Time-critical investigation and testing of a precast concrete beam using Ultrasonic Pulse Velocity (UPV)

Overview

- Durability Engineers assessed a potential discontinuity or cold joint in a precast beam (over 68 ft; 20 m long) that was delivered to an active construction site.
- Ultrasonic pulse velocity testing was performed using Pundit 200 in direct and indirect transmission modes..
- The Pundit 200 UPV results clearly showed that no defect was present and the beam was fit for purpose. Construction resumed immediately.

Durability Engineers PLLC (Michigan, USA) provides comprehensive consulting services throughout the entire lifecycle of concrete structures. Their mission is to provide expert consulting services that meet the unique challenges of each project and help extend the longevity and safety of concrete structures.

Durability Engineers participates in various national and international technical organizations, such as American Concrete Institute (ACI), ASTM International, and International Concrete Repair Institute (ICRI). In addition, they collaborate with academia, research institutions, and other industry organizations to advance the state-of-the-art in concrete performance and durability.

This case study showcases a project that Durability Engineers performed for their client, IHC Construction and Chicago Testing Lab.

Challenge

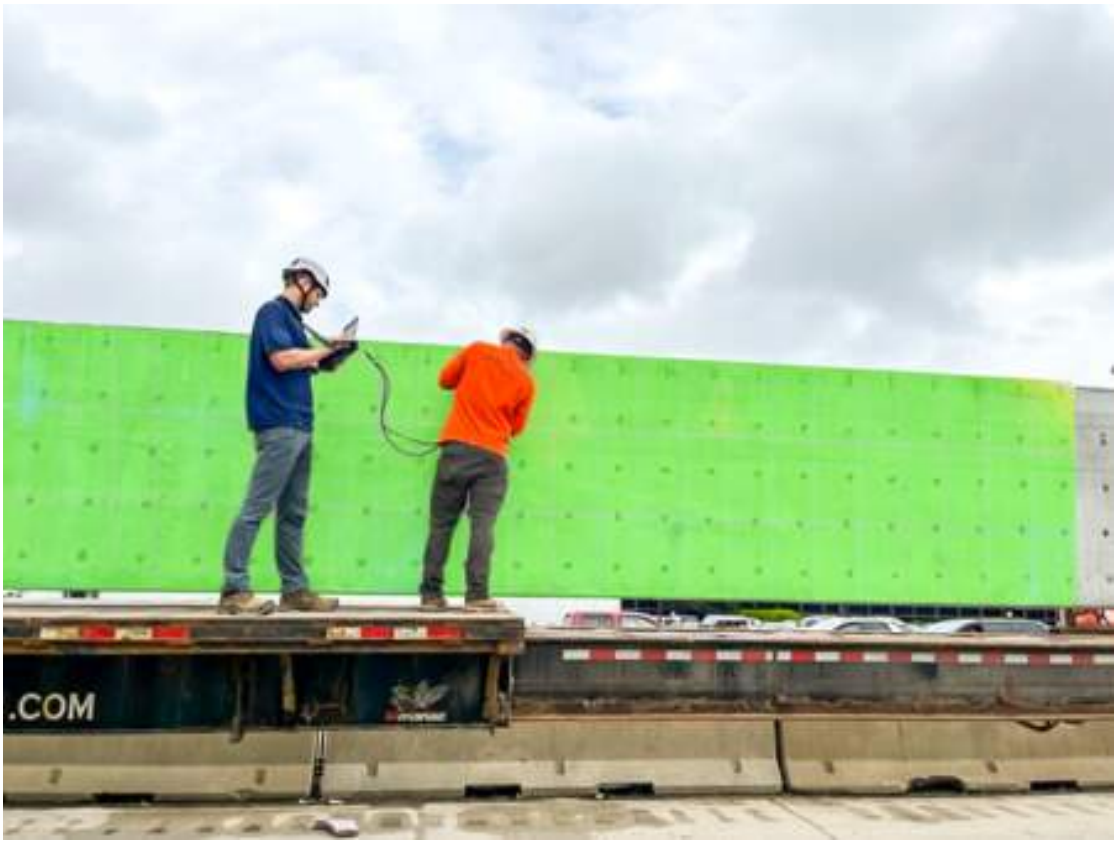
A precast concrete beam, approximately 68 ft (20 m) long, 5 ft (1.5 m) high and 1 ft (0.3 m) wide, was constructed of high-strength concrete (approximately 6,000 psi) and delivered to a pumping station construction site. Upon, arrival the beam was inspected by Illinois Department of Transportation (IDOT) representatives. The inspection identified an approximately 25 ft (7 m) diagonal line of darker paste that was suspected to be a discontinuity or cold joint.

To investigate and determine the nature of the suspected discontinuity, Durability Engineers was engaged to perform an evaluation of the beam. The client and IDOT wanted to implement nondestructive testing to evaluate the risk, reduce the interruption to construction schedule, and reduce cost of investigation and laboratory testing.

Solution

Ultrasonic Pulse Velocity (UPV) testing was performed in general accordance with ASTM C597, “Standard Test Method for Pulse Velocity Through Concrete.” The UPV test method employs a “pitch-catch” non-destructive type testing approach, where two transducers are set in series, one transducer transmits an ultrasonic pulse and another transducer receives the pulse. Slower transmission times (lower pulse velocities) may be indicative of low strength concrete, poor concrete consolidation, cracks, large voids, or in this case, a potential cold joint.

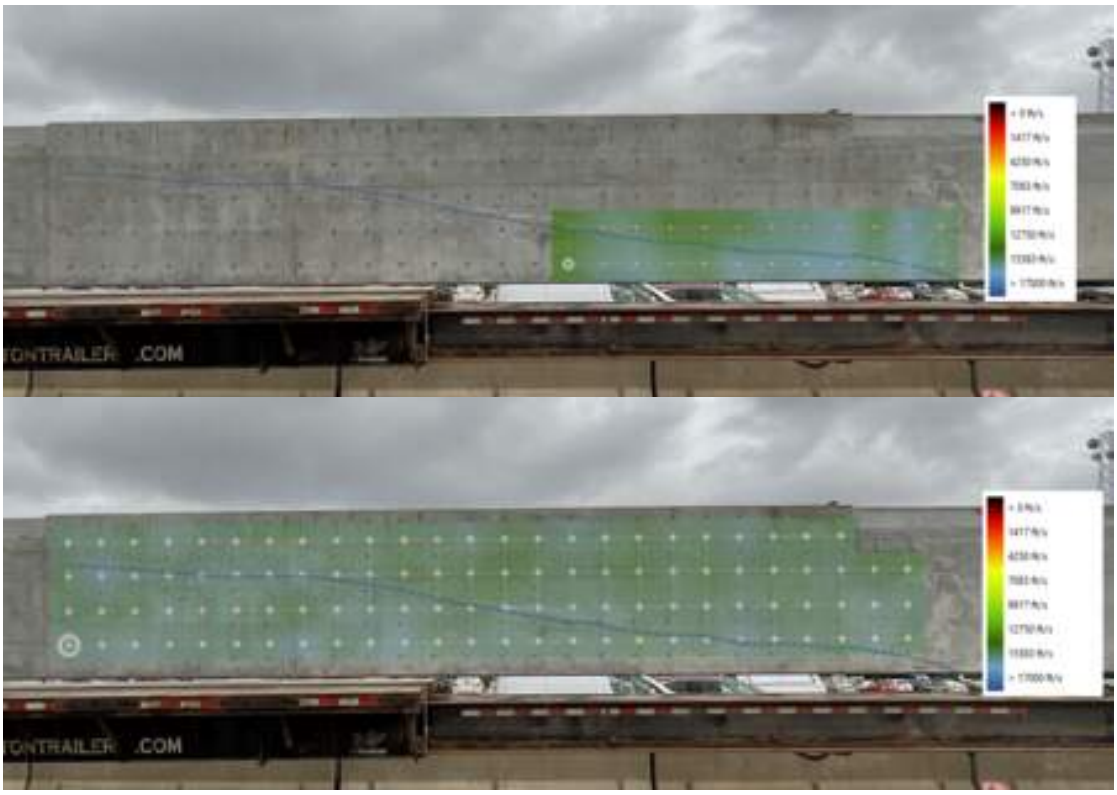
Typically performed in “direct transmission,” the transducers are set on opposites sides of a structural member with a known cross-sectional thickness. However, to assess the potential presence of a longitudinal discontinuity, “indirect transmission” measurements were taken by placing the transducers on the same face of the structural member at a fixed separation distance. If a discontinuity or cold joint was present, the transducers measuring across the longitudinal discontinuity would correspond to a reduction in the signal strength and decreased pulse velocity readings.



As a control test area, Durability Engineers' performed UPV on 12 ft by 2 ft direct transmission grid through the width of the beam (1.5 ft). The velocity readings ranged from 14,865 ft/s to 16,145 ft/s with an average 15,730 ft/s. This direct UPV testing was done to determine the baseline velocity of the concrete and to calibrate the measurements for indirect UPV testing.

The results are shown superimposed on a photograph of the beam. Note that the blue dashed line shows the location of the presumed cold joint and the small white circles are the measurement positions.

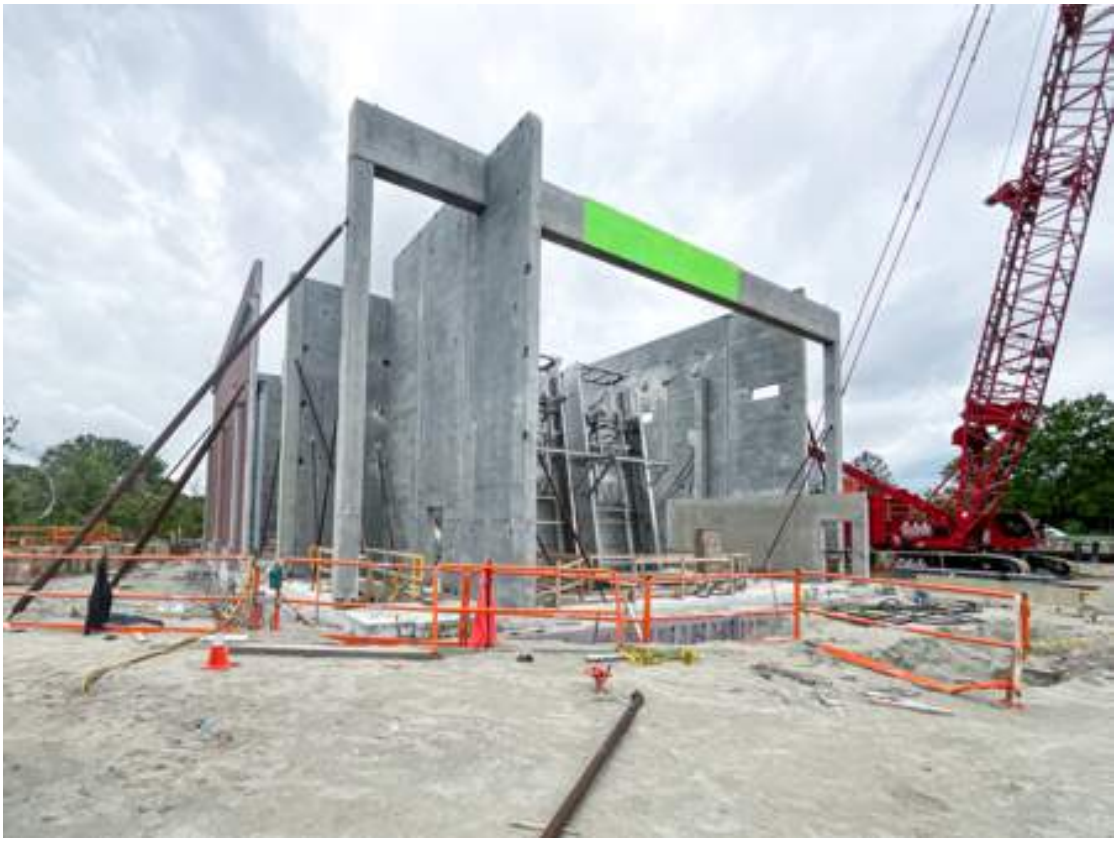
To evaluate the presence of a potential discontinuity, UPV was performed on a 26 ft by 5 ft grid on the South face of the beam with a 1 ft transducer spacing. Indirect velocity readings ranged from 14,390 ft/s to 16,555 ft/s with an average 15,440 ft/s (results are shown superimposed on a photograph of the beam). A 12 ft by 3 ft indirect transmission grid was also performed on the North face of the beam with a 1 ft transducer spacing. These indirect velocity readings ranged from 14,205 ft/s to 16,420 ft/s with an average 15,480 ft/s.



It was clear from the results that the velocities were similar throughout the measurement grid and do not indicate discrepancies or areas of weakness. Therefore, the UPV measurements indicated the beam has been placed monolithically and did not suggest the presence of a cold joint or discontinuity.

Results

Durability Engineer’s successful investigation and analysis is testament to their expertise and the quality of Screening Eagle's sensors and software.



The approach taken by Durability Engineers for this investigation paired with the real-time interpretation capabilities of Screening Eagle's equipment gave the client and IDOT the confidence to move forward with construction. The nondestructive approach mitigated the need for destructive laboratory testing, saving time and money to repair/replace the precast beam and resumption of construction safely, maintaining the original timeline and budget.

Screening Eagle's Pundit PD8050 is an ultrasonic array that could also have been applied to this project for quicker UPV testing and also for efficient 3D imaging using ultrasonic pulse echo technology.

See more case studies with ultrasonics in our Tech Hub.