



Appendix B: Falsework Reminder List

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B-1 Introduction

This appendix lists the location of falsework information required for the review, authorization and inspection of falsework. The information referenced addresses safety, submittal of shop drawings, design criteria, erection and removal of falsework. This reminder list is not intended to be an all-inclusive comprehensive list but is a guideline in which the structure representative can base a competent review.

B-2 Location of Falsework Information

B-2.01 Falsework Manual:

- Web link: <https://dot.ca.gov/programs/engineering-services/manuals>
- Chapter 1, *Introduction*: Purpose, design methodology, contractual relations, etc.
- Chapter 2, *Review of Shop Drawings*: Review procedure for shop drawings including when railroad is involved.
- Chapter 3, *Loads*: Loads on falsework.
- Chapter 4, *Design Considerations*: Various considerations for falsework, including camber, prestressing, various bridge types, openings at roadways and railroads, etc.
- Chapter 5, *Analysis*: Analysis of falsework members.
- Chapter 6, *Stability*: Falsework overturning, collapse, and bracing.
- Chapter 7, *Manufactured Assemblies*: Testing and application of commercial and non-commercial assemblies including vertical shoring systems.
- Chapter 8, *Foundations*: Analysis of foundation members, pads, piles, etc.
- Chapter 9 *Inspection*: Inspection of falsework members.

B-2.02 Special Provisions:

- Project specific requirements and considerations
- 12, *Temporary Traffic Control*: Project specific specifications for traffic openings

B-2.03 Standard Specifications:

- 5-1.20C, *Railroad Relations*: Railroad relations are available in the Information Handout.
- 5-1.23, *Submittals*: General specifications for submittals and shop drawings.
- 7-1.04, *Public Safety*: Specifications for public safety, including:

- Paved passageway or wooden walkway.
- Vertical clearance sign for vertical clearance of 15.5-feet or less.
- Do not move or temporarily suspend anything over a traffic lane open to the public unless the public is protected.
- 12-3, *Temporary Traffic Control Devices*: Specifications for traffic handling equipment and devices including K- rail.
- 48-1, *General*: General specifications for all temporary structures.
- 48-2, *Falsework*: Specifications for falsework.
- 48-2.01C, *Submittals*: Specifications for falsework submittals.
- 48-2.01C(2), *Shop Drawings*: Specifications for falsework shop drawings.
- 48-2.01D(2), *Welding and Nondestructive Testing*: Specifications for welding falsework.
- 48-2.03B, *Foundations*: Specifications for falsework foundations and pile driving.
- 48-2.03E, *Falsework Lighting*: Specifications for falsework lighting.
- 51-1.03C(2), *Forms*: Specification for deflection of forms.
- 51-1.03D(2), *Concrete Bridge Decks*: Requirement for placing concrete decks.
- 55-1.03B, *Falsework*: Specifications for falsework supporting steel structures.

B-2.04 Bridge Construction Records and Procedures

Manual:

- Volume 1:
 - BCM B-2.05, *Emergency Operations Plan (EOP)*: Opening or closing of road or structure.
 - BCM C-4.14, *Notice of Change in Structure Clearance or Permit Rating*: Reporting changes in clearance. Submit notification, form TR-0019 and TR-0020 or TR-0029.
- Volume 2:
 - BCM 48-2, *Temporary Structures – Falsework*: Submitting falsework shop drawings, including railroad.
 - BCM 51, *Concrete Structures*: Lost deck forms and soffit forms.
 - BCM 75, *Miscellaneous Metal*: For permanent work.
 - BCM 50-1.03B, *Prestressing Concrete – General – Constructions – Prestressing*:

- BCM 52, *Reinforcement*: Used in concrete pads.
- BCM 180, *Welding*: For permanent work.

B-2.05 Cal-OSHA – Title 8 Regulations:

- Chapter 3.2, *California Occupational Safety and Health Regulations, Subchapter 2 Regulations of the Division of Occupational Safety and Health, §341 Permit Requirements*: Permits for falsework.
- Chapter 4, *Division of Industrial Safety, Subchapter 4 Construction Safety Order, §1717 Falsework and Vertical Shoring*. Requirements for submittals and construction of falsework and vertical shoring.

B-2.06 SC HQ Falsework Engineer:

- (916) 227-8060

B-3 Pre-Job Meeting

It is recommended that the structure representative prepares to address these items for discussion in the pre-job meeting.

B-3.01 Falsework Design Review and Authorization:

- Review time allowed.
- Review time starts when a complete submittal is received.
- Review time starts over when corrections or revisions are made.
- Priority listing for multiple submittals.
- Information required for complete submittal. Refer to Section 2-4.01, *Initial Review*.
- For proprietary products and manufactured assemblies, the engineer should request technical data to be included in the submittal. Items include hardware items such as overhang brackets, jacks, hangers, concrete inserts, finishing machines, etc., and all commercial shoring systems.
- For cable bracing systems, the engineer should request manufacturer's technical data to be included in the submittal.
- Falsework erection cannot begin until drawings are authorized except for pad and pile foundation work.
- Request meeting with the falsework designer, foreman, SC engineers and other key individuals prior to falsework erection, grading and removal operations.

- Request that a joint safety stand down be held after falsework incident in the event it should happen.
- Verify Cal-OSHA Title 8 Regulations considerations are addressed
- Verify Storm Water Pollution Prevention Plan requirement are addressed

B-3.02 Falsework Erection and Removal Plans:

- Project specific considerations
- Erection and removal procedure must be shown on the shop drawings.
- See Section B-9, *Erection Plan Check List* and Section B-10, *Removal Plan Check List*.

B-3.03 Welding and Welded Connections:

- All welds must comply with AWS. Certified welder is required.
- Splice welds require NDT
- For previously welded splices all necessary testing and inspection must be documented to certify the ability of the weld to sustain the design stresses.

B-3.04 Traffic Considerations:

- Traffic openings, vehicle, pedestrian, railroad, etc.
- K-rail
- Lighting
- Detours, closures
- Erection and removal. Cannot erect or remove falsework over traffic.

B-3.05 Railroad Involvement:

- Railroad requirements
- Shop drawing submittal procedure and review time where railroad is involved

B-3.06 Application of Construction Safety Orders:

- Cal-OSHA Title 8 Regulations

B-3.07 Deck Placement Plan:

- *Bridge Deck Construction Manual*

B-4 Design Loads

B-4.01 Vertical Design Loads:

- Minimum vertical design load (dead load plus live load) on any falsework member is 100 psf. This includes supports for a construction walkway extending beyond edge of deck or for bent cap falsework.
- For stress analysis, the design dead load is the weight of concrete, forms, reinforcing steel and falsework members.
- For deflection, the design dead load is the weight of concrete only, i.e. without forms and rebar dead weight.
- Design live load includes the following:
 - 20-psf over the total area supported by the member under consideration.
 - 75-plf at edge of deck overhang acting over a maximum length 20-feet. Does not need to be applied simultaneously with Bidwell on deck overhang brackets.
 - Weight of equipment (finishing machine, etc.) applied as a concentrated load at point of contact.

B-4.02 Horizontal Design Load:

- The assumed horizontal load is the greater of the following:
 - Sum of the actual loads due to equipment, construction sequence or other causes and wind loading.
 - 2% of the total supported dead load of the bridge during the unloaded and loaded condition.

B-4.03 Miscellaneous Loads:

- Increased vertical design load adjacent to roadway and railroad.
- Increased vertical load due to load redistribution caused by prestressing forces.
- Horizontal load caused by stream flow pressure. See Caltrans *Trenching & Shoring Manual* for hydrodynamic forces.
- Loads due to vertical and horizontal components of cable loads.

B-5 Shop Drawings

The items in this list should be shown on the shop drawings. This list is not all inclusive but is intended as a guide when reviewing the shop drawings.

All items listed in Section 2-4.01, *Initial Review*.

Anticipated settlement, not to exceed 1-inch.

B-5.01 Pads:

- Assumed soil bearing value for pad foundations
- Joint location in continuous timber pads
- Design details for concrete pads

B-5.02 Piles:

- Diameter
- Section type for steel piles
- Design details for concrete piles
- Pile tip and resistance
- Driving tolerances, maximum pile-pull, and eccentricity

B-5.03 Dimensions:

- Bent locations
- Post heights
- Post spacing
- Span lengths
- Stringer spacing
- Vertical distance between connections in diagonal bracing
- Size of all load supporting members

B-5.04 Timber Bracing:

- Type of connection (single or double shear)
- Type, size, and number of fasteners at each connection

B-5.05 Cable Bracing:

- Cable description, number and size of cables in each cable brace
- Number and type of connectors (Crosby clips, etc.)

- Detail showing method or device by which cable will be attached to falsework components, and location of attachment
- Cable anchorage
- Cable preload value and method by which preload force will be applied and measured
- Constructional stretch considerations
- Adjustment plan for grading and adjusting falsework more than 1/2-inch
- Cable adjustment and release procedure during grading and adjustment

B-5.06 Welds:

- All welds must comply with AWS

B-5.07 Commercial Shoring Systems:

- For commercial shoring systems, the trade name and nominal load-carrying capacity

B-5.08 Erection and Removal Plans:

- The method or procedure to be followed, including details for temporary bracing

B-6 Design Considerations

B-6.01 General

B-6.01A Loads:

- Loaded zone
- Differential beam deflection considered
- Additional requirements for deck overhangs on steel girder bridges
- Steel girder widening falsework independent of existing bridge
- Load redistribution due to application of prestressing forces

B-6.01B Foundations:

- Soil bearing value compatible with site conditions. Soil load test required.
- Pad joint location
- Corbel spacing

- Bearing on timber piles limited to 45 tons
- Pile bents:
 - Driving tolerance
 - Required penetration
 - Bracing
 - Horizontal deflection
 - P-delta deflection
 - Longitudinal stability

B-6.01C Posts and Columns:

- Timber post L/d
- Steel post L/r
- Steel crush plate between timber post and timber cap

B-6.01D Commercial Shoring Systems:

- Manufacturer's technical data furnished and reviewed
- Design loads comply with manufacturer's recommendations for all loading conditions
- Shoring designed in accordance with manufacturer's recommendations and falsework manual design criteria
- Cable bracing connected to cap at top and to external support at bottom
- Cable design load meets falsework manual criteria

B-6.01E Bracing:

- Diagonal bracing members and connections
- Timber members sized to accommodate number of fasteners
- Fastener capacity values adjusted for load duration
- Timber bracing compression members and compression connections adjusted to 1/2 the design value
- Connection at center of cross bracing
- Steel bracing, welded connections meet design criteria
- Cable bracing, review manufacturer's technical data. Perform load test if required

- Cable bracing, cable attached to falsework cap, not posts or columns. Check cable anchorages for uplift.
- Cable can only be used for single tier bents

B-6.01F Beams and Stringers:

- Joist stresses at girder flares, diaphragms, and caps
- Timber beams stable against buckling and rollover
- Steel beam compression flange buckling
- Steel beam bi-axial bending
- Steel beam web yielding
- Camber strips centered on stringers and within compression stress limit
- Beam deflection limited to $L/240$ under weight of concrete only
- Continuous beams, effect of beam continuity and beam uplift

B-6.01G Stability:

- Collapse
- Overturning
- Friction to resist horizontal forces
- Grading or adjustment:
 - Adjustment plan
 - Adequate space for jacks
 - Bearing

B-6.01H Plywood:

- Deflection limits

B-6.01I Erection and Removal Plans:

- See Section B-9, *Erection Plan Check List*, and Section B-10, *Removal Plan Check List*.
- Falsework components stable during all stages of erection and removal
- Temporary bracing (including connections) meets minimum design load criteria
- Access for removal equipment after new bridge is built

B-6.01J Miscellaneous Considerations:

- Proprietary products used in accordance with manufacturer's recommendations, manufacturer's technical data furnished and reviewed
- Manufacturer's technical data is required for all proprietary products used in the falsework, and for all cable installations
- Ledger connection for lost deck forms

B-6.02 **Adjacent to Roadways****B-6.02A** Clearances:

- Check Horizontal and Vertical Clearances:
 - Roadway: Shop Drawings: H _____ V _____
 Special Provisions: H _____ V _____
 Bridge Plans: H _____ V _____
 - Pedestrian: Shop Drawings: H _____ V _____
 Special Provisions: H _____ V _____
 Bridge Plans: H _____ V _____
- Openings conform to table in Special Provisions 12-4, *Maintaining Traffic*
 - Vertical clearance sign required for vertical clearance of 15.5-feet or less, see Standard Specifications 7-1.04, *Public Safety*
 - K-rail length and clearance to falsework adequate

B-6.02B Posts:

- Steel or timber with minimum section modulus about each axis:
- Post design load is greater of:
 - 150% of normal post loading
 - Increased or readjusted loads caused by prestressing

B-6.02C Bracing:

- 5/8-inch diameter or larger bolts for timber bracing connections

B-6.02D Mechanical Connections to Resist Impact:

- 2000 lb. capacity at base of posts in all directions except toward the roadway
- 1000 lb. capacity top of post all directions

- 500 lb. capacity for certain stringer-to-cap connections effective in all directions including uplift

B-6.02E Falsework Lighting:

- Lighting Plan
- Portal lighting and white panels
- Roadway illumination
- Pedestrian walkway lighting

B-6.02F Pedestrian Openings:

- Paved passageway or wooden walkway see *Standard Specifications*, Section 7-1.04, *Public Safety*
- Handrail per Cal-OSHA requirements
- Overhead debris protection

B-7 Adjacent to Railroad

B-7.01 General:

- Requirements listed in the Information Handout *Railroad Relations*

B-7.02 Shop Drawings:

- Construction features affecting railroads require approval by the railroad company

B-7.03 Clearances:

- Check Horizontal (H) and Vertical (V) Clearances:
 - Railroad: Shop Drawings: H _____ V _____
 - Special Provisions: H _____ V _____
 - Bridge Plans: H _____ V _____
- Vertical clearance measured from top of rail. Consider beam deflection and settlement
- Horizontal clearance measured from centerline of tracks
- Complete railroad checklists. See [Temporary Structure Technical Team website](#)

B-7.04 Posts:

- Steel or timber with minimum section modulus about each axis.
- Post design load is the greater of:
 - 150% of normal post loading
 - Increased or readjusted loads caused by prestressing

B-7.05 Bracing:

- 5/8-inch diameter or larger bolts for timber bracing connections

B-7.06 Mechanical Connections to Resist Impact:

- 2000 lb. capacity at base of posts in all directions except toward the roadway
- 1000 lb. capacity top of post all directions
- 500 lb. capacity for all stringer-to-cap connections effective in all directions including uplift

B-7.07 Bents Within 20 Feet of Track Centerline:

- Solid sheathing 5/8-inch plywood or 3/4-inch thickness lumber between 3 and 17 feet above track on track side of bent
- Bracing designed to resist the horizontal design load, but not less than 5000 lb.

B-8 Authorizing Shop Drawings**B-8.01 General:**

- Review the shop drawings and perform an engineering analysis
- Stamp each shop drawing sheet with the Caltrans Authorization stamp. Structure representative or licensed engineer who reviewed the shop drawings signs and dates the stamp
- Structure representative or licensed engineer who reviewed the shop drawings stamps, signs, and dates temporary structure analysis report
- See also BCM 48-2, *Temporary Structures – Falsework*

B-8.02 When Railroad Company is Involved:

- Review the shop drawings and perform an engineering analysis
- Complete railroad checklists. See [Temporary Structure Technical Team](#) website

- After reviewing the shop drawings, but before authorizing them, send the shop drawings and the check list to the SC HQ Falsework Engineer who will forward them to the railroad for approval
- Do not authorize the shop drawings until notified by SC HQ Falsework Engineer that the railroad has approved the shop drawings
- See also BCM 48-2, *Temporary Structures – Falsework*

B-9 Construction Considerations

B-9.01 Erection Check List:

- See Section B-10, *Erection Plan Check List*

B-9.02 Erection Plan:

- Before erection begins, review the erection plan with State and contractor personnel
- For stage construction, effect of erection and location of other stages considered

B-9.03 Pad Foundations:

- Foundation material adequate to support design soil pressure
- Soil bearing test needed
- Splices in continuous pads located properly
- Pads protected from flooding and surface runoff

B-9.04 Pile Foundations:

- Required pile resistance obtained
- For pile bents: penetration and driving tolerances meets design assumptions

B-9.05 Timber Construction:

- Timber quality
- Connections conform to design details
- Connectors properly installed
- Workmanship

B-9.06 Manufactured Assemblies:

- All commercial products and devices used and installed in accordance with manufacturer's recommendations
- Certifications furnished

B-9.07 Metal Shoring Systems:

- Assembly meets manufacturer's recommendations
- Certifications furnished

B-9.08 Cable Bracing:

- Cable is same size and type as shown on shop drawings
- Connections conform to shop drawing details
- Crosby clips properly installed and torqued
- Cable preload force applied
- Cable preload force applied twice for cables attached to timber members

B-9.09 Falsework Openings:

- Clearance notification:
 - Contractor to notify resident engineer no less than 25 days and no more than 125 days before operation
 - Structure representative notifies the resident engineer who notifies the Transportation Permits Board. See Section 4-12.02, *Falsework Openings*
 - Re-notify after erection if actual clearance is different
 - If clearance is less than notified, stop operations and remove the stringers already set until clearance issues are resolved
- White panel boards properly positioned
- Lighting inspected after dark

B-9.10 Field Changes:

- All changes must be documented and resubmitted for authorization, see *Falsework Manual*, Section 9-3.22, *Field Changes*

B-9.11 Certification:

- See *Falsework Manual*, Section 9-3.26, *Falsework Certification*

- Certification of falsework by licensed engineer
- Certification of manufactured assemblies including shoring systems

B-9.12 Inspection During Concrete Placement:

- See *Falsework Manual*, Section 9-4.01, *Inspection During Concrete Placement*
- Contractor must follow the deck placement plan
- Inspect falsework at frequent intervals during concrete placement. Look for the following indicators of incipient failure:
 - Excessive compression at the tops and bottoms of posts and under the ends of stringers. Crushing of wedges. Settlement of sand jacks
 - Movement or deflection of diagonal bracing. Distortion at connections Pulling of nails
 - Tilting or rotation of joists or stringers. Excessive deflection of any horizontal member
 - Posts or towers that are bowing or moving out of plumb
 - Excessive settlement as indicated by telltales
 - The sound of falling concrete or breaking timbers. Any unusual sound
- Inspect tell tales
- Settlement must not deviate more than $\pm 3/8$ -inch from the anticipated settlement on the shop drawings

B-9.13 Inspection After Concrete Placement:

- See *Falsework Manual*, Section 9-4.02, *Inspection After Concrete Placement*
- Foundation protected from undermining by curing water
- Foundation protected from undermining by rain water

B-9.14 Deck Shrinkage:

- Deck shrinkage during curing can redistribute loads toward the center of the bridge spans
- Post tensioning of bridges will redistribute loads toward the bridge supports. This can also affect the falsework loads.

B-9.15 Falsework Removal:

- See *Falsework Manual*, Section 9-5, *Removal*

- See Section B-10, *Removal Plan Check List*
- Review removal plan with State and contractor personnel
- Falsework components stable during all stages of removal
- Effect of temporary unbalanced and/or eccentric loads
- Effect of jacking loads
- Effect of crane set on the permanent structure
- Winch loads on new bridge
- For stage construction, effect of removal sequence considered

B-10 Erection Plan Check List

B-10.01 Items That Should be Included in the Erection Plan

B-10.01A Information (for example) to be Provided as Part of the Falsework Erection Sequence:

- Falsework pad grading:
 - Verify soil capacity
 - Provide for drainage
- Method of falsework bent construction:
 - Type of equipment used for erection
 - Location of equipment used for erection
 - Material storage areas
- Sequence of falsework bent erection. For example, the plan could state:
 - First erect and stabilize bents at columns and abutments
 - Secure top and bottom of bents at column or abutment
- Install stability measures (bracing) as indicated on the approved falsework plans before placing stringers:
 - Temporary and permanent stability measures are to be shown on the authorized falsework plans
- Order of stringer erection. Are interior or exterior stringers placed first? Be aware of stringers on the cantilever portions of bents.
- Sleeper and camber strip placed on the stringer prior to or after stringer erection

B-10.01B Notes (for example) Stating:

- Falsework bents are to be stable at all stages of erection. Details of interim stability measures are shown on the plans
- All permanent stability measures shall be in place before erecting falsework members above the stringers
- Secure stringers prior to soffit joist or panel placement
- Where bolts are required for permanent bracing, nails may be used as a temporary measure

B-10.01C Safety Measures:

- Details provided for workers rolling out soffit joists
- Details provided for soffit form or panel placement. Including measures for possible high winds
- Details provided for exterior girder panel placement. Including measures for possible high winds

B-10.01D Adjustment Including Grading:

- Details of falsework grading procedure
- Adjustment plan if adjustment is over 1/2-inch

B-10.01E Special Locations:

- See Standard Specifications 48-2.02B(4), *Special Locations*

B-10.01F Falsework over Roadways:

- Verify that the plan adequately addresses time available for erection. Refer to lane closure charts in the contract Special Provisions.
- Verify that permanent bracing is installed, and falsework is stable prior to allowing traffic to pass through falsework.

B-10.01G Falsework over Railroad:

- See Railroad Relations in the Information Handout
- See Union Pacific Railroad (UPRR) – BNSF Railway, *Guidelines for Railroad Grade Separation Projects*. Available on the UPRR or BNSF websites. The most current version always applies regardless of which one is listed in the Information Handout.

- Verify that the plan adequately addresses time available for erection. Refer to railroad relations in the Information Handout
- Verify that permanent bracing is installed, and falsework is stable prior to allowing traffic to pass through falsework

Review *Standard Specifications*, Section 48-2.03C, *Erection*, for other requirements.

B-11 Removal Plan Check List

B-11.01 Items That Should be Included in the Removal Plan

B-11.01A Sequence of Falsework Removal:

- Order in which falsework spans, bents, stringers, and formwork will be lowered and removed

B-11.01B Considerations for Load Redistribution Due to Pre-stressing:

- How is the load redistribution determined?
- Effect on individual falsework bents
- Effects on the removal sequence

B-11.01C Method of Falsework Release:

- How is falsework released from the structure?
- Sand jacks being used
- Effect of falsework release on bracing
- Details and description on how falsework stability is maintained

B-11.01D Notes Stating:

- Falsework will be stable during all phases of removal. Specific stability measures at all stages of removal should be outlined

B-11.01E Indicate (for example) on Plan:

- Equipment to be used
- Location of equipment during various stages of removal
- Sequence of stringer removal
- Lay down areas for materials removed
- How falsework stability is maintained throughout falsework removal process

- Person in charge to be on site during falsework removal operations
- Number and function of people required onsite to safely remove falsework

B-11.01F Winch Systems:

- *Standard Specifications*, Section 7.1.04, *Public Safety*, states: “Do not move or temporarily suspend anything over a traffic lane open to the public unless the public is protected.”
- Submittal should include details regarding:
 - Winch placement
 - Winch capacity, loads, and dead men required
 - Winch cable connection to falsework
 - Supplemental and redundant support system
 - Patching details for holes through deck and soffit
- Falsework may not be supported by winches over traffic. Another independent support system is required

B-11.01G Special Locations:

- See Standard Specifications 48-2.02B(4), *Special Locations*

B-11.01H Falsework over Traffic:

- Verify that the plan adequately addresses time available for removal. Refer to lane closure charts in the contract Special Provisions.
- Verify that temporary bracing is installed, and falsework is stable prior to releasing permanent bracing.
- If falsework is to be released and lowers the vertical clearance, estimate and report changes to impaired vertical clearances prior to the operation.
- Provide contingency plans for falsework mishap.

B-11.01I Falsework over Railroad:

- See Railroad Relations in the Information Handout
- See Union Pacific Railroad (UPRR) – BNSF Railway *Guidelines for Railroad Grade Separation Projects*. Available on the UPRR or BNSF websites. The most current version always applies regardless of which one is listed in the Information Handout.
- Verify that the plan adequately addresses time available for removal. Refer to railroad relations in the Information Handout.