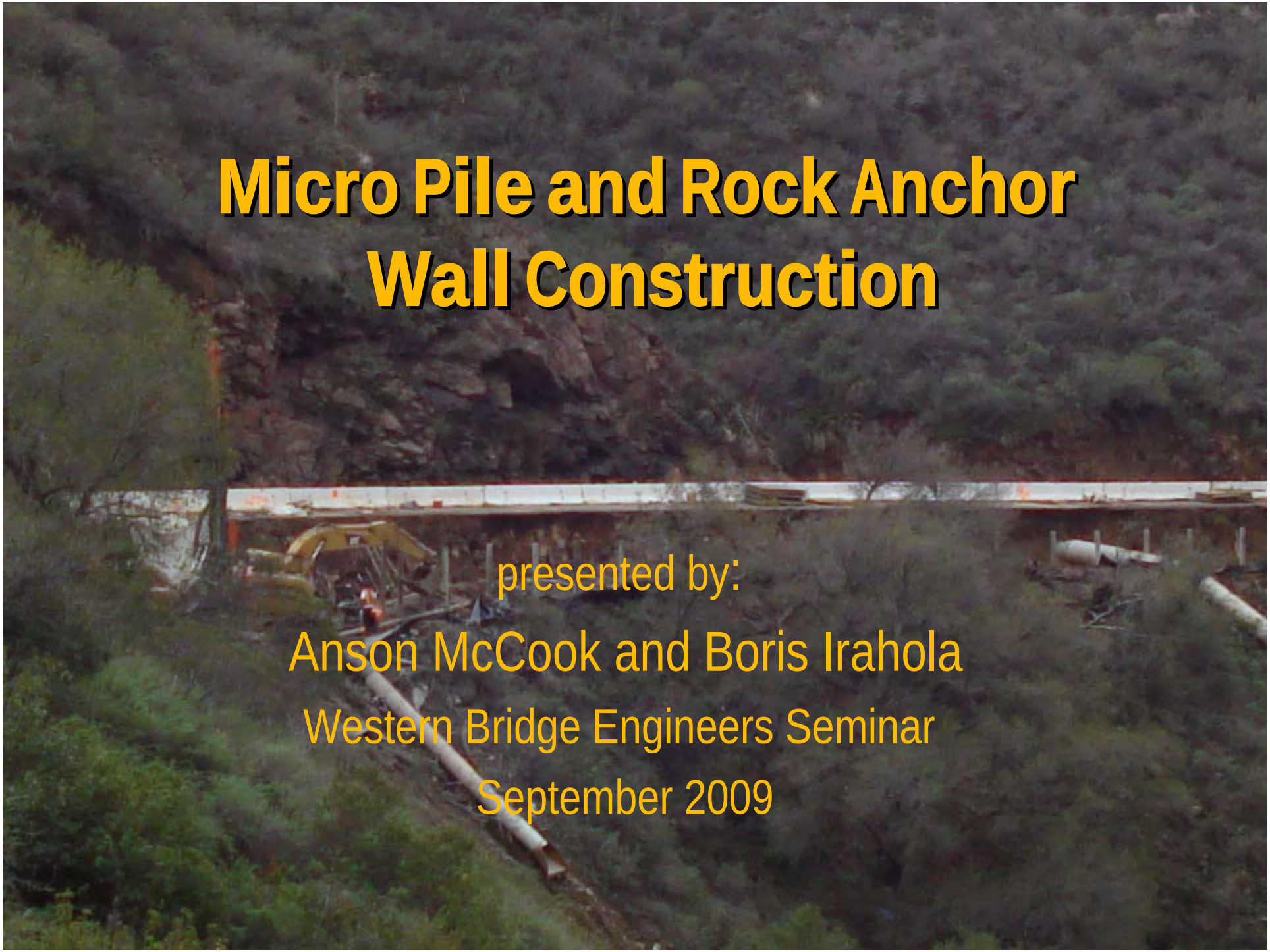


Micro Pile and Rock Anchor Wall Construction

presented by:

Anson McCook and Boris Irahola

Western Bridge Engineers Seminar

September 2009

Accomplishments

Awards received for this project include,

- *" Exceptional Award" in the Transportation Category from the Western Council of Construction Consumers.*
- *" Capella Award" from the PRSA-CEIC Polaris Awards for the Upper Ortega, SR 74 public outreach program.*
- *" Partnering Award" in the transportation category.*

Historic Culvert

Historic Culvert

SCOPE

- Culverts were down rated from significant historic culverts to historic culverts.
- Change from viaducts to retaining walls.
- Save time
- Save money
- Improved safety for motorists

Project Challenges

- Bedrock and hard-decomposed granite ground.
- Tight access for equipment.
- Appropriate equipment
- Environmental constraints
- Permit requirements
- Construction administration


KOMATSU
PC228USLC

ENVIRONMENTAL

- Environmentally Sensitive Area
- Migratory Birds
- Arroyo Toad
- Fire Safety Plan

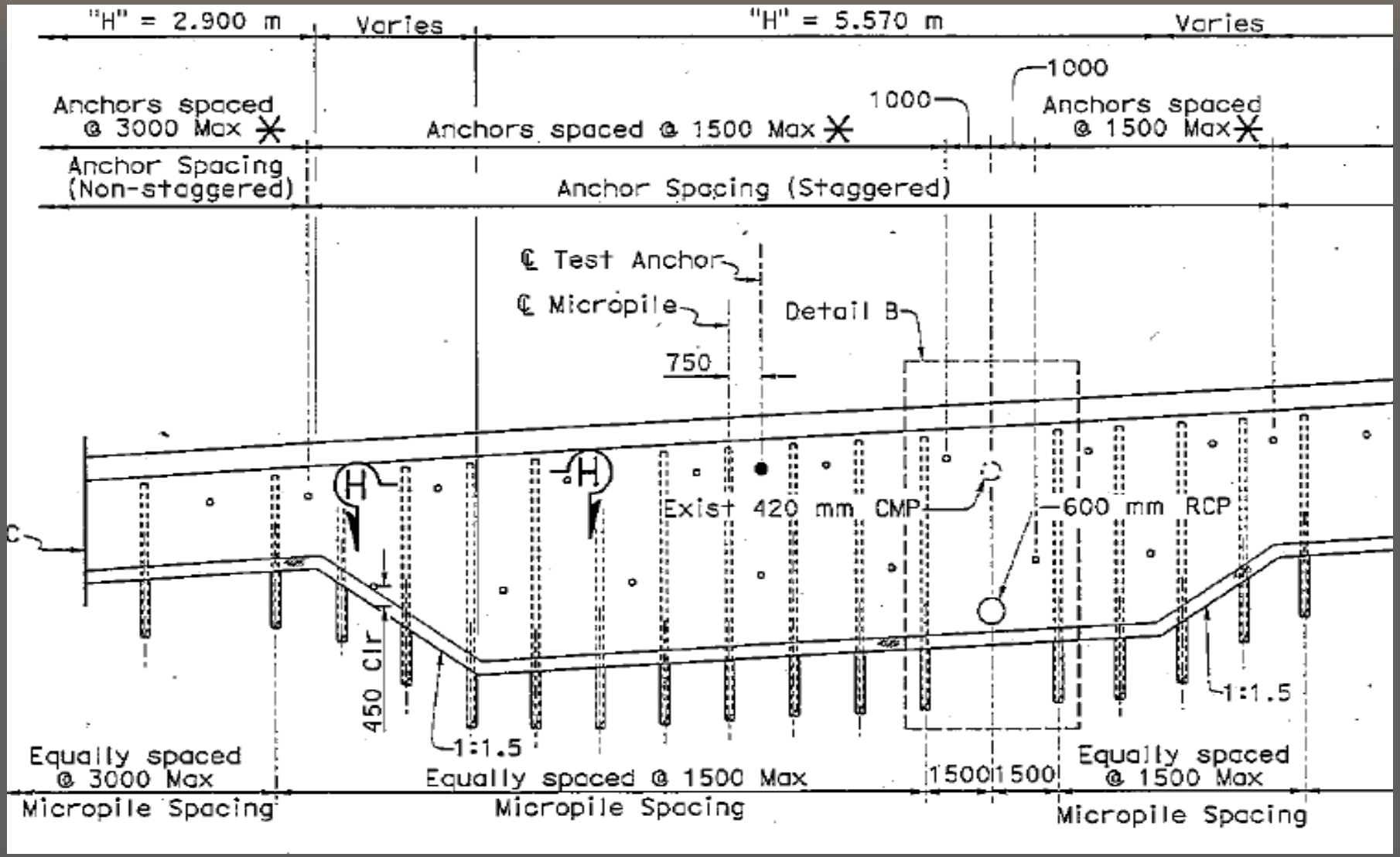
Permit Requirements

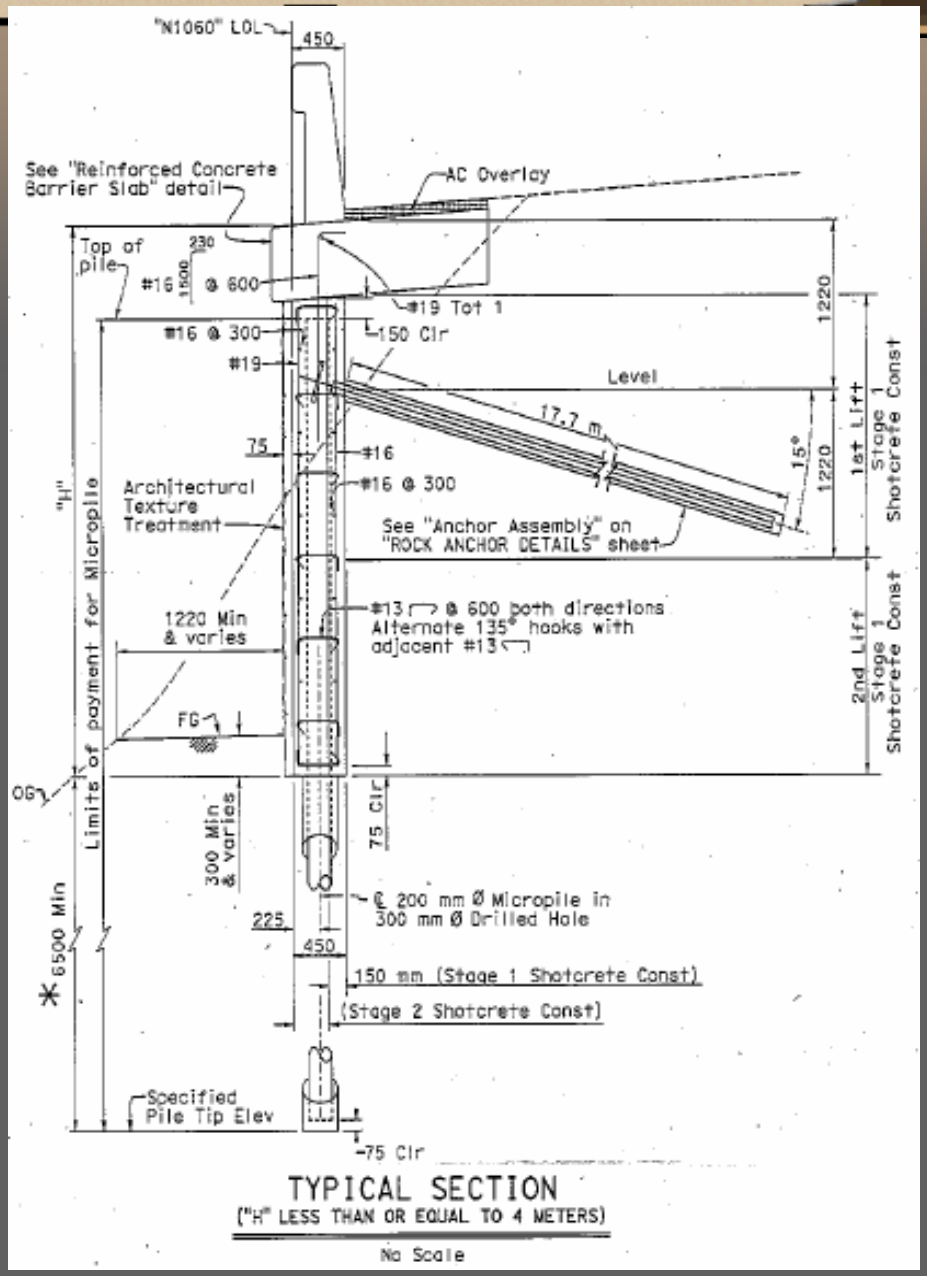
- US Forest Service
- Reg. Water Quality
- US Army Corps of Engineers
- Archeological Monitoring

Project Solutions

- Equipment innovation
- Partnering.
- Environmental constraint management

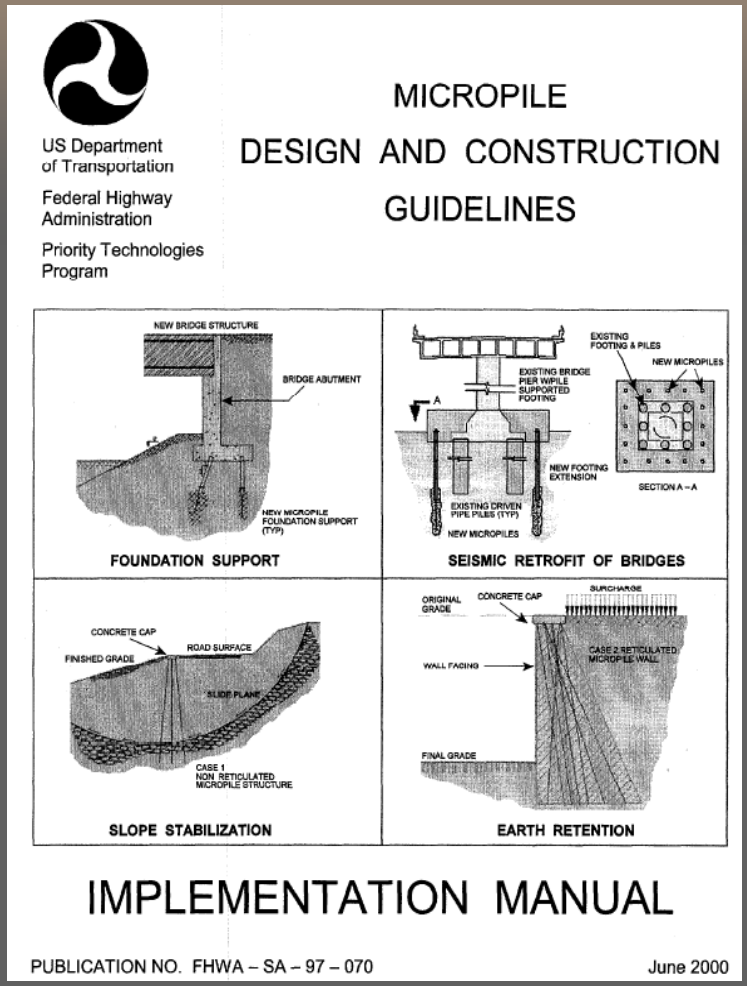
CALTRANS DESIGN ORTEGA HIGHWAY




"N1060" LOL
450
See "Reinforced Concrete Barrier Slab" detail
AC Overlay
Top of pile
230
1900
#16 @ 600
#19 Tot 1
1220
#16 @ 300
150 Clr
#19
Level
17.7 m
15°
1220
1st Lift Stage 1 Shotcrete Const
75
#16
#16 @ 300
"H"
Limits of payment for Micropile
Architectural Texture Treatment
See "Anchor Assembly" on "ROCK ANCHOR DETAILS" sheet
#13 @ 600 both directions Alternate 135° hooks with adjacent #13
1220 Min & varies
FG
2nd Lift Stage 1 Shotcrete Const
OG
300 Min & varies
75 Clr
* 6500 Min
225
450
@ 200 mm Ø Micropile in 300 mm Ø Drilled Hole
150 mm (Stage 1 Shotcrete Const)
(Stage 2 Shotcrete Const)
Specified Pile Tip Elev
75 Clr
TYPICAL SECTION
("H" LESS THAN OR EQUAL TO 4 METERS)
No Scale

MICROPILE RESOURCE

- FHWA Micropile Design and Construction Guidelines



Construction Sequence

- Change environmental permit.
- Change Order to change from viaduct to retaining wall.
- Shore culvert.
- Retrofit culvert
- Construct Retaining Walls
- Monitor culvert.

Culvert Retrofit

Culvert Retrofit

MICROPILES

- Definition and Description
- Construction Techniques & Type
- Contract Administration
- Testing

MICROPILES BASIC TYPES

- Displacement pile
  - Driven or vibrated into the ground
  - Displacing the soil laterally during installation
- Replacement pile
  - Placed in a drilled borehole
  - Replacing excavated ground

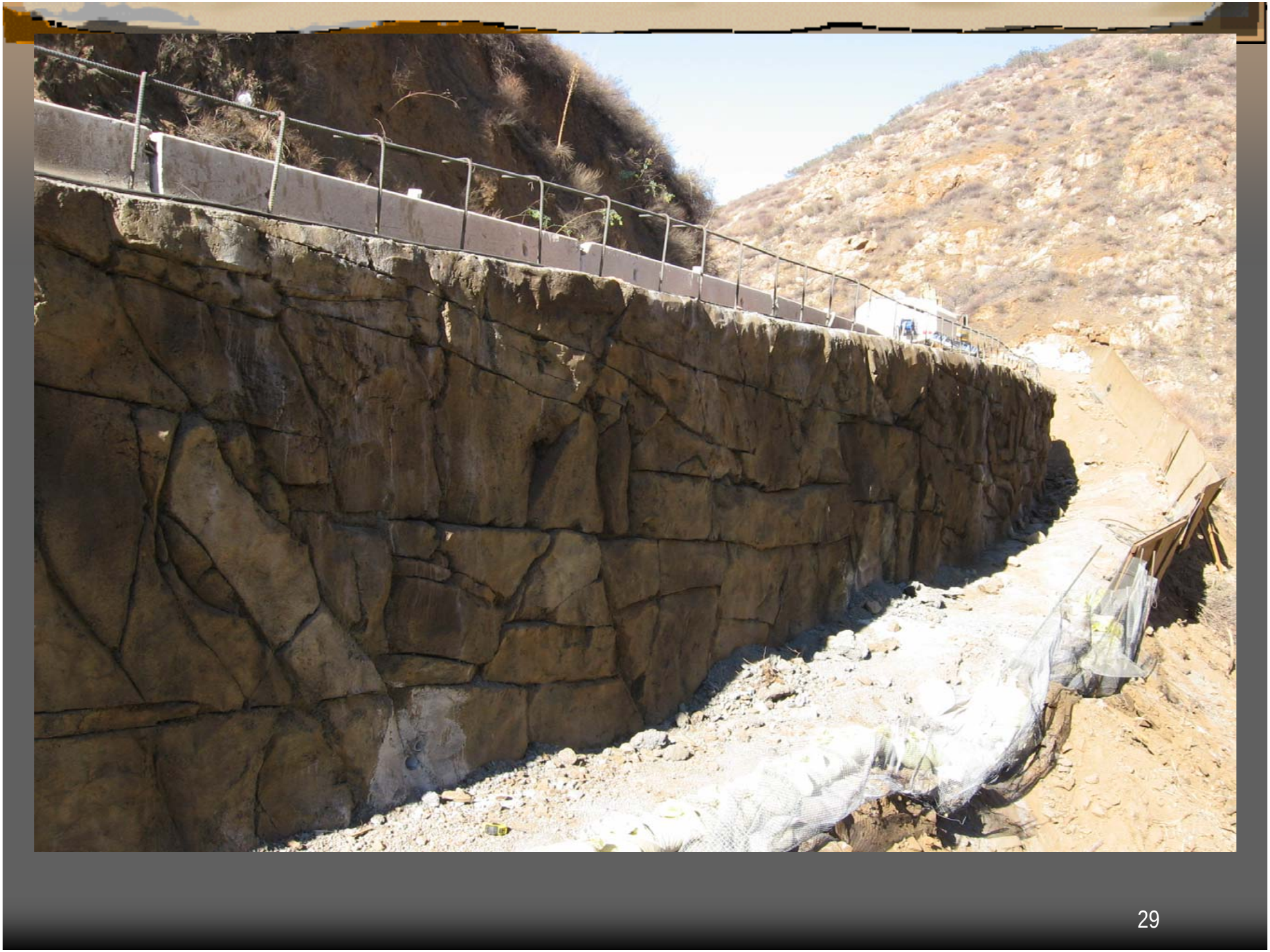
MICROPILES EQUIPMENT

MICROPILE DRILLING TECHNIQUES

MICROPILE DRILLING

WHY MICROPILES?

- Difficult Access
  - Low Headroom
  - Environmental Constraints
- Installed in all Soils Types
- Minimal Disturbance
  - Structures
  - Soil
  - Environment



Micropile Testing

- Proof Test
- Cooperative Venture (Contractor & FTB)

Performance Testing

- Verify Conceptual Design
- Test to Geotechnical Failure

Proof Testing

- QA Verification
- Service Load Testing
- 2 or 10%
- Random

Rock Anchor Walls

Drilling

Top View of drilling

Drilling

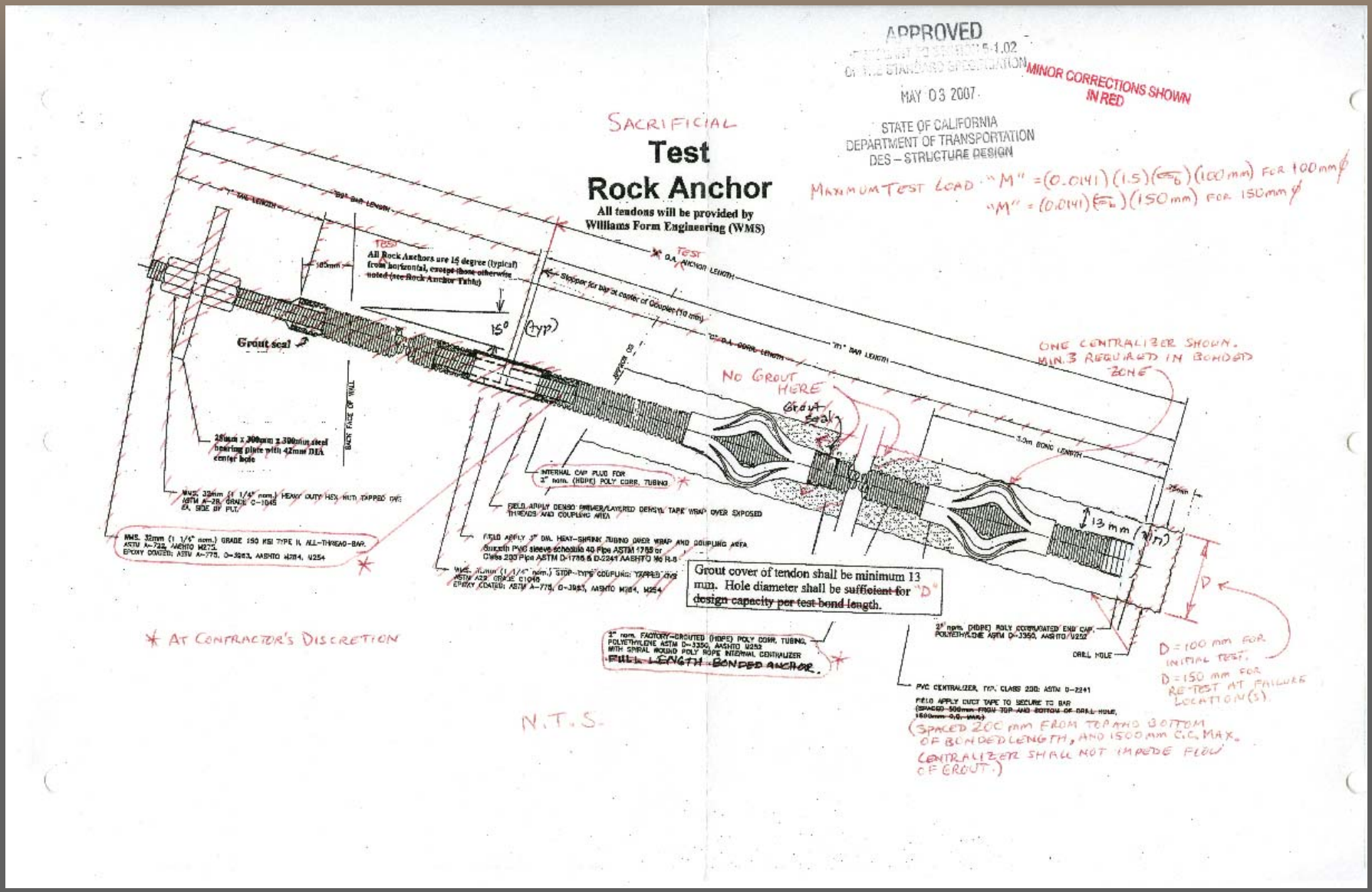
Rock Anchor Capacity

- Soil characteristics
- Density
- Anchor rod diameter and length
- Hole diameter
- # grout stages and grout pressure

Submittal Reviews

- Testing details:
- Test setup & loading frame Info.
- Test equipment calibration
- Bonded tieback dimensions
- Theoretical anchor elongation

Submittal


APPROVED
MAY 03 2007
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DES – STRUCTURE DESIGN
MINOR CORRECTIONS SHOWN IN RED
SACRIFICIAL
Test
Rock Anchor
All tendons will be provided by
Williams Form Engineering (WMS)
MAXIMUM TEST LOAD "M" = (0.0141)(1.5)(Fy)(100mm) FOR 100mm ϕ
"M" = (0.0141)(Fy)(150mm) FOR 150mm ϕ
All Rock Anchors are 15 degree (typical) from horizontal, except those otherwise noted (see Rock Anchor Table)
15° (typ)
Grout seal
Stopper for bar at center of coupler (10 mm)
"B" BAR LENGTH
ONE CENTRALIZER SHOWN. MIN. 3 REQUIRED IN BONDED ZONE
NO GROUT HERE
Grout Seal
13 mm
D
D = 100 mm FOR INITIAL TEST.
D = 150 mm FOR RE-TEST AT FAILURE LOCATION(S).
Grout cover of tendon shall be minimum 13 mm. Hole diameter shall be sufficient for "D" design capacity per test bond length.
* AT CONTRACTOR'S DISCRETION
FULL LENGTH BONDED ANCHOR.
N.T.S.
(SPACED 200 mm FROM TOP AND BOTTOM OF BONDED LENGTH, AND 1500 mm C.C. MAX. CENTRALIZER SHALL NOT IMPEDE FLOW OF GROUT.)

Material Inspection & Release

- Anchor Heads
- HS rod
- Bearing plates
- Inspection documents

Centralizers and Spacers

Rock Anchors

Rock Anchor vs Tieback Testing

- 2 to 5 % are Tested
- Verification Test - validates installation and geotech criteria
- Proof Test - validates product. nail capability

- 100% are tested
- Proof Test - validates product.
- Performance test

Types of Rock Anchor Testing

- Verification
- Proof Test
  - Cycle Loading
  - Load Carrying Capacity
  - Correct Unbonded Length
  - Rate of creep stabilizes within specified time

ROCK ANCHOR TESTING

ROCK ANCHOR TESTING

ROCK ANCHOR TESTING

- Test Loads:

  Loading as specified within the Special Provisions

  Test load, $M = \pi * D * L_b * \sigma_b * F.S.$ where:

  - σ_b = ultimate bond stress
    - provided within General Notes in Plans
  - D = drilled hole diameter for test nail
  - L_b = actual bonded length
  - F.S. = factor of safety for pullout = 1.5

ROCK ANCHOR TESTING

Test Load	Hold Time
AL (0.10T)	Until Stable
.20T	2 min.
.40T	2 min.
.60T	2 min.
.80T	2 min.
1.0 T (Creep Test)	60 min. (10 min. PT)
1.25 T	2 min.
1.50 T	10 min. (2 min. PT)
AL	Until Stable

SAFETY

- Be safe around drilling and stressing operations!

Environmental

- Water Quality

- Air Quality

Questions?