FOOTING UNDERPINNING

Courtesy: Structural Preservation Systems
DESIGN ISSUES

- Connection capacity between micropile and the existing concrete

- How to predict it?

- How to improve it?

- How to account for it?
CONNECTION TYPES
TESTS
CONCRETE BLOCK REINFORCEMENT

- **LONGITUDINAL STEEL:**
  - 4 – NO. 8 BARS (25.4 mm)

- **TRANVERSE STEEL:**
  - 4 – NO. 8 BARS

- \( F_y = 60 \text{ KSI} (414 \text{ MPa}) \)

- 1% BY VOLUME OF THE CONCRETE BLOCK
SMOOTH INSERTS

- 4.5” OD (114.3 mm) CASING, API N80
- 0.53” WALL THICKNESS (13.5 mm)
- 1.75” OD (44.5 mm) REINFORCING BAR
- GRADE 75 KSI (517 MPa)
SAS BAR INSERTS

- 1.75” OD (44.5 mm)
- REINFORCING BAR
- GRADE 75 KSI (517 MPa)
TEXTURED INSERTS
STRAIN GAUGES
**PREDRILLED HOLES**

- **CAST IN BLOCK**
- **PREDRILLED HOLE DIAMETERS:**
  - 4.5 – 5 – 6 – 8 INCH
  - (114 – 203 mm)
- **LENGTH:**
  - 17 – 24 – 35 INCH
  - (432 – 890 mm)
- **STYROFOAM AT BOTTOM OF HOLES TO AVOID END BEARING**
PREDRILLED HOLES

- NUMA CHAMPION 60HFE DOWN HOLE HAMMER
- ROUGH HOLE WALLS
- TWO OR THREE HOLES PER BLOCK
PREDRILLED HOLES
GROUTING OF ANNULUS

- **0.45 W/C RATIO**
- **F'c = 6,400 PSI**
  AVERAGE AT 28 DAYS (44 MPa)
- **E = 900 TO 1,200 KSI**
  (6200 TO 8300 MPa)
TESTING

PKF-MARK III

Schnabel Engineering
SMOOTH INSERTS

Deflection (in)

Bond Stress Around Insert (psi)

6” hole

8” hole
TEXTURED INSERTS

- Bond Stress Around Insert (psi)
- Deflection (in)
TEXTURED INSERTS
MECHANISM OF BOND STRENGTH

Bond Stress Around Insert (psi)

Deflection (in)

- Adhesion
- Bearing
- Friction

Friction

0.00 0.05 0.10 0.15 0.20
POISSON EFFECT
EFFECT OF SURFACE ROUGHNESS
EFFECT OF SURFACE ROUGHNESS
FRICTION MECHANISM

- LATERAL EXPANSION DUE TO POISSON EFFECT AND DILATION DUE TO SURFACE ROUGHNESS
- RADIAL NORMAL STRESSES AND TENSILE TANGENT STRESSES (HOOP STRESSES)
- FRICTION ALONG MICROPILE SURFACE
- IF BLOCK IS UNREINFORCED, NORMAL STRESS LIMITED BY CONCRETE TENSILE STRENGTH
- IF BLOCK REINFORCED, REBAR YIELD STRESS MAY CONTROL
- LOWER COMPRESSIVE STRESSES AND FRICTION FOR LARGER ANNULAR SPACE
PREDICTION OF CAPACITY

- ESTIMATION OF THE CAPACITY OF TEXTURED CONNECTIONS IS POSSIBLE BASED ON FOOTING REINFORCEMENT (SEE REPORT)
- NOT EASY FOR SMOOTH CONNECTIONS
- ALWAYS TEST FOR CRITICAL PROJECTS OR LARGE CONNECTION LOADS
CONCLUSIONS

- Neat cement grout provides significant bond >200 PSI in tests performed.
- Texturing of micropile surface may significantly increase bond.
- Reinforcement of footing is crucial to bond strength, especially for textured micropiles.
CONCLUSIONS

- Bond strength decreases for increasing width of annular space around micropile.
- May use experimental chart for preliminary estimate of bond strength for design of smooth micropiles.
- For smooth micropiles, recommend to perform specific tests if design bond > 250 PSI ultimate.
- Watch for experimental scatter.
Acknowledgement

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NUMA
MANUFACTURER OF DOWN HOLE HAMMERS AND BITS

Foster Piling

GEOKON

SASstresssteel