Chapter 9: Temporary Supports and Jacking

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9-1 Introduction

Temporary supports are used to support structures during retrofit, reconstruction, erection, and removal activities. The design of temporary supports is similar to falsework except for some unique loading and design requirements. One major difference between falsework and temporary supports is the duration of the maximum loading. Falsework is typically loaded with plastic concrete for only a day or two, but temporary supports can be in place for months. Temporary supports are often associated with jacking operations which will be discussed in this chapter. Jacking is done to raise or lower structures or just to relieve the load for repairs. See Figure 9-1 for support of precast girders, see Figure 9-2 for an illustration of lowering a bridge, and Figure 9-3 for an illustration of raising a bridge.

Figure 9-1. Route 46/99 Separation ABC Project

Figure 9-2. Temporary Support for Bridge Lowering

Figure 9-3. Temporary Support Highway 70 Bridge Raising

9-2 Contractual Requirements

The *Contract Specifications* Section 48-3, *Temporary Structures – Temporary Supports,* requires the Contractor to submit to the Engineer for review and authorization, temporary support shop drawings and calculations. Temporary support shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State. Specific design criteria can be found in the *Contract Specifications* or shown on the project plans.

Jacking is typically associated with temporary supports, and the requirements are found in the *Contract Specifications* Section 48-5, *Temporary Structures – Jacking*. The Contractor must submit shop drawings and calculations, which include the information listed in Section 48-5 for the jacking system. Jacking system shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

Contract Specifications Section 48-5.01D(2) *Temporary Structures – Jacking – General – Quality Assurance – Displacement Monitoring*, requires control points on the structure be monitored at a minimum as follows:

1. Before starting jacking activities.
2. Immediately after completing jacking.
3. After completing bridge removal.
4. Before connecting the superstructure to the substructure.
5. After removing the jacking support system.

The displacement monitoring plan should either be a separate submittal or part of the jacking submittal.

9-3 Cal/OSHA Requirements

Requirements from Cal/OSHA's Construction Safety Orders:

Article 29, *Erection and Construction*, § 1717, *Falsework and Vertical Shoring,* subsection 1717(b)(1), *Design,* requires [falsework or] vertical shoring be designed by a civil engineer, currently registered in the State, when any of the following conditions exist:

(A) The height, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet

(B) Individual horizontal span lengths exceed 16 feet

(C) Provisions for vehicular or railroad traffic through the falsework or vertical shoring are made.

§ 1717(c), *Inspection,* subsection (1), requires:

After construction of the falsework or vertical shoring system enumerated in section 1717(b)(1) and prior to placement of concrete, a civil engineer, currently registered in California, or authorized representative, shall inspect the falsework or vertical shoring system for conformity with the working drawings. The person performing the inspection shall certify in writing that the falsework or vertical shoring system substantially conforms to the working drawings and that the material and workmanship are satisfactory.

9-4 Review and Authorization

Temporary support and jacking systems are temporary structures and are reviewed and authorized in accordance with BCM C-11, *Shop Drawing Review of Temporary Structures.*

Initial review of the submittal for completeness should check for the following items:

1. Legible drawings
2. Stamped by a registered civil engineer in the State
3. Supporting calculations
4. All components identified and information for manufactured assemblies are included.
5. All dimensions shown on the shop drawings.
6. Sequence and installation procedures are included.

An independent analysis by Caltrans (typically SC staff) should be performed to verify if the design of the temporary support and jacking system conforms to the *Contract Specifications* and stresses in members are within the specified allowable limits. Documentation for calibration of the jacks and gauges should be reviewed for conformance with the *Contract Specifications*.

A detailed work plan is required for guying submittals that involve the railroad. The work plan must include procedures for installing rebar assemblies and forms. The work plan must include the following:

1. Crane pick plan for rebar assemblies and forms.
2. Procedures for installing forms without releasing supports.
3. Staging areas for equipment and materials.

4. Path of travel for equipment in and out of railroad right-of-way.
5. Utilities within the railroad right-of-way.
6. Critical dimensions including dimensions to centerline of track.

9-5 Temporary Support System Design

Temporary support systems have unique requirements that differ from typical falsework design. The most notable difference is that the temporary support design requires the system to resist a significantly larger lateral load than falsework. The lateral load that the temporary support system is required to resist is typically found in the contract documents. The minimum lateral load for temporary supports is typically 10 percent of the supported dead load, as specified in *Contract Specifications* Section 48-3.02B, *Temporary Structures – Temporary Supports – Materials – Design Criteria*.

An often overlooked requirement found in the *Contract Specifications* is for the temporary support to resist lateral loads in any direction. The temporary support system must resist the lateral loads shown. Transferring lateral loads through the existing structure is only allowed when specifically permitted by the *Contract Specifications*.

Temporary supports are required to be mechanically attached to the supported structure and its foundation. The mechanical connection must accommodate movement resulting from vertical adjustments made to the temporary supports while providing restraint to lateral movement. Removing the connection for adjustment is not allowed. See Figure 9-4 for an example of a mechanical connection that allows adjustment vertically.

Lateral forces induced on temporary supports may be resisted by the partially constructed, demolished, or augmented structure if it can be shown through analysis and calculations that such components have adequate stability and capacity.

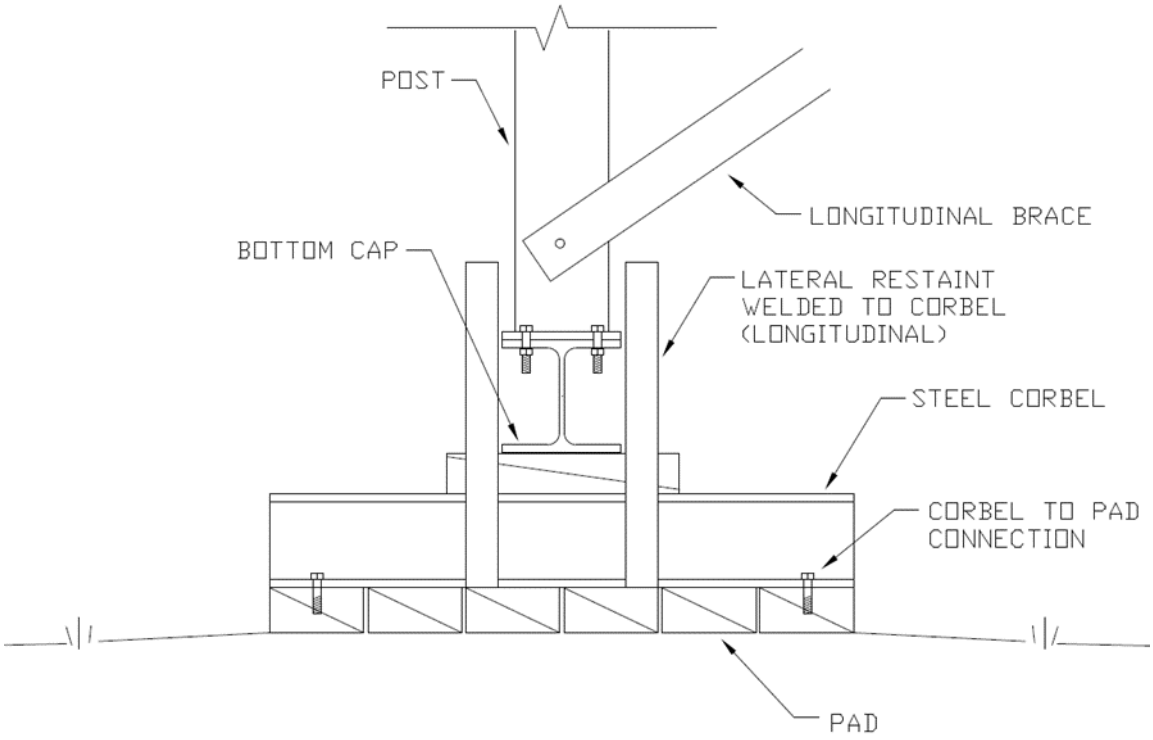

Figure 9-4. Typical Mechanical Connection Allowing Adjustment (vertical)

9-6 Jacking System Design

The design of the jacking system must support the dead load and lateral design forces plus additional loads from jacking equipment and activities. It is common for the jacking load to be greater than the supported dead load to initiate the initial movement of the structure.

During jacking operations, a redundant system of support must be provided, as illustrated in Figure 9-5. Lock rings on jacks are not considered a redundant system of support. Typical redundant systems consist of stacks of metal plates adjacent to the jacks. Alternative plate material is acceptable provided it can support the load without being overstressed or resulting in excessive deflection.

The quality assurance requirements of the *Contract Specifications* Section 48-5, *Temporary Structures – Jacking,* require jacks to be calibrated by an authorized laboratory within 6 months of use or after repair. The list of authorized laboratories can be verified with the Materials Engineering and Testing Services (METS) Representative.

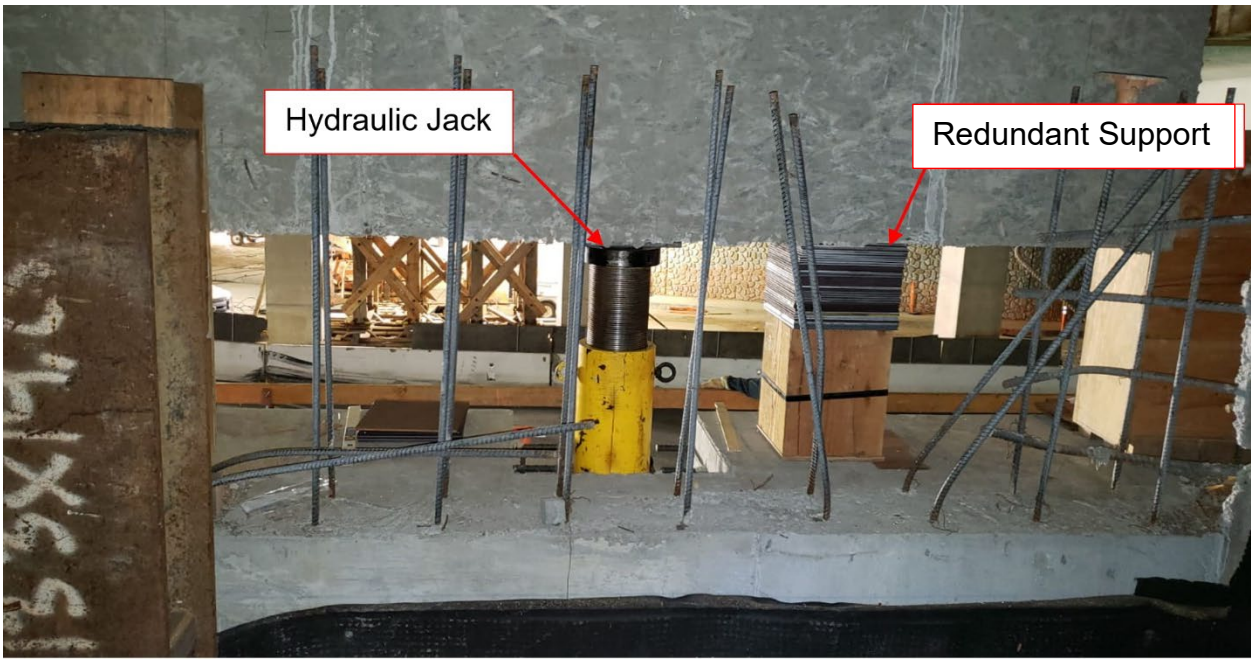

Figure 9-5. Typical Jacking System with Redundant System of Support