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Design Guide for Connections in Precast Jointed Systems

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The proper detailing and design of precast concrete connections are essential to the performance of a precast concrete structure. This guide provides information on design, detailing, and construction of connections between precast members in jointed systems, including moment frame and structural wall systems.

Keywords: bolting; connection; debonding; ductility; erection; moment frame; precast; pretopped; post-tensioning; structural walls; welding.

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CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

Precast concrete structural systems are composed of individually fabricated components. Because of the segmental nature of precast concrete construction, connections between individual components are required to support the design loads. Connections are also required to accommodate deformations, including rotations and strains.

1.1.1 *Connection methods*—Precast components are connected by one of two methods. The first method connects components by reinforcement that protrudes from each component end, spliced using proprietary hardware or by lap-splicing with a small quantity of cast-in-place concrete to complete the connection. This method is referred to as emulation, or a wet connection, because it involves field-placed cast-in-place concrete and mimics the behavior of cast-in-placed monolithic structures. The second, more-common, method of connection is dry and connects components by welding, bolting, post-tensioning, or doweling without using field-placed concrete. Because dry connections are typically less stiff than their connecting precast components, deformations tend to be concentrated in the connections.

Connections should allow for easy and economical component casting and assembly, fabrication, erection clearance, and erection tolerances. They should also tolerate anticipated deformation without significant loss of strength.

1.1.2 *Connection groups*—Connections are categorized into five groups:

1) **Gravity load transfer**—Gravity loads alone, such as hollow core members placed on a beam ledge

2) **Shear transfer**—Either vertical shear, horizontal shear, or both, such as a double-tee flange-to-flange connection

3) **Moment transfer**—The tension and compression forces created by moment, such as a connection between a precast moment frame and its foundation

4) **Structural integrity**—Code-prescribed structural integrity forces; typically a connection with combination accommodations

5) **Combination connection**—A combination of loads, such as moments and shear

In all cases, the load paths and external loads are accommodated in all elements of connections (Fig. 1.1.2).

Tying all precast members to each adjacent member is essential for structural integrity as required by Chapter 16 of ACI 318-11. Such connections, however, should not be so rigid as to prevent member rotation or volume change strains when required.

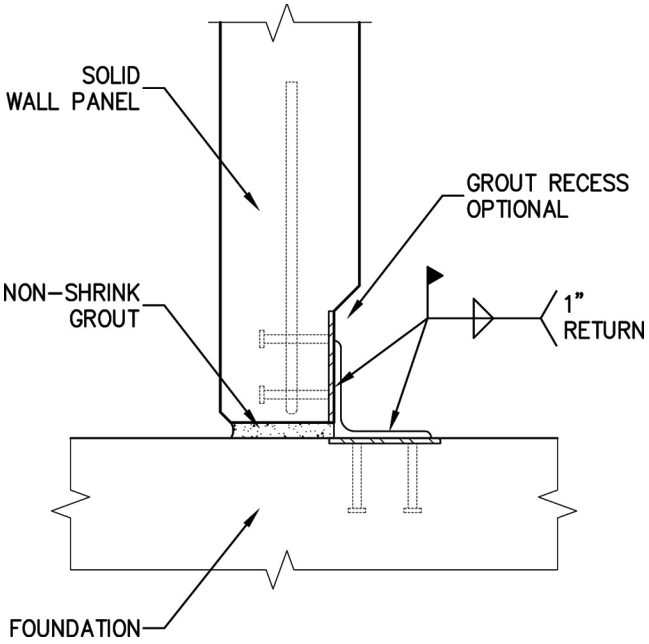

Fig. 1.1.2—Wall panel to foundation connection.

1.2—Scope

This guide provides information on the characteristics and design of connections between precast concrete components and between precast components and cast-in-place construction. The proper detailing and design of precast concrete connections are essential to the performance of a precast concrete structure.

This guide describes typical precast jointed systems and their connection types, performance, and characteristics, and provides recommendations for design and construction. Three classes of connections are identified and their characteristic and key design considerations given. Also included are guidelines for designing connections and their anchorage, a description of precast systems, typical lateral-load-resisting systems, key design considerations, and erection requirements including special welding considerations.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

C_d = deflection amplification factor
f'_c = specified compressive strength of concrete, psi (MPa)
R = response modification factor
ϕ = strength reduction factor

2.2—Definitions

ACI provides a comprehensive list of definitions through an online resource, "ACI Concrete Terminology," http://terminology.concrete.org. Definitions provided herein complement that resource.

deformable connection—a class of connection between precast members designed to either display significant flexibility or to yield, without losing strength, when subjected to expected deformations.