A Brief History of Pullout Testing

With Particular Reference to Canada

By

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A Personal Journey
portable apparatus

German-Petersen designs a

straight line relationship

Kierkegaard-Hansen establishes a

in Russia, USA and Canada

1930's to 1970's Applied Research

History
There is a good correlation between pullout strength and compressive strength. The parameter of concrete is affected by a fundamental strength irrespective of failure theory, pullout strength.

Correlation
correlation
— lightweight aggregate, however, produces significantly different
Shape or size of aggregate up to 40 mm
Admixtures
Air entrainment
Age
Water-cement ratio
Cementitious materials

Not affected by:

Robust Correlation
and economic
lok-test made safety attainable
Hard to sell safety
Financial savings
leads to faster completion and
Early form removal generally

Safety
Strength for Formwork Removal

- The cylinder strength at the time passed the requirement.
- Subsequent investigation showed standard cylinders tested had
- Boston, USA.
- Multi-story building collapse in

At formwork removal, the cylinder strength at the time in-place strength to be 50% of
Cooling Tower Collapse, April 1978
Willow Island, W. Va., USA

51 deaths
- Failure due to insufficient strength to support next "lift"
- LOK-TEST is now used to estimate in-place strength before moving to next "lift"

Courtesy of NIST
• ASTM C-900-78T was first standard
• Strength determination of compressive
• Multiple inserts allow accurate
• Well designed and easy to use
• Portable

ENTER LOK-TEST
Reaction Ring

Pullout Force

Insert

CLIP-Pullout Test
Pullout Test

Pull Machine

COMA Meter

Conical Fragment
Post-installed (PI): CAPO-Test
Cast-in-Place (CIP): LOK-Test
anchored in concrete
Measure force to pullout an insert
ASTM C 900
Pullout Test
- Post-installed (PI): CAPO-Test
- Cast-in-place (CIP): LOK-Test
  - Anchore in concrete
  - Measure force to pullout an insert

ASTM C 900
Pullout Test
allowed

Core tests or pullout tests

Curving and removing restraints

or post-tensioning, terminating

remove forms, applying prestressing

In-place strength required to

Canadian Standard CSA A23.1
Concrete Optimisation

• On most projects the acceleration of the construction results in significant financial savings
• Optimisation assesses all the factors involved in acceleration and assesses the extra costs or savings
reliable acceptance by this approach was confirmed that test results based on pullout tests in concrete on 2 major projects of the City of Toronto were accepted by in-place tests.
Scotia Plaza

Canada.
Scotia Plaza – Toronto,

- Earnings due to speeding up construction schedule reported to be about 0.2 to 1.5 M dollars
- Earnings due to speeding up structures
- North America on about 300 major place strength has been done in using LOK-TESL for estimating in - SAFE and EARLY STRIPPING OF FORMS
Pullout tests confirmed strength

Adequate strength

Maturity meters predicted

11 hours

Spandrel beams at ages as short as supported on concrete columns and self climbing form system

Scotia Plaza
Identity tests is an option 
confirmation by pullouts as 
early as by in-place tests' early
where acceptance of a structure
be the next generation norm
Performance Specifications
Performance Specifications
- Remote from testing laboratories (Near Magnetic North Pole)
- Supply only by air except for one ship a year
- Confirmation of adequate early foundation strength doubled column project length
• It allows acceleration of construction without compromising safety
• Strength determining in-situ compressive
• Reliable and economic way of Lok-Test is a quick, simple

Summary