IN-LB	Inch-Pound Units
SI	International System of Units

ACI 351.2R-10(20)

Report on Foundations for Static Equipment

Reported by ACI Committee 351

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First Printing
February 2020
ISBN: 978-0-87031-372-1

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ACI 351.2R-10
(Reapproved 2020)

Report on Foundations for Static Equipment

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This document addresses static equipment foundation engineering and construction. It presents various design criteria, methods and procedures of analysis, design, and construction applied to static equipment foundations by industry practitioners. This document should, hopefully, encourage discussion and comparison of ideas.

Keywords: anchorage (structural); bolts, anchor; equipment; forms; formwork (construction); foundation loading; foundations; grout; grouting; pedestals; pile loads; reinforcement; soil pressure; subsurface preparation; tolerances (mechanics).

CONTENTS

ACI 351.2R-10 supersedes ACI 351.2R-94 and was adopted and published April 2010.

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Background

Foundations for static equipment are used in industrial processing and manufacturing facilities throughout the world. Engineers with varying backgrounds are engaged in the analysis, design, and construction of these foundations. They often perform their work with little guidance from building codes, national standards, owner's specifications, or other published information. Because of this lack of consensus standards, most engineers rely on engineering judgment and experience. Some engineering firms and individuals, however, have developed their own standards and specifications as a result of research and development activities, field studies, or many years of engineering or construction experience. Only by sharing and discussing this information can a meaningful consensus on engineering and construction requirements for static equipment foundations be developed.

As used in this document, "state of the art" refers to state of the practice, and encompasses various engineering and construction methodologies.

1.2—Purpose

This document presents various design criteria and methods and procedures of analysis, design, and construction currently being applied to static equipment foundations by industry practitioners. The purpose of this report is to present these various methods and elicit critical discussion from the industry. This report is not intended to be a recommended practice; rather, it is a document that encourages discussion and comparison of ideas.

1.3—Scope

This report is limited in scope to the engineering and construction of static equipment foundations. Static equipment, as used herein, refers to industrial equipment that does not contain significant moving parts, or that has operational characteristics essentially static in nature. Outlined and discussed herein are the various aspects of the analysis, design, and construction of foundations for equipment, such as vertical vessels, stacks, horizontal vessels, heat exchangers, spherical vessels, machine tools, and electrical equipment such as transformers.

This report does not include foundations for:

- Equipment, such as turbine generators, pumps, blowers, compressors, and presses, which have operational characteristics that are essentially dynamic in nature. ACI 351.3R covers concrete foundations for dynamic equipment;
- Vessels and tanks whose contents structurally bear directly on soil (for example, clarifiers and large-diameter storage tanks);
- Buildings, concrete silos, chimneys, and structures that contain static equipment; or
- Equipment sensitive to external vibration. These foundations are generally isolated from the neighboring dynamic equipment foundations to minimize transmission of vibration from other equipment. These foundations rarely require their own separate foundations and are usually located and supported in buildings. ACI 351.3R provides some guidance, although its scope is for equipment that generates dynamic forces.

The geotechnical engineering aspects of the analysis and design of static equipment foundations discussed herein are limited to general considerations. This report is essentially concerned with the structural analysis, design, and construction of static equipment foundations.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

A = base area of footing, ft^2 (m^2)
A_{se} = effective cross-sectional area of anchor, in.^{2} (mm^2)
B = width of footing, ft (m)
D = edge-to-edge distance of footing in direction of overturning moment, ft (m)
d_{bc} = diameter of bolt circle, ft (mm)
d_o = nominal bolt diameter, in. (mm)
e = M/P, ft (m) (Section 4.4)
e_v = M/W, ft (m) (Section 5.5.1)
F = maximum bolt force for anchors in circular pattern, kip (kN)
f'_c = specified compressive strength of concrete, psi (MPa)
f_y = specified yield strength of reinforcement, psi (MPa)
h_{ef} = effective embedment depth of anchor, in. (mm)
k_c = coefficient for basic concrete breakout strength in tension
L = length of footing, ft (m)
M = overturning moment applied to footing or pier, ft·kip (kN·m) (Section 4.4)
M_p = resisting moment provided by passive lateral soil pressure, ft·kip (kN·m)
M_v = moment about the centroidal axes of the foundation, ft-lb (N-m) (Section 5.5.1)