

An ACI Standard

# Requirements for Design of a Special Unbonded Post- Tensioned Precast Shear Wall Satisfying ACI 550.6 (ACI 550.7) and Commentary

Reported by Innovation Task Group 5

ACI 550.7-19



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*This standard defines procedures that may be used to design special precast concrete shear walls, coupled or uncoupled, composed of discretely jointed precast panels that are vertically post-tensioned to the foundation with unbonded tendons. Such walls are suitable for use in regions of high seismicity and for structures assigned to high seismic design categories. After a major seismic event, these walls can be expected to exhibit minimal damage in the flexural hinging region at the base of the wall as well as negligible permanent displacements. Such walls do not satisfy the prescriptive requirements of Chapter 18 of ACI 318-14 for shear walls of monolithic construction. According to 18.2.1.7 of ACI 318-14, their acceptance requires demonstration by experimental evidence and analysis that the walls have strength and toughness equal to or exceeding those provided by comparable monolithic reinforced concrete walls that satisfy the prescriptive requirements of Chapter 18. This standard describes the procedures that the designer may use to demonstrate, through analysis, that one type of unbonded post-tensioned precast wall has strength and toughness at least equal to that of comparable special reinforced concrete monolithic walls. The standard consists of Design Requirements and a Commentary.*

*Among the subjects covered in these Design Requirements are requirements for:*

*1. Materials, including considerations for the coupling or connection devices, that provide the primary source of energy dissipation for the wall system;*

*2. Individual walls, including considerations to ensure ductility, energy dissipation, integrity, stiffness, and strength; and*

*3. Coupled walls, including considerations of the roles of the post-tensioning tendons and coupling devices in providing energy dissipation, and strength and stiffness for coupled walls greater than the sum of those provided by the coupled walls acting as separate units.*

*The Commentary references documentary evidence, additional to the references of ACI 550.6 and Chapter 18 of ACI 318R-14, that supports these Design Requirements. In this standard, however, no comparison is made between the performance of precast test modules satisfying the prescriptive requirements of ACI 318 and modules satisfying these Design Requirements but not satisfying ACI 318. Such comparisons, both experimental and analytical, are available in the cited references.*

*All references to ACI 318 and ACI 318R in these Design Requirements and Commentary refer to ACI 318-14 unless another edition of ACI 318 is specifically designated. All references to ASCE/SEI 7 in these Design Requirements and Commentary are to ASCE/SEI 7-10, including third printing updates.*

*In this standard, consistent with the format of ACI 318-14, the word "Section" is not included before a reference to a section of ACI 318-14. To more clearly designate a section in this standard, however, the word "Section" is used before any reference to a section of this standard. Consistent with the format of ASCE/SEI 7-10, the word "Section" is included before a reference to a section of ASCE/SEI 7-10.*

**Keywords:** coupling devices; drift angle; energy dissipation; lateral resistance; post-tensioning; precast concrete; prestressed concrete; seismic design; special shear wall; test module; toughness.

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## CHAPTER 1—GENERAL

### 1.1—Introduction

For regions of high seismic risk, where structures assigned to Seismic Design Category (SDC) D, E, or F shall be used, 18.2.1.7 of ACI 318 permits the use of structural systems that do not meet the prescriptive requirements of Chapter 18 if certain experimental evidence and analysis are provided (all references to ACI 318 and ACI 318R in this standard refer to ACI 318-14 unless another edition of ACI 318 is specifically designated). The intent of ACI 550.6 is to define the minimum experimental evidence that is deemed sufficient to permit the use of unbonded post-tensioned precast structural wall systems, in accordance with 18.2.1.7 of ACI 318, when those systems do not satisfy fully the prescriptive requirements for wall systems in Chapter 18 of ACI 318.

Before validation testing can be undertaken, ACI 550.6 requires that a design procedure be developed for prototype wall systems having the generic form for which acceptance is sought, and that design procedure is used to proportion the test modules. This standard defines the design procedure for a specific type of wall system that does not satisfy the prescriptive requirements of Chapter 18 of ACI 318, but is validated for use in regions of high seismicity under ACI 550.6. The wall system uses precast concrete panels that are post-tensioned to the foundation and intended to rock on that foundation under seismic actions.

For coupled walls, coupling devices located along the vertical boundaries of adjacent walls provide the required energy dissipation and energy-dissipating reinforcement that crosses the wall-foundation interface is unnecessary. During an earthquake, the coupled walls displace as rigid bodies that are tied together. Wall deformations occur primarily at the interface between each individual wall and the foundation, with each wall rocking separately at that interface.

The unbonded post-tensioning has two purposes. First, the post-tensioning steel is deliberately designed to remain essentially elastic during the design basis earthquake (DBE), defined in ASCE/SEI 7, so that it forces the walls to return to their undeformed positions following the event. Second, the friction induced by the post-tensioning and gravity loading on the wall transfers the horizontal shears due to lateral loadings at the interfaces between the wall and the foundation and between the precast panels of the wall.

The detailing procedures described in this standard are for one specific type of unbonded post-tensioned precast shear wall system, coupled or uncoupled. Four statements define key characteristics of uncoupled and coupled unbonded post-tensioned precast concrete cantilever shear walls that satisfy this standard:

- (a) Post-tensioning tendons unbonded from an anchor in the foundation to an anchor at the top of the wall and located in a single duct on the vertical centerline of the wall or, if needed, in two or more ducts positioned symmetrically on either side of that vertical centerline and within 10% of the wall length from that centerline;
- (b) Precast panels one story or more in height; and
- (c) For uncoupled walls, two sets of energy-dissipating reinforcing bars crossing the interface between the lower-