Chapter 5: Guying Forms and Rebar Assemblies

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5-1 Introduction

Guying systems are used to support structure components until they become self-supporting. During column construction, guying systems are used to support column cage rebar and column forms. Guying systems are also used to support forms and rebar assemblies for walls and other structural components. Guying systems typically consist of either wire rope (guy wire) for a tension-only system (Figure 5-1) or rigid struts (braces) for a push-pull system (Figure 5-2). The guying system is typically secured to a concrete block deadman or other load-resisting member to resist the applied loads.

A properly designed system with the appropriate installation sequence and procedure, constructed in accordance with the authorized shop drawings, will ensure that the column rebar and column forms will not collapse during construction. A column collapse has many adverse results which include equipment and property damage, injuries, schedule delays, and expensive repair costs.

Figure 5-1. Guy Wire System, Butte City Bridge

Figure 5-2. Support Frame System, Antlers Bridge

5-2 Contractual Requirements

The *Contract Specifications* Section 52-1.01C(2), *Reinforcement – General – Submittals – Shop Drawings,* requires the Contractor to submit to the Engineer for review and authorization, temporary support system shop drawings and calculations. This temporary support system plan is commonly referred to as a “guying plan”.

Submittal of the temporary support system plan is required if a portion of an assemblage of bar reinforcing steel exceeds 20 feet in height and is not encased in concrete. Forms that encase the rebar must also be secured to resist overturning.

Temporary support system shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

5-3 Cal/OSHA Requirements

Requirements from Cal/OSHA's Construction Safety Orders, Article 29, *Erection and Construction*:

§ 1711, *Reinforcing Steel and Post-Tensioning in Concrete Construction*

(a) 1711(e)(1) states: "Reinforcing steel for walls, piers, columns, prefabricated reinforcing steel assemblies, and similar vertical structures shall be guyed, braced, or supported to prevent collapse."

(a) 1711(e)(3) states: "Reinforcing steel shall not be used as a guy or brace."

§ 1713, *Framed Panels and Concrete Forms*

(a) 1713(b) states: "Form panels for concrete structures shall be securely anchored, guyed, or braced to prevent them from falling or collapsing."

5-4 Review and Authorization

Guying 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. All components identified and information for manufactured assemblies included.
4. Supporting calculations
5. All dimensions shown on the shop drawings.
6. Sequence and installation/removal procedures included.
7. Anchors and cables not conflicting with existing roadways/structures/utilities.

An independent analysis by Caltrans should be performed to verify whether the capacity of the guy wire system components is greater than the applied wind load against the column assemblage. See Appendix A Example 2*, Column Guying*, for an example of a column guying analysis.

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.

5-5 Sequence and Installation Procedures

Special emphasis should be placed on the requirement of *Contract Specifications* Section 52-1.01C(2), *Shop Drawings*, which states, ***"If form installation or other work requires changes to or the temporary release of any part of the temporary support system, the shop drawings must show the support system to be used during these changes or the temporary release."*** On a fixed column-to-footing connection, the column rebar cage is imbedded in the footing. A column guy wire system typically supports the column rebar cage during the footing construction. After the footing concrete is placed, the column forms are installed. However, the guy wire locations usually conflict with the column forms and must be temporarily removed. During this stage, the column rebar cage is vulnerable to instability and collapse. It is very important that the Contractor has a sequence and installation procedure. The sequence and installation procedure can be written as general notes on the drawings, or it can be on a separate sheet, which is included in the submittal.

Typically, for a fixed column, two cranes are needed. The Contractor will use one crane to support the column rebar cage while the guy wire system is temporarily removed. The second crane will be used to install the column forms, and then the guy wire system will be reinstalled.

Typically, for a pinned/hinged column, the Contractor will use a crane to erect the column forms. Then the guy wire system will be installed on the column forms. After the guy wire system is installed, the same crane will be used to lift the rebar cage and set it inside the column form.

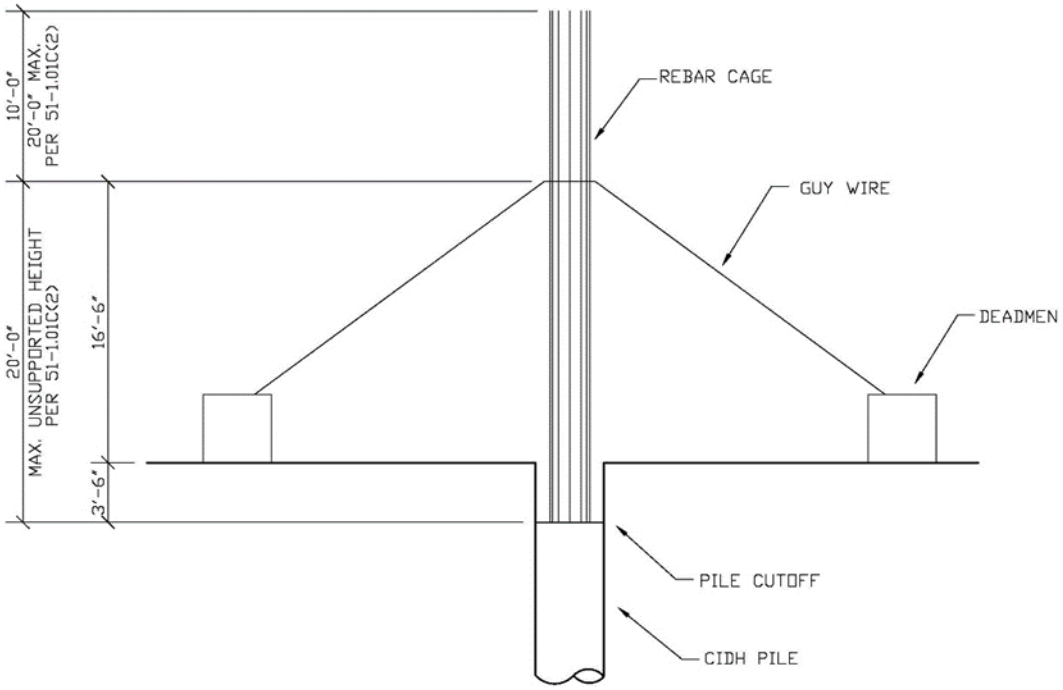

Figure 5-3. Rebar Assembly Support

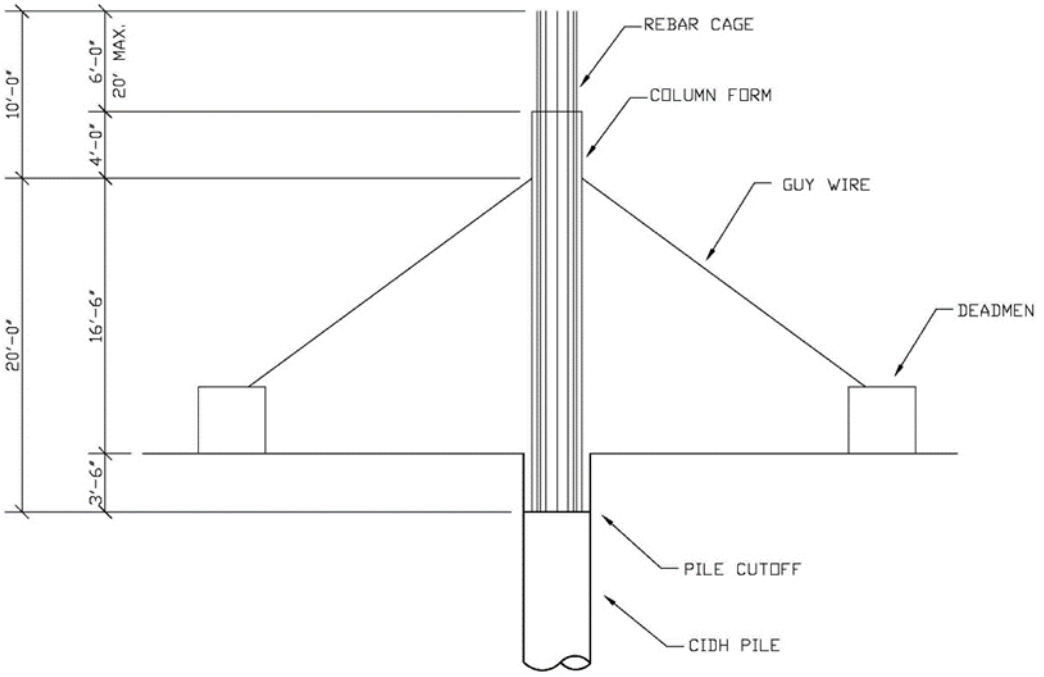

Figure 5-4. Column Form Support

5-6 Guying System Design

The minimum horizontal wind load to be applied to the reinforcing steel assemblage or to a combined assemblage of reinforcing steel and forms must be the sum of the products of the wind impact area and the applicable wind pressure value for each height zone. Wind pressures for forms and rebar assemblages are found in the previously referenced *Contract Specification* Section 52-1.01C(2), S*hop Drawings,* as shown in Figure 5-5 below:

Wind Pressure

Height zone, H (feet above ground)	Wind pressure value (psf)
$0 \leq 30$	20
$30 < H \leq 50$	25
$50 < H \leq 100$	30
$H > 100$	35

Figure 5-5. Wind Pressure Height Zones

The wind impact area is the projected area of the forms or rebar assemblage normal to the direction of the applied wind. The projected area of rebar assemblages is the full area and includes openings through the reinforcement. Reinforcement that cantilevers above the rebar cage is also included, and the areas between the rebar are included.

Cable bracing for guying systems should be designed using the procedures found in the *Falsework Manual* Chapter 5, *Analysis*, Section 5-5, *Cable Bracing Systems*. A minimum factor of safety, **FS = 2**, based on the minimum breaking force, is required when determining the allowable design capacity of the cable units.

In most cases, cables will be secured by fastening the end to a concrete anchor block (deadmen), although temporary cast-in-drilled hole (CIDH) anchors are sometimes used when relatively large forces must be resisted.

For either concrete anchor blocks or CIDH anchors, the method of connecting the cable to the anchorage is part of the design. The connecting device must be designed to resist both vertical (uplift) and horizontal forces. If manufactured devices are used to connect the guy cable, follow the manufacturer’s instructions for loadings.

For the procedure to review cable anchored to CIDH anchors, see *Falsework Manual* Section 5-6, *Short Poured-In-Place Concrete Piles.*

Concrete anchor blocks must be proportioned to resist both sliding and overturning. The weight of the anchor block must be reduced by the vertical component of the cable tension to obtain the net or effective weight to use in the anchorage computations.

For dry service conditions:

The coefficient of friction assumed between the concrete anchor block and base material must not exceed the values displayed in Figure 5-6.

For wet service conditions:

Multiply the values for dry conditions by 0.67. This reduction must be used if it is likely that the base material will become wet (saturated) during the construction period.

If the blocks are submerged, buoyancy effects must be addressed.

Friction of Concrete Anchor Blocks	
Base Material	**Coefficient of Friction**
Sand	0.40
Clay	0.50
Gravel	0.60
Pavement	0.60

Figure 5-6. Industry Standard Coefficient of Friction for Concrete Anchor Blocks

The minimum factor of safety for overturning and sliding of deadman anchor blocks is one (**FS = 1**) in each case.