Non-Destructive Test Methods
LTEC 2007

Presented by
Mark A. Cheek, P.E., FACI
Vice-President
Beta Testing & Inspection, LLC
New Orleans
- Slab Flatness & Levelness (F-Number System)
- Maturity Method (Concrete)
- Mass Concrete Temperature Monitoring
- Pulse Velocity Techniques
- Pile Integrity Testing
Slab Flatness & Levelness (F-Number System)
10-ft Straightedge
- The difficulty in testing large areas
- The difficulty of randomly sampling floors
- The inability to reproduce testing results
- The inability using normal construction procedures to meet the tolerance limits normally specified, such as 1/8 inch in 10-ft or ¼ inch in 10-ft.
E 1155 Standard Test Method for Determining $F_f$ Floor Flatness & $F_l$ Floor Levelness numbers

**SCOPE**

“This test method covers a quantitative method of measuring floor surface profiles to obtain estimates of the floor’s characteristic $F_f$ Flatness and $F_l$ Levelness Face Floor Profile Numbers using the inch-pound system of units.”
The F-Number system uses floor surface curvature over 24 inch distance as a measure of flatness, and floor slope over a distance of 10 ft as a measure of levelness. Curvature and slope are calculated from elevation readings.
F-Number System Vs. the 10-ft Straightedge Method

Fig. 4.5.6(c)—F-number system is clearly superior to the “gap under a straightedge” approach for distinguishing between the surfaces of obviously different qualities shown in this diagram.
While there is no direct equivalent between F-Numbers and straightedge tolerances, the graph on the right gives a rough correlation between the two systems.
Organization of Test Area

On any one building level, the entire floor area of interest shall constitute the *test surface* (randomly trafficked).

*Test section* shall consist of any subdivision of a test surface.

*Sample measurement line* (test run) shall consist of any straight line on the test surface.
Sample Layout
Collect Data
Test Run Data (graph format)

Flatness (Ff) = 26.71  Levelness (Fl) = 19.42
PROJECT INFORMATION

PROJECT NAME:
Site work, Foundations & Building Slab for New Rapidmat Manufacturing Facility

LOCATION:
St. Bernard Port Harbor & Terminal Dist., Chalmette Louisiana

CONTRACTOR:
Gootee Construction
Remediation
Contour map

1st Pour
"0,0,0" Located at Southwest Corner of Section

Contour interval = 0.025"
Scale: 1" = 10'
Wire mesh

1st Pour
"0,0" Located at Southwest Corner of Section

-1.1
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
Maturity Method (Concrete)
Why use Maturity Methods for estimating in-place properties?
Because traditional test specimens do not accurately reflect in-place strength

- **Geometric differences**
  - Cylinders have small volumes but large surface areas so they retain less heat and thus mature at a different rate than the actual placement.

- **Environmental differences**
  - Temperature history for test specimens vary due to curing conditions and thermal protection different than the actual placement and so gain strength at a different rate.

- **Handling differences**
  - Cylinders can be improperly prepared, handled, or tested resulting in inaccurate breaks.
Benefits in Using Maturity

- Streamline concrete workflow
  - Accelerate Construction Schedules
  - Reduce Man-Hours
  - Allow Earlier Form Removal
  - Reduce cylinder break costs
- Enhance Quality Control
  - Early mix verification/batch quality
- Enhance Quality Assurance
  - Document Time/Temperature History
  - Early data for post-tensioning, saw-cutting, steel cutting, cold-weather protection
Maturity Rule

“Concrete of the same mix at the same maturity (reckoned in temperature-time) has approximately the same strength whatever combination of temperature and time go to make up that maturity.”

A.G.A. Saul, 1951
Maturity Equipment
Implementing the Concrete Maturity Method

Strength-Maturity Relationship

\[ y = 734.43 \ln(x) - 3685.9 \]

\[ R^2 = 0.9931 \]
1. Develop a mixture specific calibration curve
2. Embed maturity loggers into plastic concrete
3. Take maturity (TTF) measurements
4. Use the calibration curve to estimate strength from maturity (TTF) measurements
Developing a mixture specific curve
Developing a mixture specific curve
Laboratory Test Data
Strength - Maturity Relationship

Compressive Strength (psi)

Maturity Index (TTF) (C - hrs.)

1 Day
3 Day
7 Day
14 Day
28 Day
Field Activities

- Embed loggers
  - Minimum 10” from pavement edges
  - Minimum 4” cover in structures (mid-depth ideal)
- Activate loggers
- Take maturity (TTF) measurements
Logger Placement Frequency

- Pavement
  1 / 2500 sqft.

- Structures
  1 / 100 cubic yards
Using the Strength-Maturity Relationship Curve

**4450 psi**

**4029 C-H**
Mass Concrete Temperature Monitoring
Logger Temperatures for BRIDGE PILE9

Max Delta Temp: 39.6 °F @ 36 Hrs

Min Temp: 66.2 °F @ 0 Hrs, Max Temp: 120.2 °F @ 81 Hrs

Logger Start Date: 9/23/2004 9:25:00 PM
Last Download Date: 10/7/2004 1:16:45 PM
Max Delta Temperature for BRIDGE PILE

Max Delta Temp: 39.6 °F @ 36 Hrs
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![Graph showing delta temperature over time]
Pulse Velocity Techniques
Figure 24. Schematic of pulse velocity device.
Figure 25. Methods of pulse velocity measurement.
(A) Direct method. (B) Semi-direct method.
(C) Surface method.
Pile Integrity Testing
Small hammer impact device

Accelerometer

(defect)
defect
input
toe