

# Recommended practice to assess and control strand/concrete bonding properties of ASTM A416 prestressing strand

## PCI Strand Bond Task Group

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## Section 1—Purpose

The purpose of this recommended practice is to define a reasonable method of strand bond testing and a reasonable design methodology so PCI producers can design and manufacture pretensioned products with an expectation of satisfactory product behavior.

## Section 2—Prestressing strand for pretensioned products

### 2.1 Test method

ASTM A1081<sup>1</sup> is a test method for determining the bond of seven-wire prestressing strand conforming to ASTM A416.<sup>2</sup> Each test consists of six pullout test specimens for which an average test result is reported.

### 2.2 Minimum ASTM A1081 value

The minimum ASTM A1081<sup>1</sup> value for prestressing strand to be used in pretensioned applications shall be a demonstrated bond strength equivalent to ½ in. diameter, 270 ksi strand exhibiting a six-quarter running average value of 14,000 lb with no quarterly test average less than 12,000 lb.

### 2.3 High bond ASTM A1081 value

The high bond ASTM A1081<sup>1</sup> value for prestressing strand to be used in pretensioned applications shall be a demonstrated bond strength equivalent to ½ in. diameter, 270 ksi strand exhibiting a six-quarter running average value of 18,000 lb with no quarterly test average less than 16,000 lb.

### 2.4 Demonstrated bond strength

Demonstrated bond strength as noted in 2.2 and 2.3 shall also apply to prestressing strand other than ½ in. diameter or other than 270 ksi specified tensile strength. Equivalency shall be specified values multiplied by  $2 \times d_b \times f_{pu} / 270$ , with  $d_b$  in in. and  $f_{pu}$  in ksi.

## Section 3—Design

### 3.1 Design development length

Based on research,<sup>3</sup> the estimated strand development length shall be determined in accordance with Eq. 1.1 for elements with concrete release strengths not less than 3,500 psi and strand meeting at least the requirements of 2.2.

$$l_d = \left( \frac{3800}{\sqrt{f'_{ci}}} + \frac{7100}{\sqrt{f'_c}} \right) d_b \geq 100d_b \quad (1.1)$$

where

$l_d$  = development length, in.

$d_b$  = strand diameter, in.

$f'_{ci}$  = concrete strength at release, psi

$f'_c$  = design concrete strength, psi

### 3.2 Design transfer length

Based on research,<sup>3</sup> the estimated long-term transfer length shall be determined in accordance with Eq. 1.2 for products with release strengths not less than 3,500 psi.

$$l_{tr} = K \left( \frac{3800d_b}{\sqrt{f'_{ci}}} \right) \geq 40d_b \quad (1.2)$$

where

$l_{tr}$  = transfer length, in.

$K$  = 1.6 for strand meeting the requirements of 2.2  
= 1.0 for strand meeting the requirements of 2.3

$K$  shall be permitted to be linearly interpolated for strand between the requirements of 2.2 and 2.3 for evaluation purposes.

### 3.3 Transfer length at detensioning

For stress calculations at detensioning, shipping and handling, the transfer length in Eq. 1.2 shall be used with  $K = 0.8$ .

## Section 4—Purchasing

It is recommended that purchase orders for prestressing strand intended for use in pretensioned products include:

Evidence of quarterly ASTM A1081<sup>1</sup> testing and conformance to required pullout strength shall be provided for the plant where the strand was produced prior to strand shipment, as well as (a) or (b).

(a) The ASTM A1081 pullout value shall demonstrate a bond strength equivalent to ½ in. diameter, 270 ksi strand exhibiting a six-quarter running average strength of 14,000 lb with no quarterly test average less than 12,000 lb.

(b) The ASTM A1081 pullout value shall demonstrate a bond strength equivalent to ½ in. diameter, 270 ksi strand exhibiting a six-quarter running average strength of 18,000 lb with no quarterly test average less than 16,000 lb.

## Section 5—Quality assurance

Through appropriate testing, it is recommended that the precast concrete producer confirm that the strand and concrete combination in use produces product performance that meets or exceeds predicted behavior.<sup>4</sup>

## Section 6—References

1. ASTM A1081. 2015. *Standard Test Method for Evaluating Bond of Seven-Wire Steel Prestressing Strand*. ASTM A1081/A1081M-15. West Conshohocken, PA: ASTM International.
2. ASTM A416. 2018. *Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete*. ASTM A416/A416M-18. West Conshohocken, PA: ASTM International.
3. Ramirez, J. A., and B. W. Russell. 2008. *Transfer, Development, and Splice Length for Strand/Reinforcement in High-Strength Concrete*. NCHRP report 603. Washington, DC: Transportation Research Board.
4. Riding, K. A., T. Polydorou, and R. J. Peterman. 2015. "Determination of Acceptance Criteria for Prestressing Strand in Pre-tensioned Applications." Research report prepared for the Precast/Prestressed Concrete Institute, Kansas State University.