWISE NOTED, I.W.R.C. OR FIBER CORE SLINGS MAY BE USED. B. ALL RIGGING HARDWARE INCLUDING SHACKLES, HOOKS, ETC. SHALL HAVE A MINIMUM SAFETY FACTOR OF 5:1. C. ALL RIGGING MATERIAL TO COMPLY WITH O.S.H.A. 1926.251.
9. STEEL ERECTION PROCEDURE SHALL TAKE PLACE AT TIMES PERMITTED IN THE CONTRACT. THE CONTRACTOR SHALL IMPLEMENT TRAFFIC CONTROLS AT AFFECTED ROADWAYS IN CONFORMANCE WITH SPECIFICATION ITEMS "MAINTENANCE AND PROTECTION OF TRAFFIC" AND "PROSECUTION AND PROGRESS".
10. CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE O.S.H.A. SAFETY REGULATIONS
11. GIRDERS SHALL BE ERECTED AND STABILIZED BY CONNECTING TO ADJACENT GIRDERS AS PRESCRIBED IN THE ERECTION SEQUENCE AND IN THIS DRAWING, BEFORE RELEASING CRANE.
12. NO CRANE WILL BE OPERATED IN A MANNER WHICH WILL EXCEED ITS RATED CAPACITY AT ANY RADIUS SPECIFIED BY THE MANUFACTURER.
13. THE TABLE OR CHART PREPARED BY THE CRANE MANUFACTURER TO DESCRIBE THE MAXIMUM LIFT AT ALL CONDITIONS OF LOADING SHALL BE POSTED IN THE CRANE CAB IN CLEAR VIEW OF THE OPERATOR.
14. TIMBER BLOCKING SHALL BE SOUTHERN PINE No.1 OR BETTER.
15. PLYWOOD SHIMS SHALL BE B-B PLYFORM CLASS 1
16. ALL FILL ADDED TO PROVIDE SURFACES UNDER TIMBER MATS SHALL BE PLACED IN CONFORMANCE WITH SECTION 2-12-"SUBBASE" OF THE STANDARD SPECIFICATION.
17. STRADDLE BENTS FWXX IS STABLE IN WINDS UP TO 65 MPH (WITH OR WITHOUT GIRDER LOADS).
18. A SINGLE GIRDER ON ANY FALSEWORK IS STABLE FROM OVERTURNING IN WINDS UP TO 65 MPH. TWO OR MORE GIRDERS CONNECTED BY CROSSFRAMES ARE STABLE IN WINDS UP TO 80 MPH.
19. THE GIRDER DELIVERY TRAILERS WILL BE STORED NEAR 400 LONG WHARF DRIVE AND ON SARGENT DRIVE.
20. FALSEWORK BENT CABLE BRACING SHALL REMAIN CONNECTED UNTIL FALSEWORK BENT IS PERMITTED TO BE REMOVED. SEE FALSEWORK REMOVAL SEQUENCE BELOW.

FALSE WORK UNLOADING SCHEDULE

FW-1, FW-2, FW-2R	CAN BE REMOVED AFTER ALL "D" GIRDERS ARE INSTALLED
FW-3	CAN BE REMOVED AFTER ALL "D" GIRDERS ARE INSTALLED
FW-4, FW-4R	CAN BE REMOVED AFTER ALL "E" GIRDERS ARE INSTALLED
FW-5, FW-5R	CAN BE REMOVED AFTER ALL "G" GIRDERS ARE INSTALLED

NEW HAVEN CONTRACT E – BRIDGE 172 NB

ABUTMENT 1 TO PIER 4N ERECTION SEQUENCE

SETTING "A" AND "B" GIRDERS, CRANE POSITION 1A

1. INSTALL ALL FALSEWORK BENTS AND TOWERS, AS SHOWN ON DRAWING 0172-41 AND 0172-45 THRU 0172-49. SURVEYOR CONFIRMS THAT TOP OF GIRDER BLOCKING ELEVATION MATCHES "NO LOAD" BOTTOM OF STEEL ELEVATION SHOWN ON THE DRAWINGS. ADJUST GIRDER BLOCKING IF NECESSARY.
2. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G8A, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
3. LIFT G8A FROM THE TRAILER AND SET IN FINAL POSITION. TIE GIRDER TO ABUTMENT-1 AND FW-1 AS SHOWN ON DRAWING 172-54, BEFORE RELEASING GIRDER FROM CRANE.
4. LIFT GIRDER G7A FROM THE TRAILER AND SET IN FINAL POSITION. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G8A AND SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
5. REPEAT ABOVE STEP FOR GIRDER G9A.
6. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G10A, INSTALL A MINIMUM OF 50% OF BOLTS, SNUG TIGHT.
7. LIFT GIRDER G10A FROM THE TRAILER AND SET IN FINAL POSITION. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G9A AND SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
8. REPEAT ABOVE STEP FOR GIRDER G11A AND G12A, RESPECTIVELY.
9. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G8B, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
10. LIFT G8B FROM THE TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. TIE GIRDER TO FW-2 AND AS SHOWN ON DRAWING 172-54, BEFORE RELEASING GIRDER FROM CRANE.
11. LIFT GIRDER G7B FROM THE TRAILER AND SET IN FINAL POSITION. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G8B AND SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
12. REPEAT ABOVE STEP FOR GIRDER G9B.

Page **1** of **5**

13. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G10B, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
14. LIFT GIRDER G10B FROM THE TRAILER AND SET IN FINAL POSITION. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G9B AND SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
15. REPEAT ABOVE STEP FOR GIRDER G11B.

SETTING GIRDER G12B, CRANE POSITION 1B

16. LIFT GIRDER G12B FROM THE TRAILER AND SET IN FINAL POSITION. INSTALL CROSSFRAMES CONNECTING TO G11B WITH A MINIMUM OF 50% OF BOLTS, SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.

SETTING "C" GIRDERS, CRANE POSITION 3A

17. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G8C, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
18. LIFT G8C FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. TIE GIRDER TO FW-3 AS SHOWN ON DRAWING 172-54, BEFORE RELEASING GIRDER FROM CRANE.
19. REPEAT ABOVE STEP FOR GIRDER G7C AND G9C, RESPECTIVELY.

SETTING "C" GIRDERS, CRANE POSITION 3B

20. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G10C, INSTALLING A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
21. LIFT G10C FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G9C, SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
22. REPEAT ABOVE STEP FOR GIRDER G11C AND G12C, RESPECTIVELY.

SETTING "D" GIRDERS, CRANE POSITION 4

23. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G8D, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
24. LIFT G8D FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. TIE GIRDER TO FW-4 AS SHOWN ON DRAWING 172-54, BEFORE RELEASING GIRDER FROM CRANE.
25. REPEAT ABOVE STEP FOR GIRDER G7D AND G9D, RESPECTIVELY.

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26. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G10D, INSTALLING A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
27. LIFT G10D FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G9D, SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
28. REPEAT ABOVE STEP FOR GIRDER G11D AND G12D, RESPECTIVELY.

SETTING "E" GIRDERS, CRANE POSITION 5A

29. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G8E, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
30. LIFT G8E FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS, BEFORE RELEASING GIRDER FROM CRANE.
31. REPEAT ABOVE STEP FOR GIRDER G7E AND G9E, RESPECTIVELY.

SETTING "E" GIRDERS, CRANE POSITION 5B

32. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G10E, INSTALLING A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
33. LIFT G10E FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G9E, SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
34. REPEAT ABOVE STEP FOR GIRDER G11E AND G12E, RESPECTIVELY.

SETTING "F" GIRDERS, CRANE POSITION 6A

35. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G8F, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
36. LIFT G8F FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. TIE GIRDER TO FW-5 AS SHOWN ON DRAWING 172-54, BEFORE RELEASING GIRDER FROM CRANE.
37. REPEAT ABOVE STEP FOR GIRDER G7F AND G9F, RESPECTIVELY.

SETTING "F" GIRDERS, CRANE POSITION 6B

38. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G10F, INSTALLING A MINIMUM OF 50% OF BOLTS SNUG TIGHT.

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39. LIFT G10F FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G9F, SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
40. REPEAT ABOVE STEP FOR GIRDER G11F AND G12F, RESPECTIVELY.

SETTING "G" GIRDERS, CRANE POSITION 7

41. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G8G, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
42. LIFT G8G FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS, BEFORE RELEASING GIRDER FROM CRANE.
43. REPEAT ABOVE STEP FOR GIRDER G7G AND G9G, RESPECTIVELY.
44. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G10G, INSTALLING A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
45. LIFT G10G FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G9G, SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
46. REPEAT ABOVE STEP FOR GIRDER G11G AND G12G, RESPECTIVELY.

SETTING "I" GIRDERS, CRANE POSITION 8

47. SURVEY ELEVATIONS OF PREVIOUSLY INSTALLED G13J AND G14J AT SPLICE 8N. COMPARE THE SURVEY WITH CALCULATED "NO-LOAD" ELEVATIONS. IF THE DIFFERENCE IS MORE THAN ALOWRANCE, REMOVE THE TEMPORARY DECK BETWEEN SPLICE 8N AND PIER 4N.
48. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G8I, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
49. LIFT G8I FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. TIE GIRDER TO FW-6 AS SHOWN ON DRAWING 172-54, BEFORE RELEASING GIRDER FROM CRANE.
50. REPEAT ABOVE STEP FOR GIRDER G7I AND G9I, RESPECTIVELY.
51. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G10I, INSTALLING A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
52. LIFT G10I FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. INSTALL

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A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G9I, SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.

53. REPEAT ABOVE STEP FOR GIRDER G11I AND G12I, RESPECTIVELY.
54. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G8H, INSTALL A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
55. LIFT G8H FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS, BEFORE RELEASING GIRDER FROM CRANE.
56. REPEAT ABOVE STEP FOR GIRDER G7H AND G9H, RESPECTIVELY.
57. ON THE TRAILER INSTALL CROSSFRAMES ON BOTH SIDES OF G10H, INSTALLING A MINIMUM OF 50% OF BOLTS SNUG TIGHT.
58. LIFT G10H FROM TRAILER AND SET IN FINAL POSITION. MAKE FIELD SPLICE WITH A MINIMUM OF 50% OF THE HOLES FILLED WITH BOLTS AND ERECTION PINS. INSTALL A MINIMUM OF 50% OF BOLTS CONNECTING CROSS FRAMES TO G9H, SNUG TIGHT, BEFORE RELEASING GIRDER FROM CRANE.
59. REPEAT ABOVE STEP FOR GIRDER G11H AND G12H, RESPECTIVELY.

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REV.	DESCRIPTION	BY	DATE
2	REVISE AND RESUBMIT		12-10-15
1	PRELIMINARY		10-16-15

BRIDGE 00172 ERECTION PLAN

DWN: D.C.
DES: D.C.
CHK: R.J.

SCALE: AS SHOWN

DWG. NO. 0172-58

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REVISION: --