CHAPTER

6 Cast-In-Drilled-Hole Piles

6-1 Description

Few terms are as self-descriptive as the one given to the Cast-In-Drilled-Hole (CIDH) pile. They are simply reinforced concrete piles cast in holes drilled to predetermined elevations. Much experience has been gained with this pile type because of its extensive use in the construction of bridge structures. While they probably are the most economical of all commonly used piles, their use is generally limited to certain ground conditions.

CIDH piling can be grouped into two categories:

1. CIDH piling placed in “dry” conditions, usually without inspection pipes (dry method).
2. CIDH piling placed under slurry or with the use of temporary casing to control groundwater, always with inspection pipes (wet method).

This chapter is applicable for both the dry and wet method of CIDH pile construction. Chapter 9, *Slurry Displacement Piles*, provides supplemental information on the wet method of CIDH pile construction. Note that piling with a diameter greater than 24″, which is de-watered with the help of a temporary casing, requires inspection pipes even if the piling is placed in “dry” conditions.

The ground formation in which the holes for CIDH piles are to be drilled must be of such a nature that the drilled holes will retain their shape and will not cave in before or during concrete placement. Because of cave-ins and concrete placement difficulties, these piles are not recommended for use as battered piles. Other pile types should be considered where groundwater is present, unless dewatering can be done with a reasonable effort and concrete can be placed without a permanent casing. If groundwater or caving conditions are present, the piles can be constructed by the slurry displacement method if permitted in the contract specifications. The slurry displacement method is described in detail in Chapter 9, *Slurry Displacement Piles*,.

The *Standard Specifications* use three definitions to classify the condition of a drilled hole. A *dry hole* is defined as a drilled hole that requires no work, such as pumping or other means, to keep it free of water. This means there must be no standing or accumulating water in the bottom of the drilled hole, although the material at the bottom of the drilled hole may be damp or wet. A *dewatered hole* is defined as a drilled hole where water may be present, but accumulates at a rate of less than 12 inches per hour and can be controlled by pumps or other means to reduce the amount of accumulated water to 3 inches or less at the time of concrete placement. The dry method of construction can be used for dry or dewatered holes. A *wet hole* is defined as a drilled hole where water accumulates at a rate of more than 12 inches per hour or where a temporary casing is used to reduce the rate of water accumulation to less than 12 inches per hour. For a wet hole, inspection pipes are required and the wet method of construction is almost always necessary.

6-2 Specifications

The contract specifications contain the information necessary to administer the construction of CIDH piles. *Standard Specification Section 49* contains information on the construction methods. *Section 52* contains information on pile bar reinforcement. *Section 90* contains information on the concrete mix design, transportation of concrete, and curing of the concrete used for CIDH piles.

The *Special Provisions* contain project-specific requirements and revised standard specifications. Because the CIDH pile specifications are continually updated and ground conditions vary from project to project, it is very important that the engineer carefully review the *Special Provisions* and discuss with the Contractor.

6-3 Drilling Equipment

The drilling auger is the most commonly used drilling tool for drilling holes for CIDH piles. Augers may be used in a variety of soil and rock types and conditions.

There are two basic varieties of augers–the standard short section (Figure 6-1) and continuous flight (Figure 6-2). Both have flights of varying diameter and pitch.

6-3.1 Continuous Flight Augers

Continuous flight augers have flight lengths that are longer than the hole to be drilled. They are generally lead-mounted. The power unit is located at the top of the auger and it travels down the leads with the auger as the hole is drilled. Drilling is performed in one continuous operation. As the auger moves down the hole, the drilling action of the flights forces the drill cuttings up and out of the hole. Hence, much material has to be shoveled away from around the drilled hole. Continuous flight augers are most commonly used for short piles, such as those used to support soundwalls or standard retaining walls, or for pre-drilling driven piles. They may also be used where overhead clearance is not a problem.

6-3.2 Short Flight Augers

Short flight augers are powered by "Kelly Bar" units fixed to the drill rig. The lengths of these augers generally vary between 5 and 8 feet. The auger is attached to the end of the Kelly Bar and, as drilling progresses; the auger (and material carried on the flights) must be removed frequently. After the auger is removed from the drilled hole, the material is "spun" off the flights onto a spoil pile and the operation is repeated. Short flight augers are generally used for smaller diameter piles (less than 48″ in diameter), although they have been successfully used for larger diameter piles.

Figure 6-1. Short Flight Auger.

Figure 6-2. Continuous Flight Auger.

6-3.3 Single Flight and Double Flight Augers

There is a variety of different auger shapes/styles used in different situations. Augers may be single flight (Figure 6-3) or double flight (Figure 6-4). Double flight augers are better balanced than single flight augers and are more useful when alignment and location of the drilled hole are important due to clearance or right-of-way problems. Soil augers are equipped with a cutting edge that cuts into the soil during rotation. The drill cuttings are carried on the flights as the auger is removed from the drilled hole and are then "spun" off. The pitch of the flights can vary and should be chosen for the type of material encountered. Soil augers may not work well in cohesionless materials, as the soil may not stay on the flights during auger extraction. They may also have issues in highly cohesive materials where the auger may become clogged.

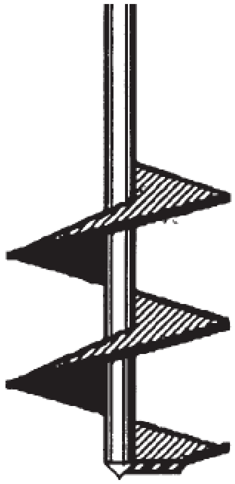

Figure 6-3. Single Flight Auger.

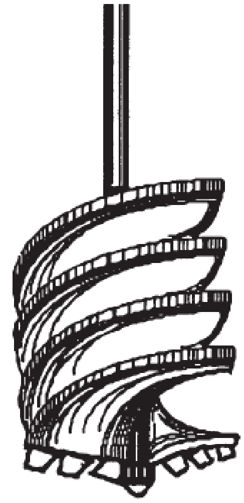

Figure 6-4. Double Flight Auger.

6-3.4 Rock Augers

Rock augers (Figure 6-5) differ from soil augers in that they are equipped with high-strength steel cutting teeth that can cut through soft rock. These augers typically have flights with a very shallow pitch so that rock pieces, cobbles and boulders can be extracted. For this reason, rock augers are generally the preferred tool for drilling in materials that have a high concentration of cobbles or boulders.

Figure 6-5. Rock Auger.

6-3.5 Drilling Buckets

Drilling buckets (Figure 6-6) are drilling tools used when augers are not able to extract material from a drilled hole. This can happen when wet materials or cohesionless materials are encountered. Drilling buckets may also be appropriate when heavy gravel or cobbles are encountered. Drilling buckets have a cutting edge that forces material into the bucket during rotation. When the drilling bucket is full, the bucket is spun in the direction opposite of drilling, which closes the built-in flaps. This prevents the cuttings from falling out of the bucket. The bucket is then extracted from the drilled hole and emptied.

6-3.6 Cleanout Buckets

Cleanout buckets (Figure 6-7) are specialized drilling buckets that are used to clean loose materials from the bottom of a drilled hole and to flatten the bottom. This ensures that the tip of the pile is founded on a firm flat surface. These buckets have no cutting teeth but are similar to drilling buckets in other aspects. Figures 6-6 and 6-7 show the difference between the drilling bucket and the cleanout bucket. Specialized cleanout buckets can be used to extract loose materials when groundwater or drilling slurry is present. These buckets, referred to as "muckout" buckets, allow fluid to pass through them while retaining the loose materials from the bottom of the drilled hole.

Figure 6-6. Drilling Bucket.

Figure 6-7. Cleanout Bucket.

6-3.7 Core Barrels

Core barrels (Figure 6-8) are used to drill through hard rock formations, very large boulders, or concrete. This type of drilling tool consists of a steel cylinder with hard metal cutting teeth on the bottom. Rock cores are broken off and extracted from the drilled hole as a single unit, or may be broken up with a rock breaker and then extracted with a drilling bucket or clamshell.

Figure 6-8. Core Barrel.

6-3.8 Down-Hole Hammers

Down-hole hammers (Figure 6-9) are also used to drill through hard rock formations. This type of drilling tool uses compressed air or hydraulic-powered percussion drilling heads to pulverize the formation and blow the resulting debris from the drilled hole.

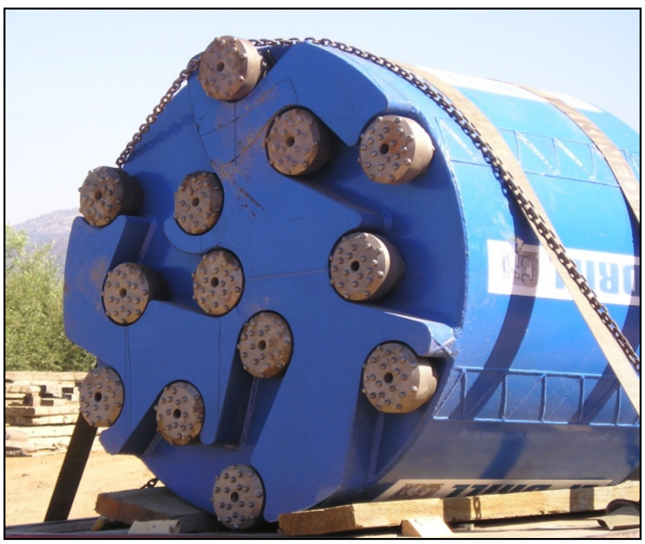

Figure 6-9. Down-Hole Hammer.

6-3.9 Rotators and Oscillators

Rotators (Figure 6-10) and oscillators (Figure 6-11) are specialized drilling equipment used to advance a drilled hole through difficult ground formations. Each machine uses a hydraulic-powered apparatus to simultaneously rotate and push down on a drilling casing. Drilling casings are sections of steel pipe, usually 20 feet in length, designed specifically for the rotator or oscillator model, with attachments for cutting teeth or splicing of additional sections. Additional sections of drilling casing are attached as the drilled hole is advanced to tip. As the drilled hole is advanced, the materials within the drilling casing are extracted using a clamshell or drilling bucket. The major difference between a rotator and an oscillator is that the rotator rotates the drilling casing in one direction, while the oscillator rotates the drilling casing in two directions, never making a complete rotation in either direction. The advantage provided by the rotator and oscillator is the drilling casing provides a temporary casing that preserves the integrity of the drilled hole, even in unstable or wet ground formations. The drilling casing remains in the drilled hole until pile concrete is placed, at which time the drilling casing is extracted from the drilled hole in a similar manner as any other temporary steel casing as described below.

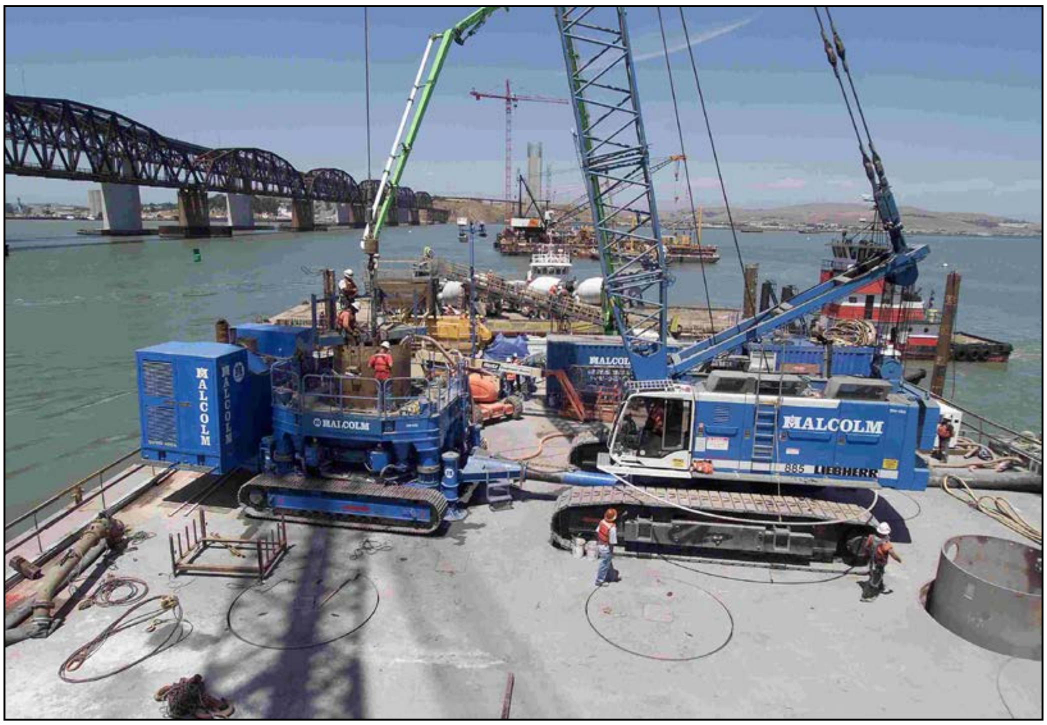

Figure 6-10. Rotator.

Figure 6-11. Oscillator.

6-3.10 Reverse Circulation Drilling Equipment

Reverse circulation drilling equipment (Figure 6-12) is used to advance a drilled hole through difficult wet ground formations. The advantage of reverse circulation is that very deep holes can be advanced without the need to cycle in and out of the hole with the drill tool to remove cuttings. The drilled hole must be full of water or other drilling fluids. The drilling head is self-contained and is driven hydraulically or by compressed air. As the hole is advanced, the drill cuttings are suspended in the water or drilling fluid. The water or drilling fluid is continuously circulated out of the drilled hole, where the drill cuttings are removed and disposed, and then re-circulated back into the drilled hole to repeat the process.

Figure 6-12. Reverse Circulation Drilling Equipment.

6-3.11 Temporary Steel Casings

Temporary steel casings (Figure 6-13) are used to support drilled holes when unstable conditions are encountered. Various methods are used to advance steel casings into the hole. Among them, spinning the casing with the Kelly Bar while applying some vertical force, driving the casing with whatever means are available as the hole is drilled, or using a vibratory hammer. Steel casings are generally extracted from the hole in the manner specified in the contract specifications as concrete is placed.

Figure 6-13. Steel Casing.

6-3.12 Drilling Rigs

Drilling is performed almost exclusively with portable drilling rigs. These units can be self-propelled crawler mounted (Figure 6-14), truck-mounted (Figure 6-15), or crane-mounted (Figure 6-16).

Figure 6-14. Crawler Mounted Drill Rig.

Figure 6-15. Truck Mounted Drill Rig.

Figure 6-16. Crane Mounted Drill Rig.

6-4 Drilling Methods

Various other materials are used to supplement the drilling work. Water or other drilling fluid is sometimes added to certain ground formations to assist drilling and lifting materials from the hole. Soil may be placed back into the hole to dry out supersaturated materials. The drilling tool is used to agitate the materials so they can be extracted from the hole. This is known as "processing" the hole.

6-5 Drilling Problems

The difficulties encountered in drilling can include cave-ins, groundwater, and utilities. The following briefly describes some actions that can be taken in these situations.

6-5.1 Cave-ins

In the case of cave-ins, the following action or combination thereof may be required:

Table 6-1. Cave-in Actions

ITEM	ACTION
1	Place a low cement/sand mix and re-drill the area of the cave-in.
2	Use a drilling slurry (refer to Chapter 9, *Slurry Displacement Piles).*
3	Use a temporary casing, which is pulled when placing concrete.

6-5.2 Groundwater

In the case of groundwater, the following action or combination may be required:

Table 6-2. Groundwater Actions

ITEM	ACTION
1	Place a low cement/sand mix and re-drill the hole.
2	Drill to tip elevation, then use a pump to remove the water and clean out the bottom of the hole.
3	Use a drilling slurry (refer to Chapter 9, *Slurry Displacement Piles*).
4	Use a temporary casing, then use a pump to remove the water, and remove the casing during concrete placement, keeping the bottom of casing below the head of concrete.
5	De-water the entire area using well points, deep wells, etc. This should be thoroughly discussed with the Bridge Construction Engineer and the project Geoprofessional.
6	Substitute an alternative type of piling by contract change order. This should be discussed with the project Designer, the project Geoprofessional, and the Bridge Construction Engineer.

6-5.3 Utilities

Construction operations should proceed with caution when drilling near utilities known or thought to be in close proximity. The Contractor should contact the area Underground Service Alert (USA) or the utility company and have the utility located. The Contractor should also pothole and physically locate the utility prior to drilling. Relocation of the utility may be required. Minor adjustments in pile location might be feasible in order to avoid conflict. Any proposed revisions to the pile layout should be discussed with the Designer, Geoprofessional, Resident Engineer and the Bridge Construction Engineer.

Under certain conditions, the contract specifications[1] allow the Contractor to propose increasing the pile diameter in order to raise the pile tip. This can be used to address problems with groundwater, cave-ins or obstructions in the lower portion of the hole. Before allowing this, the Engineer should consult with the Designer and Geoprofessional to see if this is feasible and if so, to obtain the revised tip elevation. Appropriate pay provisions are also included in the contract specifications and a change order is not required.

Ordinarily, the above drilling problems would stimulate the Contractor's action and a change would be proposed to the Engineer. Sometimes the drilling problem is the result of unanticipated ground conditions or unanticipated utility conflicts. In such cases, a differing site condition or a buried manmade object may exist, and it will be the Engineer's responsibility to resolve the problem.

[1] 2010 SS, Section 49-3.02C(1), *CIDH Pile Construction, General,* or 2006 SS, Section 49-4.03, *Drilled Holes.*

6-6 Inspection and Contract Administration

Cast-in-Drilled-Hole piles are designed to resist compressive loads, tensile loads, and lateral loads. Most CIDH piles are designed to resist these loads using skin friction and passive earth pressure, with minimal or no contribution from end-bearing. The Designer should be contacted to determine the manner in which the pile was designed to transfer load.

The Engineer should review the contract plans, the *Foundation Report* and the *Log of Test Borings* thoroughly. If there are any discrepancies noted between the pile type shown on the contract plans, the pile type called for in the *Foundation Report*, and/or the soil materials/profile and groundwater level shown on the *Log of Test Borings*, the Designer should be contacted for clarification.

A *CIDH Pile Construction Checklist* is presented in Appendix K-2 to assist field personnel in preparing documents and inspecting fieldwork to ensure compliance with contract requirements.

6-6.1 Pile Installation Plan

The contract specifications[2] require the Contractor to submit a pile installation plan to the Engineer for review and authorization. The pile installation plan should provide sufficient detail for the Engineer to grasp the means, methods, and materials that the Contractor plans to use to successfully complete CIDH pile installation. Typical requirements for all CIDH piling include the following:

Table 6-3. Pile Installation Plan Requirements.

ITEM	PILE INSTALLATION PLAN REQUIREMENT & REASONING
1	Concrete mix design, certified test data, and trial batch reports. ***Reasoning:*** *CIDH pile concrete is designated by compressive strength.*
2	Drilling or coring methods and equipment. ***Reasoning:*** *This gives the Engineer advance knowledge of what equipment the Contractor proposes to use to drill the CIDH pile and whether the proposed equipment is appropriate.*
3	Proposed methods for casing installation and removal when necessary. ***Reasoning:*** *This gives the Engineer advance knowledge of whether the Contractor plans to use casing and if so, how it will be installed and removed and whether the proposed installation and removal methods are appropriate.*
4	Methods for placing, positioning, and supporting bar reinforcement.

[2] 2010 SS, Section 49-3.02A(3)(b), *Pile Installation Plan,* or Special Provisions for contracts using 2006 SS.

ITEM	PILE INSTALLATION PLAN REQUIREMENT & REASONING
	Reasoning: *This gives the Engineer advance knowledge of how the Contractor plans to assemble and install the pile bar reinforcement cage and whether the proposed method of installation is appropriate.*
5	Methods and equipment for accurately determining the depth of concrete and actual and theoretical volume placed, including effects on volume of concrete when any casings are withdrawn. ***Reasoning:*** *This is necessary so the Engineer and Contractor can determine whether an unplanned event, such as a cave-in, has occurred during concrete placement. If such an event happens, the actual volume of concrete placed will be substantially different from the theoretical volume at the location of the event and the Engineer and Contractor will be able to pinpoint the location of the event for mitigation if necessary.*
6	Methods and equipment for verifying that the bottom of the drilled hole is clean prior to placing concrete. ***Reasoning:*** *Over 50% of all pile defects occur at the bottom of the drilled hole due to the presence of loose soil cuttings that were not removed prior to concrete placement. This gives the Engineer advance knowledge of how the Contractor plans to remove these loose materials, verify that they were removed, and whether the proposed methods of removal and verification are appropriate.*
7	Methods and equipment for preventing upward movement of reinforcement, including the Contractor's means of detecting and measuring upward movement during concrete placement operations. ***Reasoning:*** *Pile bar reinforcement cages have been known to shift laterally or upward during concrete placement. This gives the Engineer advance knowledge of how the Contractor plans to prevent movement of the pile bar reinforcement cage and whether the proposed methods are appropriate.*
8	Drilling sequence and concrete placement plan. ***Reasoning:*** *Contractors sometimes prefer to drill some or all of the holes at one time and come back to place reinforcement and concrete at a later time, which may impact the quality of the piles. If the drilled holes are close together, this increases the risk of side blowout into adjacent holes during concrete placement. This gives the Engineer advance knowledge of the Contractor's planned construction sequence and provoke discussion of how to prevent problems due to construction sequencing.*
9	Methods for ensuring the inspection pipes remain straight, undamaged, and properly aligned during concrete placement, if inspection pipes are required. ***Reasoning:*** *Inspection pipes that were properly placed during reinforcement cage construction can become misaligned when the*

ITEM	PILE INSTALLATION PLAN REQUIREMENT & REASONING
	cage is placed in the drilled hole and during concrete placement. This gives the Engineer advance knowledge of the Contractor's plan to keep the inspection pipes aligned at all times until the pile concrete has set.

6-6.2 CIDH Pile Preconstruction Meeting

Before drilling begins, the *Standard Specifications* require the Contractor to schedule and the Engineer to conduct a CIDH pile preconstruction meeting. The purpose of this meeting is to establish contacts and communication protocol for the Contractor, the Engineer and their representatives involved in CIDH pile design and construction, and to afford all parties a common understanding of the construction process, acceptance testing, and mitigation of CIDH piles. Items to be discussed should include any recently revised contract specifications, the contract pay limits, the Contractor's planned method of operation and schedule, the equipment to be used, the plan for avoiding existing utilities (if any), and safety precautions to be taken during the work. Bridge Construction Memo 130-20.0*, Cast in Drilled Hold (CIDH) Pile Preconstruction Meeting,* provides the Structure Representative with guidelines on how to conduct the meeting.

6-6.3 Construction

The Contractor is required to layout the pile locations at the site prior to drilling. The Engineer should verify the layout is correct prior to drilling and set reference elevations in the area so pile lengths and pile cutoff can be ascertained.

During the drilling operation, the Engineer should verify that the piles are in the correct location and drilled plumb. Usually, the Contractor will check the Kelly Bar with a carpenter's level during the drilling operation. The Engineer should also evaluate the material encountered and compare it to the *Log of Test Borings*. If the material at the specified tip elevation differs from that anticipated, the Designer and Geoprofessional should be consulted, as a change in pile length might be needed. A written record of the drilling progress should be kept in the project daily report and the record utilized to investigate any differing site condition claims submitted by the Contractor.

When the hole has been drilled to the specified tip elevation, the Contractor should use a cleanout bucket or other authorized means as described in the pile installation plan to remove any loose materials and to produce a firm flat surface at the bottom of the drilled hole.

The depth, diameter, and plumbness/straightness of the drilled hole must be checked and verified after drilling is completed. Check the drilled hole using a suitable light, furnished by the Contractor, or a mirror. At this time, the Engineer should measure and record the length of each pile. Unless the Engineer orders the Contractor, in writing, to change the specified tip elevation, no payment will be made for any additional depth of pile below the specified tip elevation.

For large diameter piles, it may be necessary for the Engineer or the Geoprofessional to inspect the bearing surface at the bottom of the drilled hole. All pertinent requirements of the *Construction Safety Orders* and *Mining and Tunneling Safety Orders* must be met before constructing or entering a drilled hole. Note that for CIDH piles over 20 feet in depth and 30 inches or larger in diameter, *CalOSHA Mining and Tunneling Safety Orders* apply. *Construction Procedure Directive CPD 04-6*, which is included in Appendix B, *Contract Administration*, and Bridge Construction Memorandum (BCM) 14-5.0*, Tunnel Safety,* address this.

Check the pile bar reinforcement cage clearances and spacers immediately after the cage is placed and secured in the drilled hole. In addition, the reinforcing cage must be adequately supported, as described in the pile installation plan and some means must be devised to ensure concrete placement to the proper pile cutoff elevation.

Immediately before placing concrete, check the bottom of the drilled hole for loose materials or water. Loose materials and small amounts of water can be removed with a cleanout bucket before placing the pile bar reinforcement cage. Large amounts of water may need to be pumped out. It is important to note that it may be necessary to remove the pile bar reinforcement cage to accomplish this. Failure to do so could affect the quality of the pile.

Those involved in the work should thoroughly review the contract specifications[3] before fieldwork begins. Applicable portions of Standard Specifications Section 90*, Concrete,* should also be reviewed with respect to concrete mix design, consistency of the concrete mix, and concrete curing requirements.

6-7 Pile Defects

The drilling problems mentioned previously, if not corrected, can cause CIDH piles to be defective. There are also problems that can occur during concrete placement or casing removal that can cause defective CIDH piles.

6-7.1 Drilling Problems

The following drilling problems can cause pile defects:

Table 6-4. Pile Defects – Drilling Problems.

ITEM	DRILLING PROBLEM/RESULTING PILE DEFECT
1	A cleanout bucket is not used to clean up the bottom of the drilled hole.

[3] 2010 SS, Section 49-3, *Cast-In-Place Concrete Piling,* or 2006 SS, Section 49-4, *Cast-In-Place Concrete Piles.*

ITEM	DRILLING PROBLEM/RESULTING PILE DEFECT
	Result: *This can result in the pile bearing on soft material. For CIDH piles designed for end bearing, this flaw can seriously compromise the value of the pile. This defect is shown in Figure 6-17.*
2	A tapered auger is used to advance the drilled hole to the specified tip elevation but a cleanout bucket is not used to flatten the bottom of the hole. ***Result:*** *Concrete may crush at the tip of the pile, which would reduce its capacity and possibly cause differential settlement. There may also be soft material at the tip of the drilled hole, which would cause the problems mentioned previously. This defect is also shown in Figure 6-17.*
3	The drilling operation smears drill cuttings on the sides of the drilled hole. ***Result:*** *This can result in the degradation of the pile's capacity to transfer loads through skin friction. This may be critical if the pile is designed as a tension pile. This condition is most likely to occur in ground formations containing cohesive materials. This defect is shown in Figure 6-18.*

These problems are preventable. Adherence to the contract specifications and timely inspection will ensure the best quality pile and mitigate most of these problems.

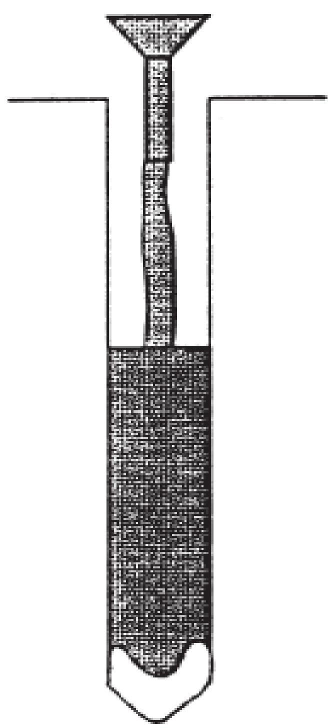

Figure 6-17. Pile Defects - No Cleanout, Tapered Bottom of Hole.

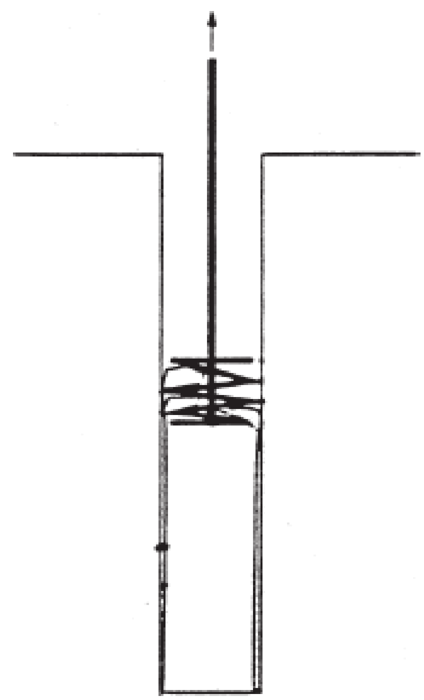

Figure 6-18. Pile Defects – Smeared Drill Cuttings

6-7.2 Concrete Placement Problems

The following concrete placement problems can cause pile defects:

Table 6-5. Pile Defects – Concrete Placement Problems.

ITEM	PLACEMENT PROBLEM/RESULTING PILE DEFECT
1	A cave-in at a location above the top of concrete or sloughing material from the top of the drilled hole occurs during concrete placement. ***Result:*** *Degraded concrete at the location, thus reducing the capacity of the pile. This defect is shown in Figure 6-19.*
2	The Contractor tailgates concrete into the drilled hole without the use of a hopper or "elephant trunk" to guide it. The concrete falls on the pile bar reinforcement cage or supporting bracing and segregates. ***Result:*** *Defective concrete, thus reducing the capacity of the pile. This defect is shown in Figure 6-20.*
3	A new hole is drilled adjacent to a freshly poured pile or concrete is placed in a drilled hole that is too close to an adjacent open drilled hole. ***Result:*** *This can result in the sidewall blowout of a freshly poured pile into the adjacent drilled hole. This would probably cause the pile bar reinforcement cage to buckle. This defect is shown in Figure 6-21.*
4	The Contractor does not remove groundwater from the drilled hole. ***Result:*** *Groundwater mingles with the concrete leading to defective concrete at the bottom of the pile. If the pile were designed for end bearing, the capacity would be reduced. This defect is shown in Figure 6-22.*

As with the drilling problems, most of these placement problems are preventable. Adherence to the contract specifications and timely inspection will prevent most of these problems. However, if a cave-in occurs during concrete placement, the Contractor may need to remove the pile bar reinforcement cage and concrete, and then start over.

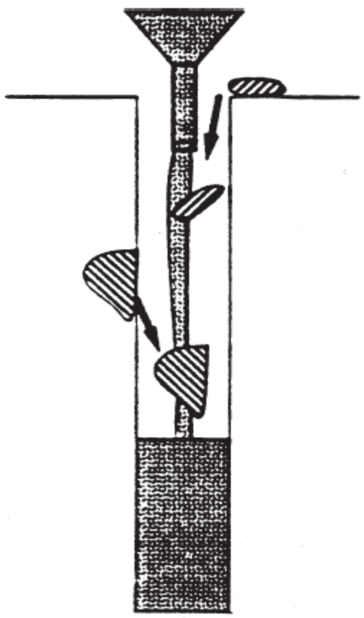

Figure 6-19. Pile Defects–Cave In.

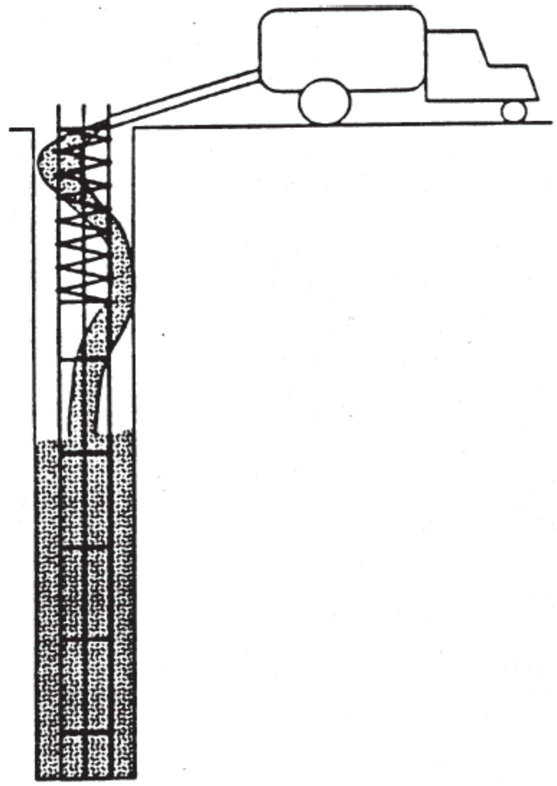

Figure 6-20. Pile Defects– Concrete Segregation.

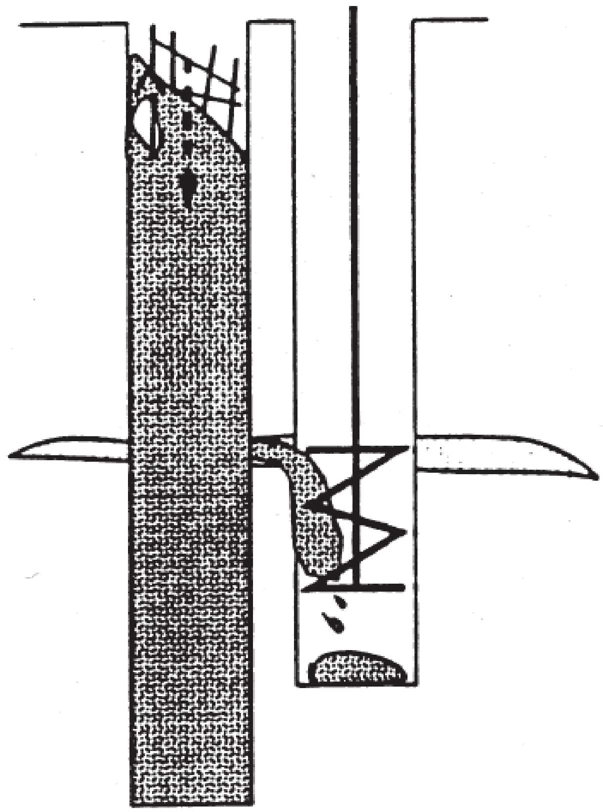

Figure 6-21. Pile Defects–Adjacent Hole Blowout.

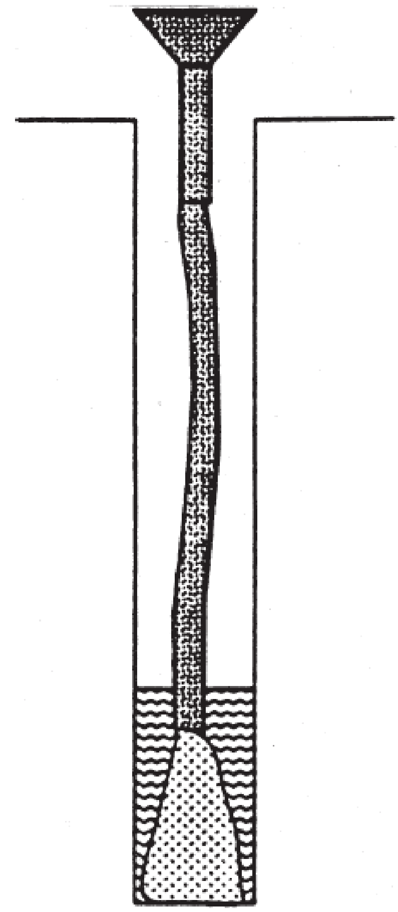

Figure 6-22. Pile Defects–Water in the Hole.

6-7.3 Casing Removal Problems

The following casing removal problems can cause pile defects:

Table 6-6. Pile Defects – Casing Removal Problems.

ITEM	CASING REMOVAL PROBLEM/PILE DEFECT
1	The Contractor waits too long to pull the casing during concrete placement. This may result in three problems: 1. The concrete sets up and comes up with the casing as shown in Figure 6-23(a). 2. The concrete sets and the casing cannot be removed as shown in Figure 6-23(b). 3. The concrete sets up enough so that it cannot fill the voids left by the casing as it is removed, as shown in Figure 6-23(c). The first problem may result in a void being formed in the pile at the bottom of the casing. It is possible that the suction created may cause a cave-in at this location. The second and third problems result in the loss of the pile's capacity to transfer skin friction to the ground.

Historically, problems with casings have produced the worst type of CIDH pile defects. Again, these problems are preventable. Adherence to the contract specifications and timely inspection will prevent most of these problems. Caltrans recommends the slump of the concrete placed in the pile to be at the high end of the allowable range. Research has shown that concrete with higher fluidity will consolidate and fill in the voids better than concrete with lower fluidity. As there is an increased risk in pouring piles with temporary casings, under certain circumstances, piles poured with this method need to undergo non-destructive testing prior to acceptance. The CIDH pile contract specifications require that all CIDH piles constructed with the use of temporary casings to control groundwater undergo acceptance testing prior to acceptance. The pile testing methods used to test piles constructed by the slurry displacement method (as described in Chapter 9, *Slurry Displacement Piles*) would be used in this circumstance.

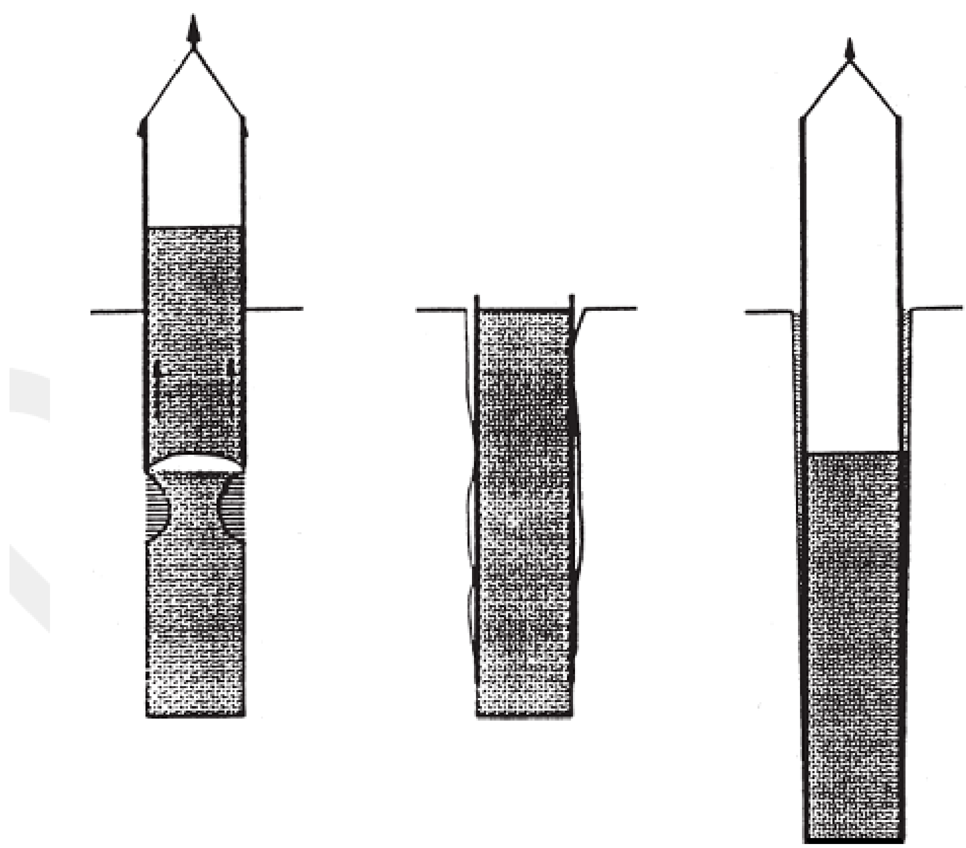

Figure 6-23(a) **Figure 6-23(b)** **Figure 6-23(c)**

Pile Defects - Casing Problems.

6-8 Safety

As with all construction activities, the Engineer should be aware of safety considerations associated with the operation. As a minimum, the Engineer must review the Construction Safety Orders that pertain to this work. A tailgate safety meeting should be held to discuss the inherent dangers of performing this work before the work begins.

The primary and obvious hazard encountered with CIDH pile construction is the open drilled hole. Common practice is to keep the drilled hole covered with plywood or steel plates, especially if the drilled hole is left open overnight. This provides protection, not only for the construction crew working in the area, but also the public. In urban areas, more stringent measures may be required to secure the site.

As with any other type of operation, use common sense safety practices when working around this equipment. If you do not need to be there, stay away from the equipment. If a crane-mounted drilling rig is used, check the crane certificate.

In addition, footing excavations should be properly sloped or shored as discussed in Chapter 4, *Footing Foundations*. Imposed loads, such as those from cranes and transit mix concrete trucks, must be kept a sufficient distance from the edge of the excavation. If the Contractor intends to place equipment of this type adjacent to the excavation, the load must be considered in the shoring design and/or in determining the safe slope for unshored excavations. Additional information on excavations can be found in the *Caltrans Trenching and Shoring Manual.*

Worker and public safety must be enforced during drilling and excavating operations. The Contractor must have a Fall Protection plan and fall protection equipment must be used when working near open holes. Personnel not directly involved in the construction operation should not stand next to an open hole to avoid falling in or if the edge collapses. For CIDH piles over 20 feet in depth and 30 inches in diameter, *Cal-OSHA Mining and Tunneling Safety Orders* apply. *Construction Procedure Directive* CPD 04-6 addresses this and is included in Appendix B, *Contract Administration*.