Technical Guideline 210.4-2009

Nondestructive Evaluation Methods for Condition Assessment, Repair, and Performance Monitoring of Concrete Structures

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THE NORTH FACE

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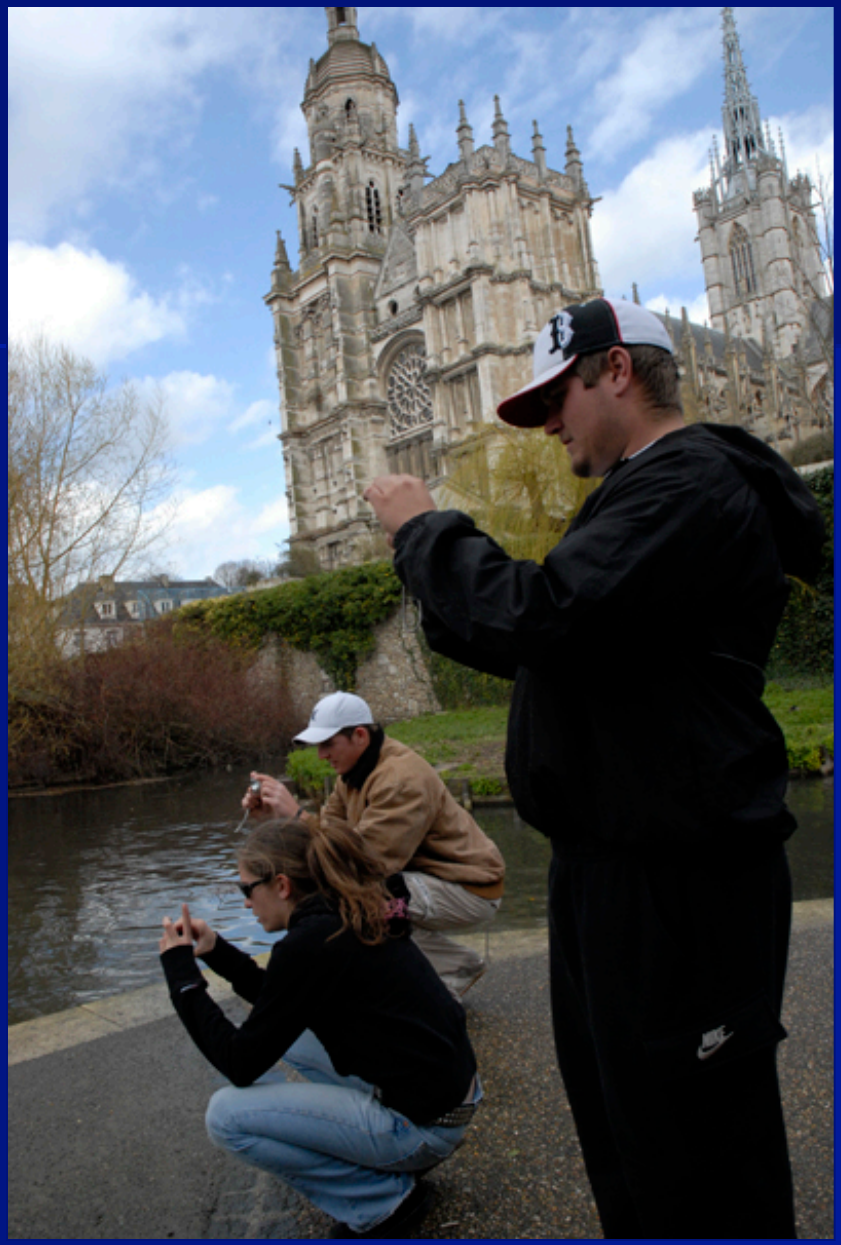
Note: Images are for illustration purposes for this presentation only; they are not in the Guideline



Purpose of the Guideline

"Assist contractors, owners, engineers, architects, and material suppliers involved in concrete repair projects in the selection of the most suitable nondestructive evaluation (NDE) methods for evaluating specific conditions relating to the condition assessment, repair program quality control, and/or performance monitoring of a structure"

Purpose of the Guideline

which specific conditions related to

- condition assessment
- repair quality control
- performance monitoring

of a structure can be *suitably evaluated* using various NDE methods

Purpose of the Guideline

An essential component to proper maintenance and repair of a concrete structure is a thorough understanding of the structure in terms of the

cause

extent

rate of progression

of distress or deterioration

Purpose of the Guideline

Arriving at this thorough understanding requires

Experience

Set of tools

that are in some ways quite distinct from those applicable to new construction

Purpose of the Guideline

The simplest repair approach is to address symptoms rather than causes which may result in ineffective repairs

Purpose of the Guideline

"Critical aspects of distress or deterioration may be hidden from view "

Purpose of the Guideline

NDE methods offer the advantage of being able to *diagnose internal concrete conditions* thereby

enhancing repair design

quality assurance of concrete repairs

providing for performance monitoring of concrete repairs over the long-term

Selecting Appropriate NDE Methods

Nature

Extent

Severity

of *hidden* internal distress or deterioration

Selecting Appropriate NDE Methods

In some applications, NDE offers essential tools without which there would remain significant uncertainties that have the potential of compromising the feasibility of repair

Selecting Appropriate NDE Methods

So many methods, so little time

Searching . . . recognizing strengths & limitations . . .
Arriving at proper NDE program . . .

. . . daunting task

Selecting Appropriate NDE Methods

Again . . .

This guideline offers assistance in selecting appropriate NDE methods to determine the properties and/or conditions of concrete

prior to repairs (diagnosis)

for quality assurance (QA) after repairs

for long-term performance monitoring of repaired structures.

Selecting Appropriate NDE Methods

Recognizing that not all NDE tools will work for all issues and there is a need to assess appropriate uses for the tools and techniques

Common uses of NDE for condition assessment of structural concrete prior to repair design and execution include:

- Predict in-situ concrete strength (relative strength comparison unless correlated with laboratory strength tests, e.g. core compressive strength tests)
- Location and extent of delaminations due to reinforcement corrosion
- Location, size and distribution of reinforcement bars
- Location and extent of concrete cracking
- Severity, location and extent of fire and frost damage
- Location and extent of void honeycombing
- Determine concrete thicknesses
- Evaluate reinforcement corrosion activity and rate

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Selecting Appropriate NDE Methods

Guideline tables for selection of NDE methods are presented including those for

- concrete strength prediction
- structural and general concrete condition assessment
- foundation condition
- integrity and length
- reinforcement location, cover depth, sizing
- corrosion condition assessment

Selecting Appropriate NDE Methods

Table 7.1 – NDE Methods for Concrete Strength Prediction

NDE Methods	Cast-in-place (CIP) Cylinders	Maturity	Rebound Hammer	Penetration Resistance		Pullout (fresh and hardened concrete)	Ultrasonic Pulse Velocity (Sonic Pulse Velocity)	Tensile Pull-Off
				Windsor Probe	Pin Penetration			
Reference Standards/Guidelines	ASTM C 873	ASTM C 1074	ASTM C 805	ASTM C 803/C 803 M		ASTM C 900	ASTM C 597	ASTM C1583 and ICRI Guideline 03739
Property/Condition								
Compressive Strength	X	X	X	X	X	X	X	
Tensile Strength	X	X				X	X	
Bond Strength								X
Bond Quality								X
Section	A.1.2	A.1.3		A.1.4			0	A.1.6

*Note that ACI 228.1R requires that nondestructive strength predictions be based on appropriate NDE to destructive strength correlation tests for the NDE methods discussed therein. Also note that the Break-off Number Test is discussed in Section A.1.1 but this test was withdrawn by ASTM in 2002 so is not included in Table I.

Example of tables contained in the Guideline

Descriptions and Illustrations

NDE methods discussed in the Guideline tables are briefly described and illustrated in the appendix

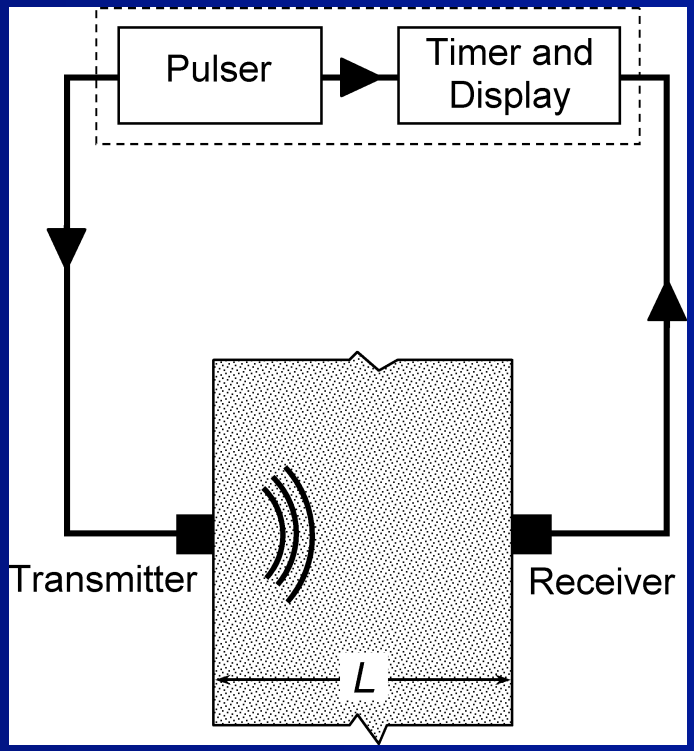
For example . . .

Descriptions and Illustrations

Ultrasonic Pulse Velocity Test (ASTM C597)

The Ultrasonic Pulse Velocity method involves transmitting and receiving ultrasonic sound wave energy at a frequency of typically 54 kiloHertz (kHz) and calculating the pulse velocity as the travel path distance divided by the travel time in microseconds as shown in Fig. 7. As discussed in ACI 228.1R, velocity raised to the 4th power is proportional to Young's Modulus to the 2nd power which is proportional to concrete compressive strength . . . .

Descriptions and Illustrations

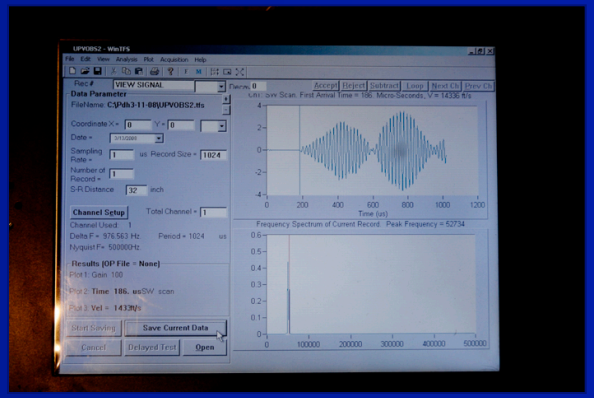


Descriptions and Illustrations

What does it look like in practice?



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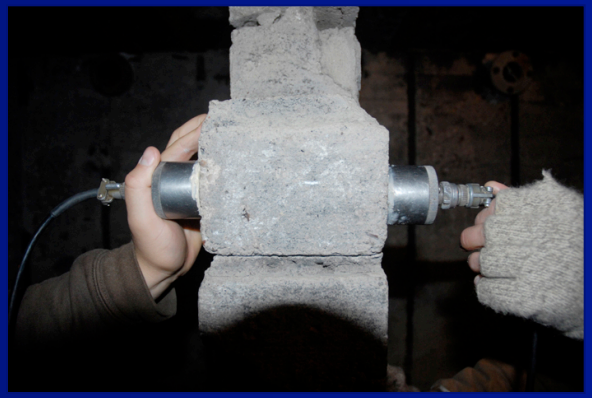



sarens

Coordination with ACI Documents

The overall Guideline compliments the American Concrete Institute's 228 Nondestructive Testing Committee reports ACI 228.1R and ACI 228.2R that provide more in-depth information on most of the NDE methods discussed in the Guideline.

Coordination with ACI Documents

ACI has given permission to reproduce a number of the NDE method schematics from the ACI 228.1R and ACI 228.2R committee reports that were drawn by Dr. Nicholas J. Carino, former Chairman of ACI 228.

Accordingly, the ICRI Evaluation Committee gratefully acknowledges the contribution by ACI and Dr. Carino to this ICRI Guideline.

Thank you!