Compacted Aggregate Pier Requirements

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Code/Section:	2018 IBC 104.11
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Purpose:
To provide guidance on what needs to be submitted, how to plan review, and how to inspect projects that include the Compacted Aggregate Piers (CAPs). This includes Geopier and Vibro Pier systems.

Background:
CMOD 200525 was an application under IBC Section 104.11 for an alternative material or method for the Geopier System. CMOD 210050 was an application for the Vibro Pier system. The reviews resulted in approvals of the systems as soil improvement, but with many stipulations. Where there are discrepancies between the approval stipulations and this document, this document shall control. The Geopier System has an ICC-ES Evaluation Report #1685 and the Vibro Pier system has ICC-ES ER#4415 that serve as the primary basis for the approvals. There are two types of installations employed to create CAP elements, which are described next.

Replacement/top-feed elements are created by removing a circular column of soil and replacing that area of soil with aggregate that is rammed or vibrated into place. See the Figure 1s.

Displacement/bottom-feed elements are created by driving a hollow cylinder into the soil, pouring aggregate down it, and then ramming or vibrating the aggregate into place. See the Figure 2s.

General Information:
1. The installation of the CAPs can occur before a foundation permit is obtained, but the system must have special inspection during installation.
2. CAPs cannot be deferred submittals.

Submitted Documents:
Documents that shall be submitted with the foundation package for plan review include:

1. CAP designer drawings showing:
   1.1. The dimensioned location of the CAP elements.
   1.2. The force or pressure capacity of the CAP elements.
      1.2.1. If the foundation designer uses the soil around the CAP elements to resist loads, then the capacity and stiffness of the CAP elements and the capacity and stiffness of the soil between the CAP elements.
   1.3. CAP designer drawings must contain a notation from a design professional employed by the firm that created the project's geotechnical investigation report. This notation shall follow the Reviewed Notation section of this document.
   1.4. CAP designer drawings must contain a notation from the designer of the foundation. This notation shall follow the Reviewed Notation section of this document.
   1.5. A statement of special inspections that includes:
      1.5.1. Verification of material used in the CAP elements.

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1.5.2. Type and number of lifts for Geopier. Quantity of aggregate for Vibro Pier.
1.5.3. Pier dimensions and elevations.
1.5.4. Rammer energy for Geopier or compaction energy for Vibro Pier.
1.5.5. Observation of the installation.
1.5.6. Identification of cave-in contamination.
1.5.7. The modulus test.
1.5.8. The bottom stabilization test for Geopier replacement elements.
1.5.9. The crowd stabilization test for Geopier displacement elements.
1.5.10 Intimate contact between the CAP element and the foundation bottom.

2. The required qualifications of the special inspector. This is to be created by the registered design professional who created the geotechnical investigation report. This can be either part of the geotechnical investigation report or as a separate document.
3. A geotechnical special inspection certificate that covers a special case write-in of Compacted Aggregate Piers.
4. A signed letter or certificate by the Geopier Foundation Company's Chief Engineer or Keller North America showing review approval of the specific project's design.
5. A geotechnical investigation report including a recommendation for the use of CAPs.

Plan Review:
Items to be reviewed during plan review:

1. Verify that the foundation designer used the locations of the CAP elements shown on the CAP design documents when designing the foundations.
2. Verify that the structural analysis was conducted in accordance with one of the following:
   2.1. The foundation is designed as if the CAP elements are individual vertical supports that the foundation spans between, ignoring the soil between, to determine internal stresses.
   2.2. The foundation was designed knowing and using the relative stiffness of the foundation, the soil, and the CAP elements to distribute forces and determine internal stresses. The stiffnesses used should be from the CAP design documents.
3. Verify that the CAP elements are not being used to resist uplift.
4. Verify all the required submitted documents listed before, are submitted and complete.
5. The City plan reviewer is not responsible for reviewing the sufficiency of the CAP soil improvement design.

Inspections:
Inspections involved with the installation, including proper depths, need to be completed by the special inspector. Like other soil improvements, the City inspector is not responsible for these inspections. Items to be inspected during City inspections:

1. The CAP element locations. Out of location within a 6-inch tolerance is acceptable, but still must be fully under the foundation it supports.
2. Aggregate of the CAP elements is exposed where the foundation will be placed, for the full area of the CAP element.
3. The CAP special inspections have occurred, and the completed special inspections certificate is provided.
4. Excavations taken in proximity to the piers after their installation are no closer than 2'-6" at the top of pier elevation and then extend downwards at 45-degree angle. See Figure 3.

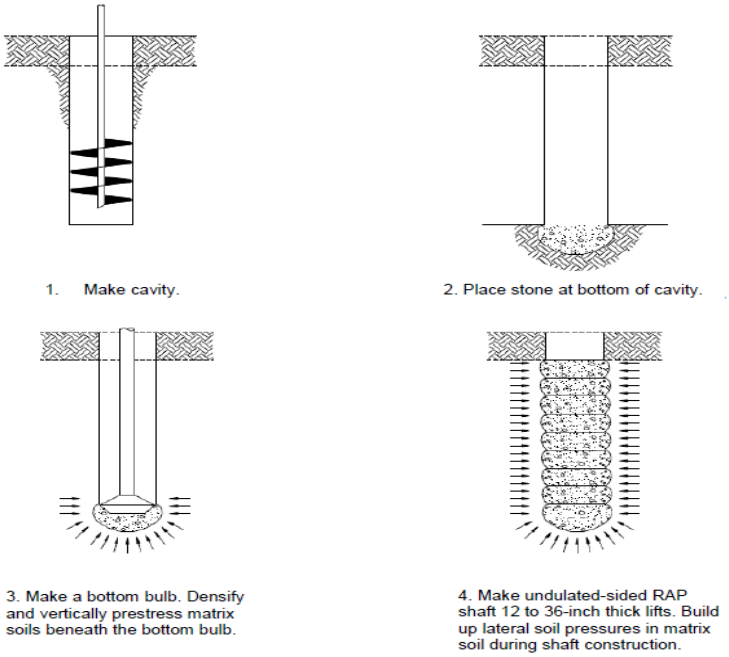


FIGURE 1—RAP CONSTRUCTION PROCESS USING THE GEOPIER SYSTEM

This Figure is from ICC-ES ESR #1685

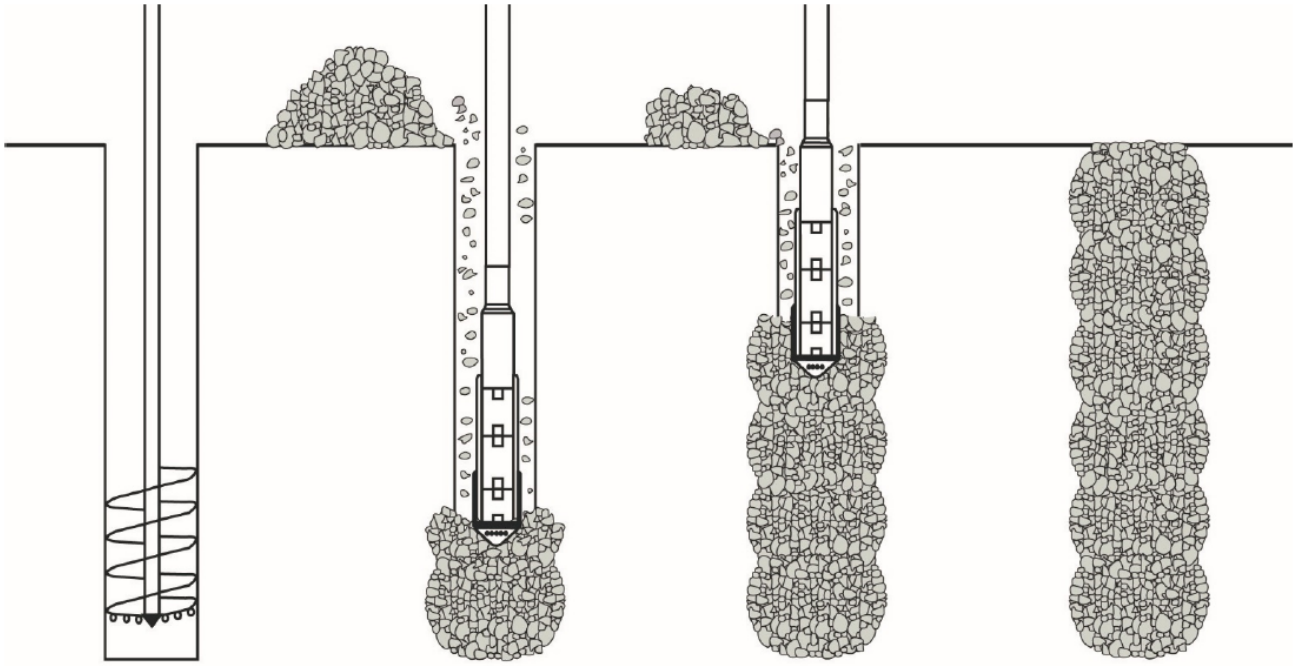
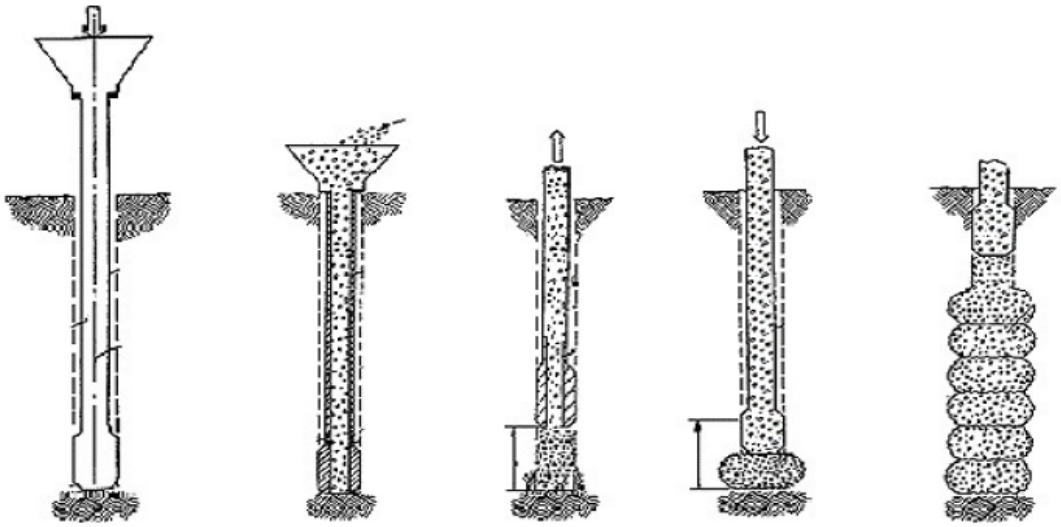


FIGURE 1—TOP-FEED VIBRO PIER CONSTRUCTION SEQUENCE

This Figure is from ICC-ES ESR #4415



1. Drive Impact mandrel to bottom of pier depth
2. Fill hopper and mandrel with aggregate
3. Raise mandrel a preset distance (3 or 5 ft typ) while discharging aggregate
4. Redrive mandrel a preset distance (1 or 3 ft typ) to create 1- to 3-ft (typ) compacted lift
5. Repeat Steps 3 and 4 until pier construction is complete

FIGURE 2—RAP CONSTRUCTION PROCESS USING THE IMPACT SYSTEM

This Figure is from ICC-ES ESR #1685

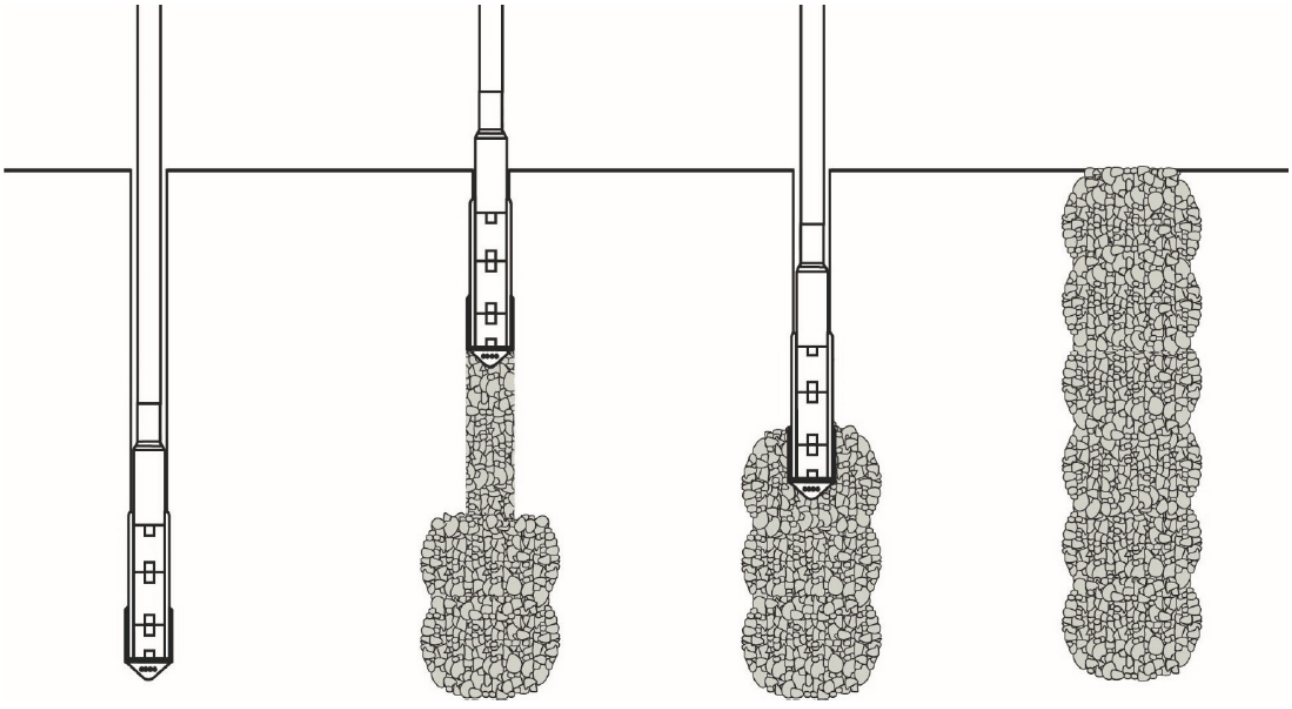


FIGURE 2—BOTTOM-FEED VIBRO PIER CONSTRUCTION SEQUENCE

This Figure is from ICC-ES ESR #4415

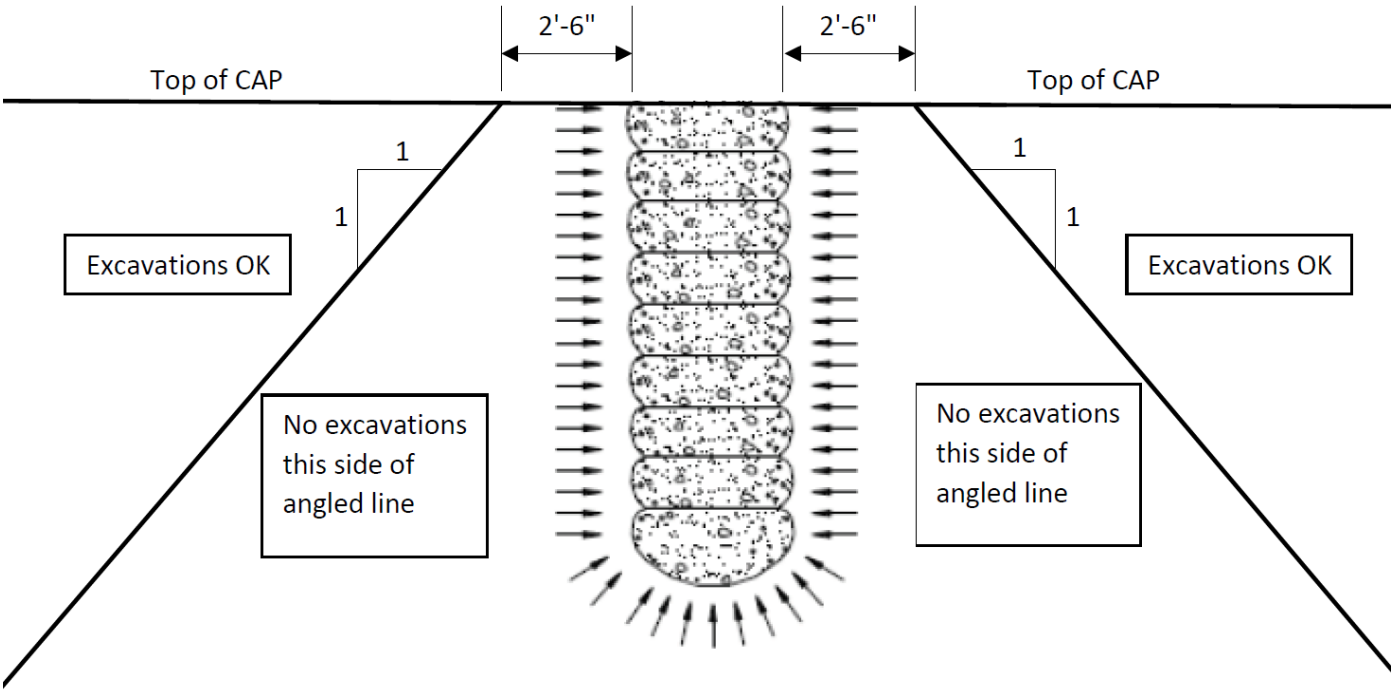


Figure 3 - CAP element assumed zone of influence (truncated cone)

Reviewed Notation

The notation from the geotechnical reviewing party shall contain at least, but not be limited to, the information shown in Figure 4. The notation from the foundation designer shall contain at least, but not be limited to, the information shown in Figure 5.

These drawings and their supporting calculations have been reviewed and found to be in general conformance with the geotechnical investigation report required by Section 4.1 of the ICC-ES ESR.

Reviewed by: _____

Reviewer's Firm: _____

Date: _____

Figure 4 – Geotechnical Review Stamp Minimum Content

These drawings have been reviewed and the location of the compacted aggregate pier elements have been found to be in general conformance with the foundation's structural design.

Reviewed by: _____

Reviewer's Firm: _____

Date: _____

Figure 5 – Structural Review Stamp Minimum Content