PRECAST / PRESTRESSED CONCRETE INSTITUTE

TECHNICAL BULLETIN

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Rev 1 (editorial revision)

STRAND-CONCRETE BONDING

SUMMARY

A report of strand end pull-in in hollow core plank came to the attention of PCI in April 2004 and raised concerns that strand-concrete bonding may still be an issue requiring further investigation. PCI began developing a bulletin to producers and subsequently initiated an investigation of the reported problem. A draft of the information bulletin dated June 18, 2004 was circulated prematurely, before the investigation was completed.

PCI completed the initial stage of its investigation and concluded that the recent report of poor bonding involved one precast concrete producer and was limited to a single PC strand supplier. The PC strand supplier in question has informed PCI that it has been monitoring customers who were recipients of strand product associated with the reported incident, and that all potentially affected customers will have been contacted by the supplier by the end of July 2004.

While this incident may affect only a limited number of precast prestressed concrete producers, PCI is advising all of its Producer Members to remain vigilant with respect to all factors that affect bonding, particularly the quality of PC strand, and is reminding them of guidelines and test methods that are presently available.

To address this matter in the long term, PCI, in cooperation with PC strand suppliers, has established a framework to review the issue of bonding between concrete and PC strand from a rigorous technical perspective, with the objective of developing and refining the tests, standards, process controls, and other measures necessary to reduce the incidence of bonding problems to the lowest practical level.

BACKGROUND

The mechanical bond between concrete and PC strand is essential to the manufacture of pretensioned prestressed concrete elements. PCI Producer Members implement operational and quality controls to assure that their processes and materials are consistent with applicable standards and overall product quality. Similarly, suppliers of PC strand, many of whom are Associate Members of PCI, work to ensure that their products are suitable for this purpose.

While there have been occasional incidents of less than acceptable strand-concrete bonding over the years in this industry, these incidents are typically traced to particular changes or deviations in materials or processes and are successfully corrected. Testing guidelines and technologies have been markedly improved in recent years and have enhanced the ability to confirm acceptable bond performance for PC strand.

RECENT INCIDENT

The recent reported concern resulted when a producer noted greater than maximum allowable strand end pull-in for manufactured hollow-core members, an indicator of poor bonding. The strand being used had been tested by the supplier using the "NASPA Test" with acceptable, albeit inconsistent, results. A sample was subsequently sent for independent testing using the "Large Block Pull-Out Test" (an improved version of the "Moustafa" test), and the results indicated a significantly lower bond strength than the control sample.

The strand supplier has been working with the producer and has thoroughly reviewed the processes and materials utilized, but they have not yet identified a specific cause for this incident. PCI has not received any other recent reports of poor bonding, connected with this or any other PC strand supplier, or with any other product type.

The strand supplier involved indicated that it has been monitoring customers who were recipients of PC strand product associated with the reported incident, that it is in the process of notifying all potentially affected customers, and that it expects to have completed these notifications by the end of July 2004.

RECOMMENDATIONS TO PRODUCERS

Acceptable bonding between concrete and strand is dependent upon many factors, all of which come together during the production process. Product inspections can detect evidence of inadequate bonding for certain product types. Management should remind production and quality control personnel of the types of observation appropriate to the product being manufactured (excessive end pull-in, unexplained camber deviations, etc.). If there is any question as to the ability of a particular concrete mix design to produce acceptable bonding using a given strand source, representative product samples should be fabricated and load tested.

Producers should take appropriate steps to assure themselves that the strand they are using has acceptable bonding characteristics. PCI's "*Manual for Quality Control for Plants and Production of Structural Precast Concrete Products*," 4th Edition (MNL-116-99), states that the capability of the strand to properly develop bond shall be substantiated either by certification from the strand supplier or by testing (see Section 6.2.2). Producers who rely on certificates from strand suppliers to meet this requirement should understand the basis for the certificates' claims. Producers who rely on testing have resources available (in addition to their own tests) for conducting independent testing of PC strand bonding characteristics. Information and guidance for testing of PC strand bonding characteristics will be provided in an Interim Guidance document to be issued separately.

Existing product standards applied to PC strand (particularly ASTM A-416) do not address bonding capacity. To provide an appropriate performance criterion, purchasing specifications should include a requirement that the strand "will bond to concrete of normal strength and consistency in conformance with the prediction equations for transfer and development length provided in ACI and AASHTO standards."

Producers should also be aware that variations in cement sources and/or blending, particularly in light of recent cement supply problems, could affect strand-concrete bonding, and that it is possible for such adjustments to be made by cement suppliers without their customers' knowledge.

Producers who encounter instances of inadequate strand-concrete bonding, regardless of the cause, are encouraged to contact PCI so that PCI can compile experiential data and issue advisories when appropriate. Information should be sent to Jason Krohn, PCI Technical Director (*jkrohn@pci.org*; 312-583-6771).

PCI ACTIONS

Near Term

- PCI has formed a task group to address the recent incident, which will form the nucleus of a permanent committee to study strand-concrete bonding (see below).

- The PCI Plant Certification Program requires that each Producer Member implement quality measures to ensure the capability of strand it uses to properly develop bond. Auditors will now explicitly include this item in every Plant Audit report. Auditors will also continue to be alert for indications of inadequate bonding that may be observed during Plant Certification audits and report any such evidence to the Producer Member.

- PCI has initiated a program to solicit, collect, and review information regarding instances of inadequate strand-concrete bonding, regardless of the cause. PCI will compile and technically evaluate this data, communicating with involved organizations as deemed necessary.

- PCI will convene a technical committee focused upon strand-concrete bonding in precast prestressed concrete, considered from all perspectives. The committee will review existing knowledge on the topic, both domestic and international, as well as continuing new information from testing and industry experience. It will analyze data developed as a result of the information gathering initiative described above, will review research results as they become available, and identify additional research needs as appropriate.

Longer Term

- PCI will work with the North American Strand Producers Association (NASPA) to develop a practical, economical test for use in strand manufacturing facilities that can reliably predict the bonding characteristics of PC strand.

- PCI will support the development, improvement, and, where appropriate, standardization of guidelines and test methods relating to strand-concrete bonding based upon research results, solid empirical data, and practicality. Where and when appropriate, these results will be incorporated into the PCI Plant Certification Program.

CONTACT FOR ADDITIONAL INFORMATION REGARDING THIS BULLETIN

Jason Krohn, PCI Technical Director
jkrohn@pci.org
312-583-6771

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