ROBERT L. NELSON & ASSOCIATES, INC.
CONSTRUCTION MATERIALS LABORATORY
1220 REMINGTON ROAD
SCHAUMBURG, ILLINOIS 60173

847/882-1146

Proposal No. 2767 Date Issued: October 28, 1998

CONFIDENTIAL PROPOSAL

Client: CETCO
Colloid Environmental Technologies Company
Drilling Products Group

Title of Project: Pull-Out Tests on Reinforcing Bars Treated with Shore Pac GCV Dry Synthetic Polymer Slurry

Description: Conduct pull-out test on steel reinforcing bars embedded in concrete under various conditioning requirements. Reinforcing bars shall be ASTM 615, #4 Grade 60. Test No. 2 shall be performed the same as Test No. 1 substituting 5/8 inch smooth bars for the #4 Grade 60 deformed rebar.

Introduction:

The purpose of this test is to examine the effect CETCO's product Shore Pac GCV has, if any, on the bond of concrete to the rebar used in the construction of drilled-shaft foundations. This test is requested by the State of California Department of Transportation (Caltrans) in order for the CETCO product Shore Pac GCV to be placed on the Caltrans list of approved products. In addition, any effects the Shore Pac Slurry has after contact with concrete will be examined.

A drilled-shaft foundation is constructed by excavating a cylindrical hole in the ground and filling the excavation with concrete, often reinforced with steel. When drilling in soils that tend to squeeze, cave or slough into the hole, a mud or polymer slurry is used to keep the hole open. The slurry maintains the stability of the excavation by forming a membrane, or filter cake on the walls of the excavation. The hydrostatic fluid pressure against the soil prevents caving. following excavation, the rebar cage is placed into the vertical shaft through the slurry and concrete is then pumped through a tremie pipe placed at the bottom of the excavation, displacing the lower-density slurry upward.

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The cage of reinforcing steel (rebar) consisting of logitudinal and spiral bars is completely assembled on-site prior to lifting, and then placed in the drilled pier excavation as a unit.

The excavation is full of a slurry created from Shore Pac GCV. Robert L. Nelson & Associates, Inc. will simulate the conditions of a drilled-shaft foundation in the laboratory. The slurry coats the steel rebar cage for a short period before being displaced by concrete from the bottom of the excavation. We will investigate whether the bond strength of the rebar and concrete is compromised by the synthetic slurry remaining on the surface of the steel rebar cage.

Laboratory Procedures: **Test No. 1**

1. Take nine Grade 60 re-bars and place each one in a 6" x 12" cylinder filled with the following solutions for 30 minutes:

    a. Tap water with a pH of 8-10.

    b. Shore Pac GCV slurry mixed at one pound per 500 gallons or a 45-50 sec/quart marsh funnel viscosity.

    c. Bentonite drilling fluid API spec 13 A 90 bbl yield 200 mesh bentonite. CETCO Premium Gel mixed at 40 pounds per 100 gallons.

2. Next a PVC tremie pipe is used to fill each separate cylinder with 3000 psi (3/8" topsize aggregate) concrete from the bottom to the top displacing the solution as the cylinders are completely filled with concrete.

3. Cast a set of cylinders on the concrete to test compressive strength.

4. Cure the test cylinders for 7 and 28 days respectively.

5. Perform pull-out tests on specimens at 28 days using tensile machine and spacer. Report results as follows:

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Report of Coated Bar Pull-Out Tests

Test No. 1
#4 Grade 60 ReBars

Age	Water Soaked, lbs	Shore Pac Soaked, lbs	Bentonite Soaked, lbs
28			
28			
28			
Average			

Test Procedures: **Test No. 2**

1. Repeat the above 5 steps in Test No. 1 substituting 5/8" smooth bars for the deformed #4 Grade 60 rebars. Report results as follows:

Report of Coated Bar Pull-Out Tests

Test No. 2
5/8" Smooth Bar

Age	Water Soaked, lbs	Shore Pac Soaked, lbs	Bentonite Soaked, lbs
28			
28			
28			
Average			

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February 11, 1999

CETCO
Colloid Environmental Technologies Company
1350 W. Shure Drive
Arlington Heights, IL 60004

Attn: Mr. John H. Berry, Hydrogeologist, P.G.
Regional Manager

REPORT OF TESTS

SUBJECT: **Pull-Out Tests on Reinforcing Bars Which Are Treated with CETCO's Shore Pac ™ GCV Dry Synthetic Polymer Drilling Slurry and Embedded in Concrete**

PROJECT: **Caltrans**

SCOPE:

This study is to examine the effect CETCO's Shore Pac GCV has on the bond of a hardened concrete matrix to reinforcing steel used in the construction of drilled-shaft (caisson) foundations.

A drilled-shaft foundation is constructed by excavating a cylindrical hole in the ground and filling the excavation with concrete, often reinforced with steel. When drilling in soils that tend to squeeze, cave or slough into the hole, a mud or polymer slurry is used to keep the hole open. The slurry maintains the stability of the excavation by forming a membrane, or filter cake on the walls of the excavation. The hydrostatic fluid pressure against the soil prevents caving. Following excavation, the rebar cage is placed into the vertical shaft through the slurry, and concrete is then pumped through a tremie pipe placed at the bottom of the excavation, displacing the lower-density slurry upward.

The cage of reinforcing steel (rebar) consisting of longitudinal and spiral bars is completely assembled on-site prior to lifting, and then placed in the drilled pier excavation as a unit.

The excavation is full of a slurry created from Shore Pac GCV. This study will simulate the conditions of a drilled-shaft foundation in the laboratory. The slurry coats the steel rebar cage for a short period before being displaced by concrete from the bottom of the excavation. We will investigate whether the bond strength of the rebar and concrete is compromised by the synthetic slurry remaining on the surface of the steel rebar cage.

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LABORATORY PROCEDURES:

1. Ten Grade 60 re-bars were placed individually in a 6" x 12" cylinder filled with the following solutions for 30 minutes:

    a. Tap water with a pH of 8-10.

    b. Shore Pac GCV slurry mixed at one pound per 500 gallons or a 45-50 sec/quart marsh funnel viscosity.

2. Next a PVC tremie pipe was used to fill each separate cylinder with 3000 psi (3/8" topsize aggregate) concrete from the bottom to the top displacing the solution as the cylinders were completely filled with concrete.

3. Six 6" x 12" concrete cylinders (ASTM C 39) were cast from the concrete mixture and tested at 28 days for compressive strength.

4. After 28 days of curing, twenty 6" x 12" cylinders embedded with the reinforcing bars were placed under the crosshead of a 60 K Universal Testing Machine. The rebars were centered through a hole in the crosshead and grips were applied to the bar and then pulled.

TEST RESULTS

Compressive Strength of Concrete Mixture at 28 Days

Cylinder Number	PSI
1	2965
2	3814
3	4022
4	3910
5	3946
6	4015

Bond Pull-Out Strength (Total Loads - Lbs)

Unit Number	Slurry Coated	Distilled Water Uncoated
1	17,950	19,500
2	18,100	19,450
3	19,000	19,500
4	18,500	18,600
5	19,200	19,100

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Conclusion

The results of the test indicate similar bond strength between the coated re-bar specimens and the distilled water specimens.

Respectfully submitted,

ROBERT L. NELSON & ASSOCIATES, INC.

Robert L. Nelson
President