CHAPTER

10 Pier Columns

10-1 Description

Pier columns are an extension of the column or pier into bedrock material and are usually the same size, or slightly larger, than the column or pier. They are ideally suited to canyons or hillside areas where there are limitations on the usual footing foundations; i.e., the need for approximately level topography and level underlying stratum. Footing foundations constructed in steep slopes are very costly because of the tremendous amount of excavation required.

Pier columns are primarily a Cast-In-Drilled-Hole (CIDH) pile, except the means of excavation is something other than the conventional drilling method. The following is taken from Caltrans Memo to Designers, Section 3-1 *Deep Foundations*, *"Pier Columns"*:

> "Pier columns are utilized when site conditions indicate that excavation by hand, blasting, and mechanical/chemical splitting of the rock is needed.
>
> Pier column excavation in rock may be more expensive than drilling methods and the pay limits must be clearly defined. The pier column cut-off elevation and tip elevation (upper and lower limits of the hard material) should be shown in the Pile Data Table. The pay limits for Structure Excavation (Pier Column) and Structure Concrete (Pier Column) shall be shown on the contract plans. See *Bridge Design Details* page 7-20 and *Bridge Design Aids* Chapter 11 for details."

See Appendix D, *Pier Column & Type I Pile Shaft,* for pay limits sketch.

As mentioned above, pier columns are primarily CIDH piles, but pier columns will have contract pay items for structure excavation and structure concrete. Pier columns can also be referred to as pile shafts. Caltrans outlines the design of pier columns in *Bridge Design Aids (BDA),* Chapter 12. Also, Federal Highway Administration (FHWA) has useful information on drilled shafts.

10-2 Specifications

Pier column information in the special provisions, contract plans, and the Standard Specifications should be reviewed prior to the start of work. The contract specifications[1] state the concrete cementitious material content. The contract specifications[2] also state the requirements for placing pier column concrete. Construction of pier columns is an excellent topic for the preconstruction conference, especially in regard to safety and excavation plans.

Almost all pier columns will have neat line excavation limits specified on the contract plans. Any excavation outside these neat lines must be filled with concrete. The Contractor should be reminded of this requirement prior to the start of work. It should also be pointed out that care must be used in constructing the access road and/or work area around the pier column(s) so that these excavations do not extend below the top of the neat line areas. The contract plans also specify no splice zones and ultimate splice zones for the main column reinforcement and for the main pile reinforcement. It is very important that the Contractor adheres to the rebar splice requirements.

10-3 Construction Methods

Methods and equipment used for construction of pier columns are dictated by several major factors. Among them is access to the work area, which is determined by the topography, and adjacent facilities such as existing structures, roads, and streambeds, and also by the type of equipment required to do the work. The cross sectional area of the pier shaft, depth of excavation, and the nature and stability of the material to be excavated are other major factors affecting the method and type of equipment to be used.

The above factors vary significantly from project to project. Hence, there is a wide variation in construction methods and equipment used by contractors on different projects. Methods that have been used in the past include using a hoe-ram, jackhammer, or Cryderman (“shaft mucker”). Others have used chemical rock splitting. The most common method used is blasting with explosives. Rotators and oscillators may also be used to perform this work. For additional information on these tools refer to Chapter 6, *Cast-In-Drilled-Hole Piles*.

10-4 Excavation

One of the first orders of work, after access roads are constructed to the pier column site, is to establish survey control points. These points should be placed so that they not only

[1] 2010 SS, Section 51-1.02(B), *Concrete,* or Special Provisions for contracts using 2006 SS.
[2] 2010 SS, Section 51-1.03E(11), *Pier Columns,* or Special Provisions for contracts using 2006 SS.

provide control during excavation operations, but also can be used for pier column construction.

After establishing survey control points, excavation operations begin. Usually, soft material is excavated by conventional methods, such as a Gradall, flight auger, clam bucket, and hand work. Hard material encountered in otherwise soft material requires other means such as blasting. Since blasting is the most commonly used excavation method, it merits further discussion.

Typically, the first phase of a pier column excavation operation with blasting utilizes a line drill along the perimeter of the shaft to create holes along the neat line dimensions of the excavation (the Contractor may elect to line drill slightly outside the neat line dimension). A line drill is an air-track compressor type drill rig that uses 2-1/2 to 5 inch diameter drill bits in 20 foot lengths. The holes are usually drilled on 12 inch centers with additional holes placed inside the perimeter if needed. The holes are then blown out and filled with sand or pea gravel to facilitate blasting at different levels. Next, blasting mats, tires, dirt, etc. are placed to protect existing facilities from flyrock. A galvanometer should be used to check for shorts in the wiring prior to blasting. After the blasting is completed, the Contractor removes the loose material. Blasting and excavation usually occur in stages until reaching the bottom pier column elevation. Hand work to some degree is required at the bottom of all pier columns.

10-5 Problem Areas

Because of the wide range of variables associated with pier columns, different problems can be expected with each project. Listed below are items common to most projects. All represent potential problems that must be addressed in order to successfully install pier columns.

Table 10-1. Pier Column Potential Problems.

ITEM	POTENTIAL PROBLEM
Alignment	It can be difficult to maintain plumb drilled holes if extensive predrilling techniques are used. Consequently, the Contractor may elect to predrill the outside shaft dimensions.
Surveying	Be prepared to improvise. Access to the site and methods employed by the Contractor may require unique solutions. Work should be monitored as it progresses.
Access	The Contractor must provide safe access to the site and inside the pier. Depending on excavation depth, this could vary from ladders to boatswain's chairs to suspended personnel cages to other means (review the Construction Safety Orders). Often this work will fall under Cal-OSHA's Division of Mines and Tunnels.
Blasting	A thorough review of the Contractor's blasting plan, if blasting is the option used to remove the bedrock material, is advised. Blasting should only be done by a licensed person with a Department of Industrial Safety (DIS) permit. This individual should

ITEM	POTENTIAL PROBLEM
	supervise placing, handling, blasting, and storage of explosive materials. Provisions must be made for handling traffic. Restrictions on the transportation of explosives must be enforced. Protection must be provided for existing facilities, utilities, etc. A galvanometer should be used to check for shorts in the wiring prior to blasting. Blasting mats, tires, dirt, etc. should be used to prevent flyrock from being scattered beyond expected limits. Proper warning signs should be provided along highways and roads near the blast site. No explosive material should be left in the area overnight. If it cannot be avoided, leave a guard overnight in the area. During the blast, guards should be placed at selected locations to prevent individuals from entering the blast area. Beware of "misfires." In general, this operation is under the control of the licensed blaster. The Geoprofessional from Geotechnical Services should be consulted whenever blasting is contemplated. If you have any questions on the responsibility of Caltrans in regards to blasting, contact the Caltrans District Construction Safety Officer. Refer to Appendix D, *Pier Column & Type I Pile Shaft,* for sample blasting specifications.
Crane Safety	Lifting pier column rebar cages into the excavated hole may require more than one crane. Proper lifting plans must be enforced. Lane closures may be required when working next to traffic lanes. Additional safety precautions are required when working near overhead electrical lines and in windy areas.
Shoring	Shoring is required in all areas that are not solid rock. In almost all cases, special designs are required in accordance with the contract specifications[3]. Shoring systems can consist of concrete lining, steel or concrete casing, box-type shields, rock bolts, and steel or timber lagging. Refer to the *Caltrans Trenching and Shoring Manual* for shoring design and details.
Geology	Be prepared for unanticipated ground conditions, such as soil instability, groundwater, fissures, or simply material of lesser quality than that assumed for design purposes. Revisions may be necessary.
Concrete	Common to all mined shafts is the requirement that concrete be placed against the undisturbed sides of the excavation. The length of shaft contact could vary from a planned length in the lower portion of the shaft to the entire length of the shaft. The special provisions for these projects will usually require a minimum side contact area (generally 50%) with certain allowances for shoring left in place or to allow for concrete flow through stay-in-place casings. In other instances the shoring or lagging has to be removed as the concrete is placed. These provisions tend to complicate concrete placing operations and therefore care must be exercised to do the job properly. Close inspection is mandatory.

10-6 Safety

Extreme caution is absolutely necessary in order to protect not only personnel working in the area, but the general public as well, since the potential for serious injury is ever present.

Safety railing and barriers must be erected near the shaft perimeter and adequate protection must be provided for personnel working inside the shaft. Workers must wear

[3] 2010 SS, Section 7-1.02K(6)(b), *Excavation Safety,* or 2006 SS, Section 5-1.02A, *Excavation Safety Plans.*

full body harness and be tied off when working adjacent to the shaft perimeter. Crane lifting plans may be required when erecting rebar cages and column forms. The contract specifications[4] require a temporary support system for supporting column forms and column bar reinforcement. Material Safety Data Sheets (MSDS) are needed when slurries are used. Also, traffic handling plans and lanes closures may be required when constructing pier columns.

[4] 2010 SS, Section 52-1.01C(3)(b), *Temporary Support System,* or Special Provisions for contracts using 2006 SS.