

**POST-TENSIONING GROUT BLEED, DUCT
AND ANCHORAGE PROTECTION TEST**

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Submitted to:

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A. PROBLEM STATEMENT

Due to substantial problems with product quality, the Department is revising all specifications concerning post-tensioning corrosion protection. New products for grouting post-tensioning ducts have recently become available. These new products must be thoroughly tested before general application. This research project is designed to evaluate several of these new products to insure that they will perform as expected. Also, the testing conducted as a part of this research will help establish the limits of product applicability and facilitate completion of the work required to produce the new specifications. This research project will focus upon three parts of the post-tensioning system: cementitious grout; internal duct; pour-back material.

B. OBJECTIVES

1. Grout Testing:

The current specification for post-tensioning grout does not differentiate between horizontal and vertical grout applications. In order to broaden the specification to address both applications, a relationship needs to be developed to associate laboratory test (Schupack) and field simulated test (wick induced bleed). The laboratory test can then be used with information collected from the testing to quantify the difference between horizontal and vertical applications. If a correlation is established between the vertical or inclined tests and the pressure tests, then the pressure tests can be used in the future to test the bleed properties of new materials.

In addition, the technique used for the simulated field test needs verification. The single wick, triple wick and inclined wick will be tested to determine the most severe condition for grout bleed. The four approved grouts will be evaluated during the test.

2. Corrugated Duct Test:

Corrugated duct is currently available with three distinct styles of ribs. The first type of duct has ribs that are parallel and oriented perpendicular to the axis of the duct. The second type has spiral ribs. The third type has parallel ribs similar to the first, but with four additional longitudinal ribs that are parallel to the axis of the duct and equally spaced radially around the circumference. This test will examine the effect of the corrugations on the bleed properties of the grout. Three 50-ft long ducts will be grouted with the same prepackaged grout. After acquiring the required strength, the duct will be cut into segments and examined to determine if the corrugations have an adverse effect on the completeness of grouting.

3. Epoxy Pour-Back Test:

A full scale mock-up of a combined multiple anchorage pour-back will be constructed and subjected to temperature variations. The test will determine if shrinkage and differential volume change between the materials causes cracking of the pour-back.

C. TEST 1 - WICK INDUCED BLEED TEST

Using a colloidal mixer (provided by DSI), mix each grout to a consistent flow of 20 sec. using the standard flow cone or 9 sec. using the modified flow cone. Perform both Schupack and wick induced bleed test to establish the percent bleed. Schupack test will be performed using pressures of 10, 20, 40, 80 and 120 psi. The six vertical bleed test set-up for each grout type is shown on the attached sketches and are listed below:

- Test 1: 10 ft vertical smooth clear duct with a single 1/2"Ø strand (1-1/2"Ø strand).
- Test 2: 15 ft vertical smooth clear duct with a single 1/2"Ø strand (1-1/2"Ø strand).
- Test 3: 20 ft vertical smooth clear duct with a single 1/2"Ø strand (1-1/2"Ø strand).
- Test 4: 20 ft vertical smooth clear duct with three 1/2"Ø strands (3-1/2"Ø strands).
- Test 5: 25 ft vertical smooth clear duct with a single 1/2"Ø strand (1-1/2"Ø strand).
- Test 6: 25 ft vertical smooth clear duct with three 1/2"Ø strands (3-1/2"Ø strands).

The four grouts to be included in the test are as follows:

- Master Builders - Masterflow GS 1205 grout.
- Sika - Sika Cable Grout.
- Five Star - Five Star Special Grout 400.
- Euclid - Euclid Euco Cable Grout PTX.

In addition, one battery of inclined wick test will be included in the test set-up in order to determine the differences between the inclined and vertical wick tests. The attached sketches describe the test set-up.

D. TEST 2 – CORRUGATED DUCT TEST

Test three different types of grouted duct to determine if the duct type influences the location, number, and type of void when present. Utilize the Masterflow GS 1205 grout for this test.

The test set-ups are as follows:

- Test 1: 4"Ø x 50 ft long corrugated polypropylene duct with standard ribbed corrugations.
- Test 2: 4"Ø x 50 ft long corrugated polypropylene duct with standard corrugations and longitudinal flow channels between corrugations.
- Test 3: 4"Ø x 50 ft long corrugated polyethylene duct with spiral corrugation ribs.

Mount duct for each test on a slight grade of 1/8" per foot. After duct is mounted, run water through each duct to fill corrugations. Grout duct with an approved grout and allow to cure for 24 hours. After a 24 hour period, saw at corrugation at spacings of 1 foot on center to determine if the duct type influences the ability to fill the corrugations.

Sketches showing the test set-up are included.

E. TEST 3 – EPOXY GROUT POUR-BACK TEST

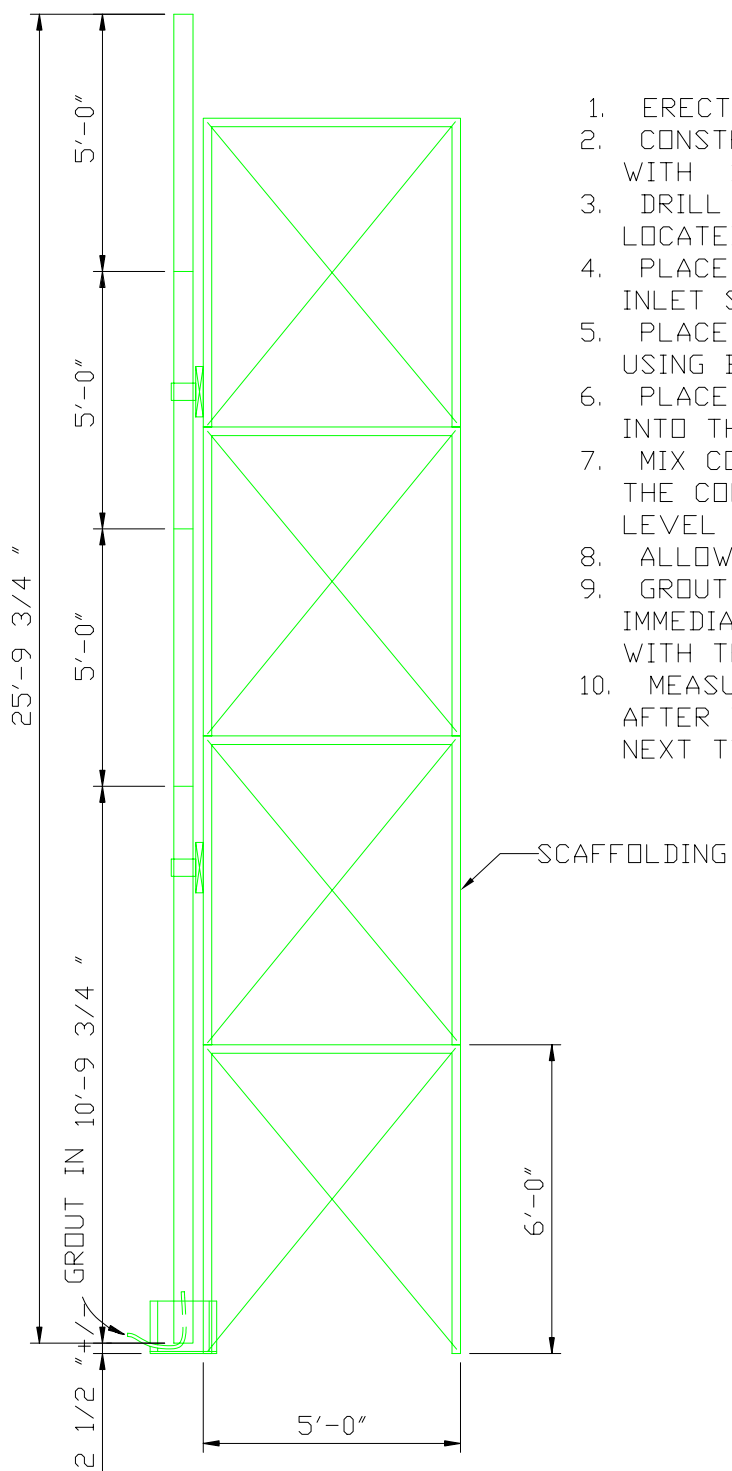
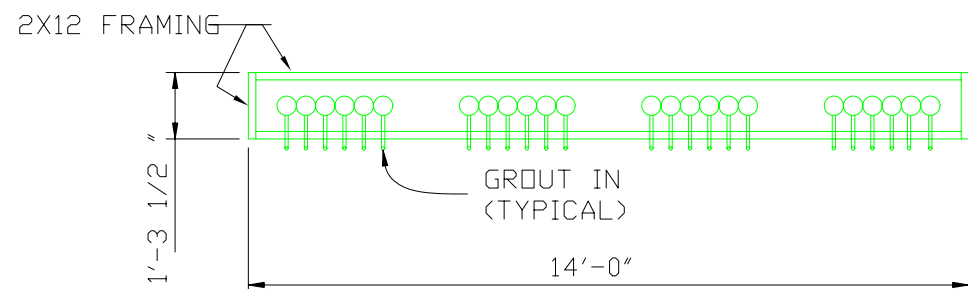
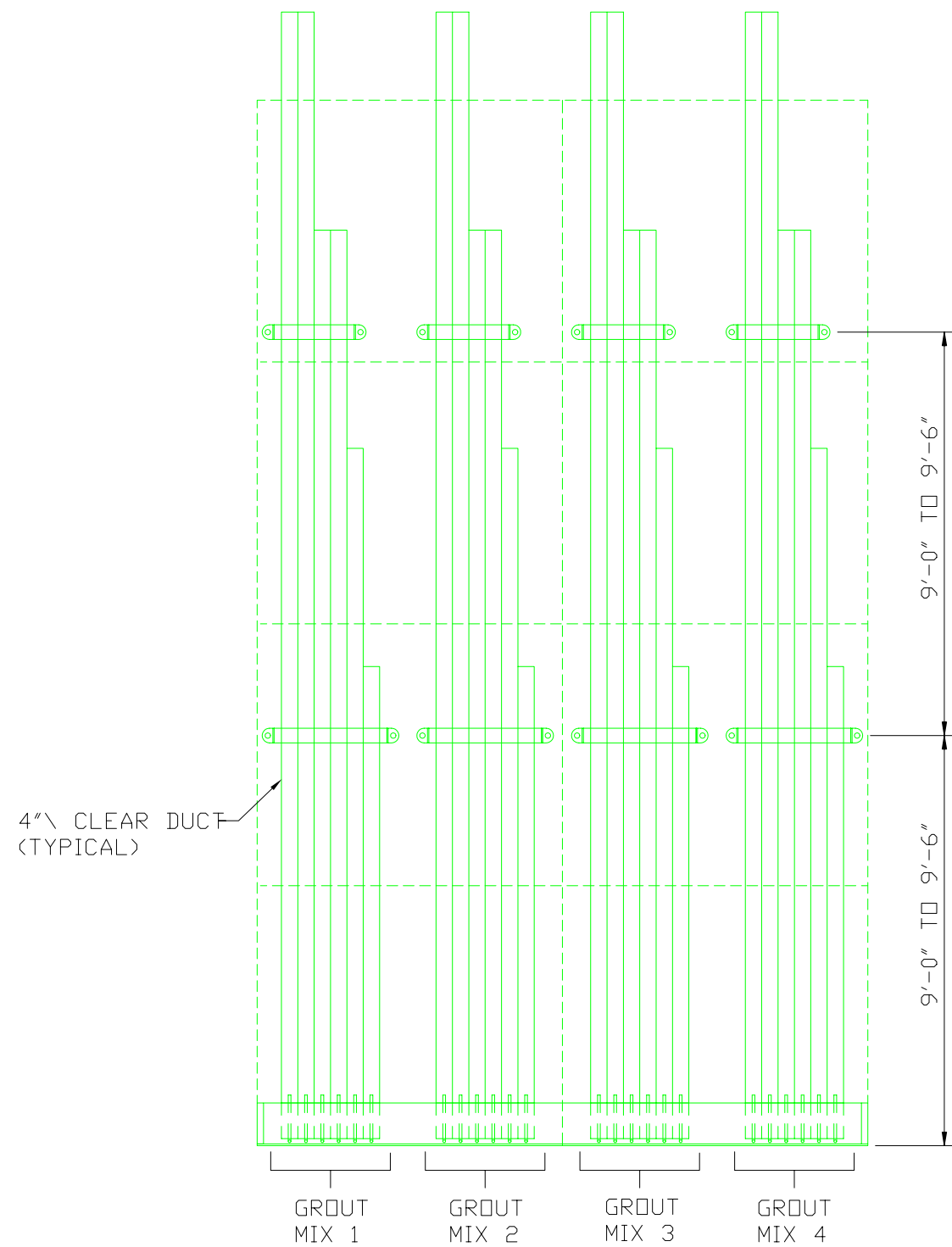
Evaluate the effects of shrinkage and thermal stresses on high bond, low shrinkage epoxy pour-backs to be used in expansion joint segments. Utilize Masterflow 648 CP + Epoxy Grout by Master Builders for the epoxy material.

Test 1: Construct a pour-back (6'-4" x 2'-0" x 5 3/4") using high bond, low shrinkage epoxy cast over 4 grout caps with 1 1/2" cover for the caps. Cast epoxy pour back into a 7'-0" x 2'-8" x 9 3/4" concrete tub with 4" wall thickness. Record any evidence shrinkage cracks or bond breakage for 28 days after epoxy pour-back has cured. After curing, expose to 5 cycles of thermal expansion/contraction for thermal compatibility.

Sketches showing the test set-up are attached.

General Information

Test Location:	Structures Laboratory Tallahassee
Principal Investigator:	Professor Trey Hamilton
Test Sponsors:	Sessions, Van Hook, Bergin & Ansley
Cost:	\$25,000
Test Set-Up Construction:	To be performed by personnel at the Structures Laboratory
Test Planning:	Van Hook / Sessions
Completion of Test:	Before June 1, 2002
Grouting: (subcontractor)	Grout mixing and injection will be provided by DSI



1. ERECT SCAFFOLDING
2. CONSTRUCT 1'-3 1/2 " X 14'-0" 2X12 BOX WITH 1/4 " OR 1/2 " PLYWOOD ATTACHED TO BOTTOM
3. DRILL 24- 3/4 " DIA HOLES FOR GROUT INLETS. LOCATED AT THE BOTTOM OF THE 2X FRAMING.
4. PLACE GROUT INLET THROUGH HOLE. THE GROUT INLET SHOULD EXTEND 6" ABOVE THE FRAMING.
5. PLACE 4" CLEAR DUCT AND ATTACH TO SCAFFOLDING USING BAND CLAMPS AND SCREWS. DUCT MAY REST ON SMALL BLOCKS.
6. PLACE REQUIRED AMOUNT OF PRESTRESSING WIRE INTO THE CENTER OF THE DUCT.
7. MIX CONCRETE AND POUR INTO FORMWORK ENSURING THAT THE CONCRETE DOES NOT POUR INTO THE GROUT INLET. LEVEL THE CONCRETE WITH THE TOP OF THE FORMWORK.
8. ALLOW THE CONCRETE TO CURE BEFORE GROUTING.
9. GROUT DUCT TO THE FULL HEIGHT OF THE DUCT. IMMEDIATELY AFTER GROUTING, CORK THE TOP OF THE DUCT WITH THE PT STRAND CENTERED IN THE CORK
10. MEASURE BLEED WATER EVERY 15 MINUTES FOR THE FIRST HOUR. AFTER THE FIRST HOUR, MEASURE BLEED EVERY HOUR FOR THE NEXT TWO HOURS.

Wick Induced Bleed Test

4" \ DUCT WITH SPIRAL CORRUGATIONS

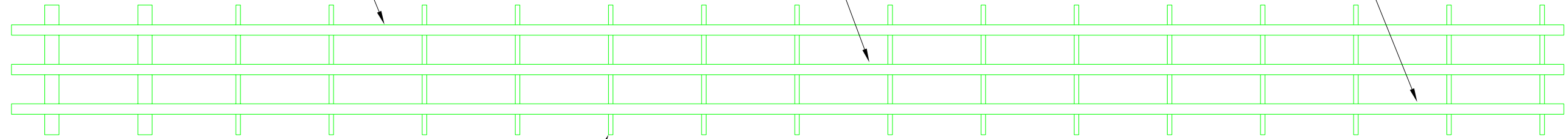
4" \ DUCT W/ STANDARD CORRUGATIONS AND LONGITUDINAL FLOW CHANNELS

4" \ DUCT W/ STANDARD CORRUGATIONS

TEST 3

TEST 2

TEST 1

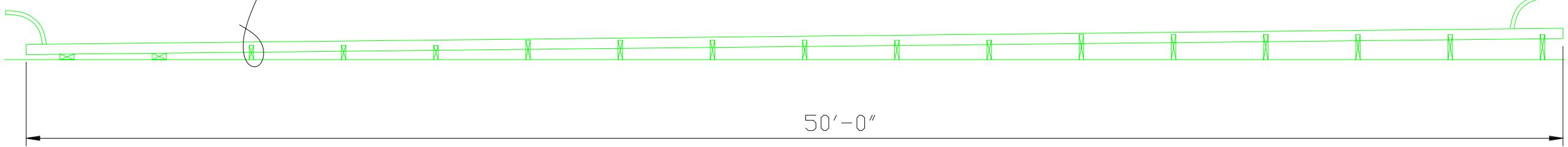


WOOD BLOCKING RESTRAIN DUCT TO BLOCKING WITH CLAMPS

PLAN VIEW

GROUT IN

GROUT OUT

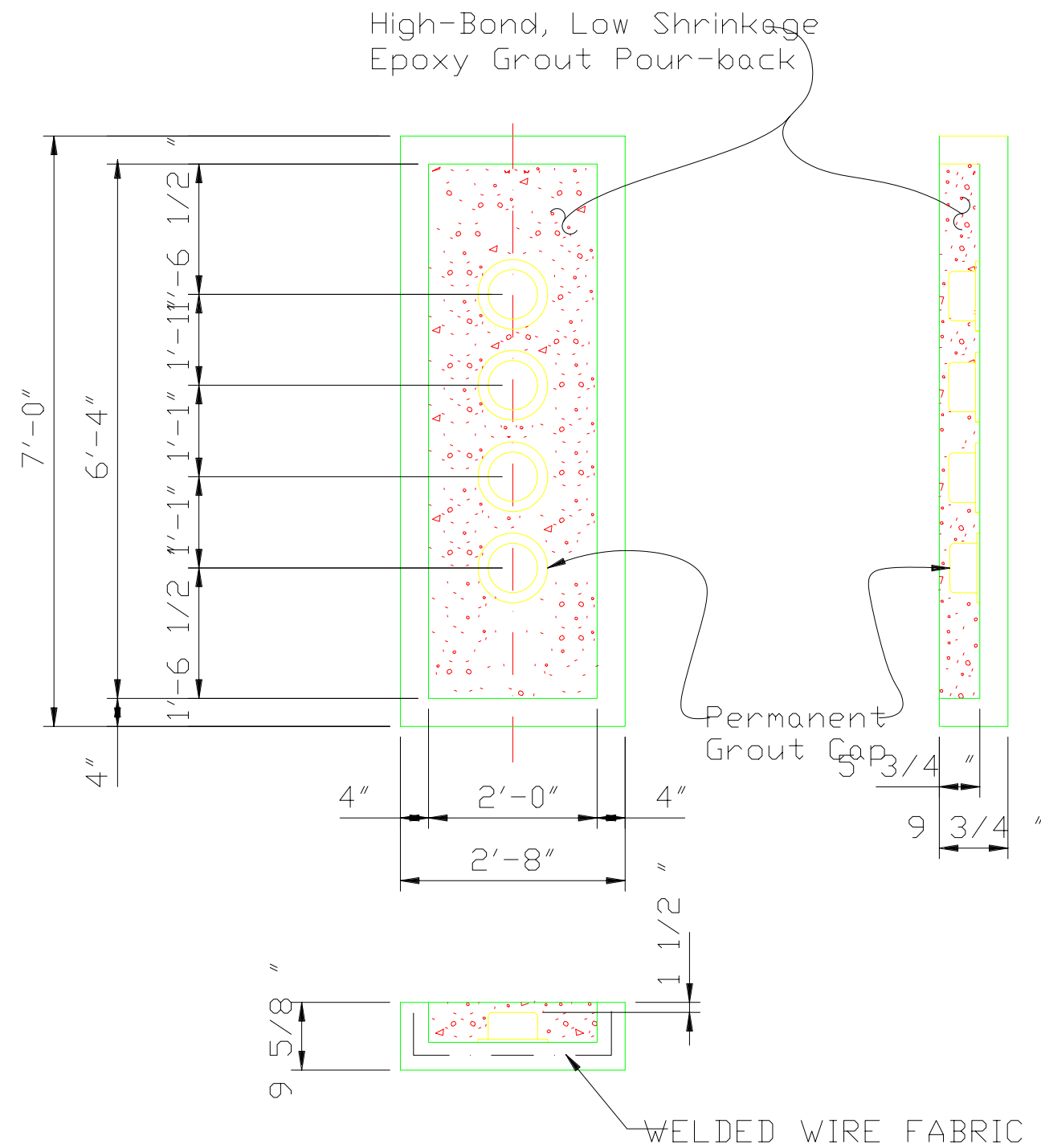


50'-0"

ELEVATION

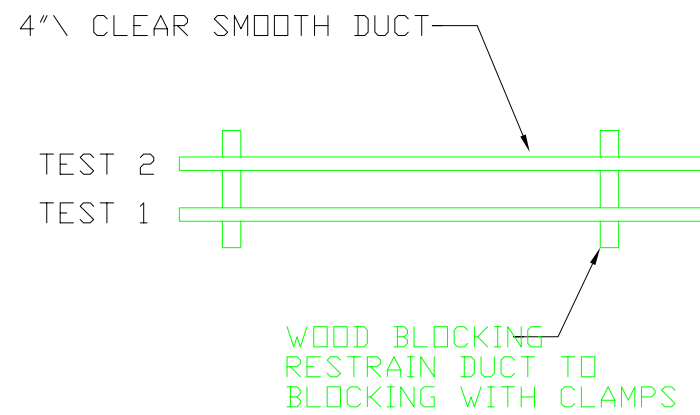
1. PLACE WOOD BLOCKING AT 3'-0" O.C.
2. PLACE 50'-0" LONG DUCTS ON BLOCKING AND ATTACH WITH CLAMPS.
3. ATTACH GROUT INLET ON THE LOW SIDE AND GROUT OUTLET ON THE HIGH SIDE.
4. PLACE CAPS AT THE END OF THE 4" \ DUCTS. ENSURE THAT CAPS ARE SEALED TIGHTLY TO DUCTS.
5. PERFORM GROUTING OPERATION AS PER SPECIFICATIONS.
6. ALLOW 24 HOURS TO CURE.
7. ONCE CURED, CUT GROUTED DUCTS AT 1'-0" O.C. ALONG THE CORRUGATIONS AND INSPECT FOR VOIDS.

HORIZONTAL CORRUGATED DUCT TEST

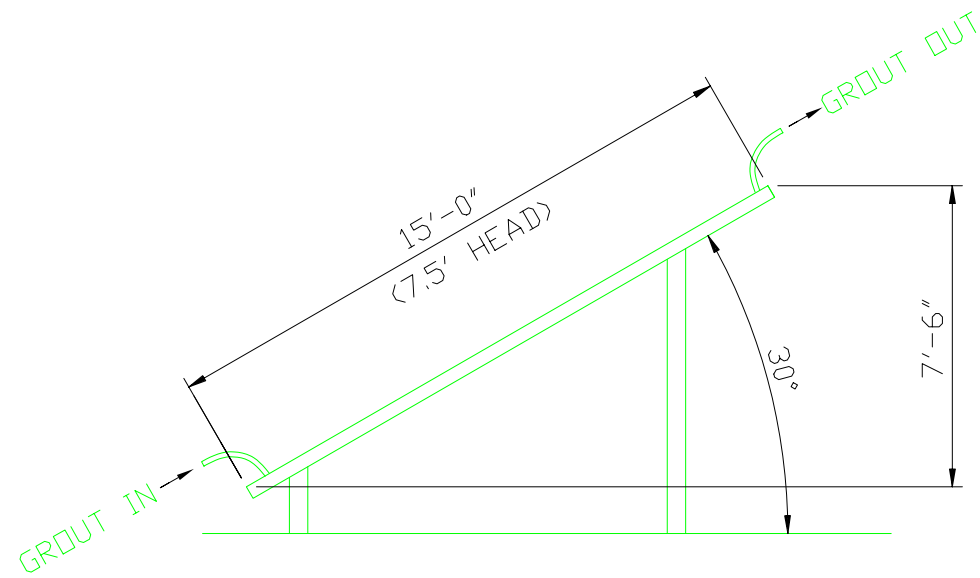


1. CAST 7'-0" X 2'-8" X 9 5/8 " TUB WITH 4" BOTTOM SLAB AND WALL THICKNESSES AND ALLOW TO CURE.
2. MOUNT VSL PERMANANT GROUT CAPS TO THE BOTTOM SLAB.
3. MAKE POUR-BACK POUR FROM A HIGH-BOND, LOW SHRINKAGE EPOXY GROUT.
4. AFTER POUR-BACK HAS CURED, RECORD ANY SHRINKAGE CRACKS (ESPECIALLY AROUND PERMANENT GROUT CAP)

TESTING FOR SHRINKAGE CRACKS IN HIGH BOND, LOW SHRINKAGE EPOXY POUR-BACKS FOR EXPANSION JOINT SEGMENTS

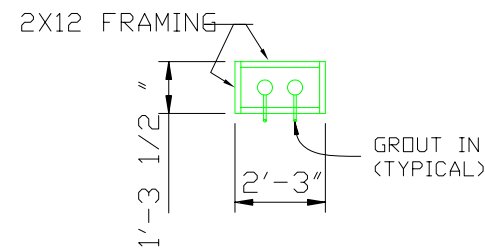


PLAN VIEW

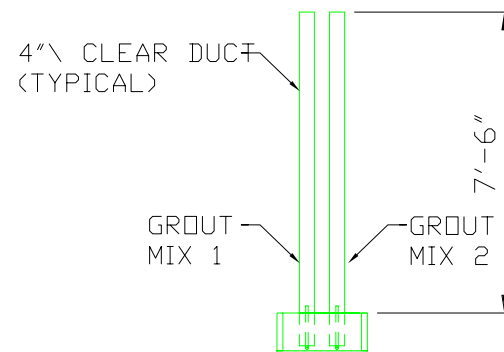


ELEVATION

INCLINED GROUT DUCT TEST



PLAN VIEW



ELEVATION

Wick Induced Bleed Test

SET UP AND PERFORM THE FOLLOWING TWO TESTS TO DEVELOP A CORRELATION BETWEEN THE INCLINED AND THE WICK INDUCED BLEED TEST.

PROCEDURE: INCLINED GROUT DUCT TEST

1. PLACE WOOD BLOCKING OR OTHER UNDER DUCT.
2. PLACE 2 CLEAR DUCTS (BOTH 15'-0" IN LENGTH) ON BLOCKING AND ATTACH WITH CLAMPS. PLACE ONE 12X0.5 TENDON IN EACH DUCT AND CENTER IN DUCT.
3. ATTACH GROUT INLET ON THE LOW SIDE AND GROUT OUTLET ON THE HIGH SIDE.
4. PLACE CAPS AT THE END OF THE 4" DUCTS. ENSURE THAT CAPS ARE SEALED TIGHTLY TO DUCTS.
5. PERFORM GROUTING OPERATION. GROUT ONE DUCT WITH STANDARD GROUT (CEMENT & WATER @ WC RATIO OF 0.45) AND THE OTHER WITH MB MORTAR-FIRM GS120S).

WICK INDUCED BLEED TEST (12K6 TENDON)

1. CONSTRUCT 1'-3 1/2 " X 2'-3" 2X12 BOX WITH 1/4 " OR 1/2 " PLYWOOD ATTACHED TO BOTTOM
2. DRILL 2- 3/4 " DIA HOLES FOR GROUT INLETS. LOCATED AT THE BOTTOM OF THE 2X FRAMING.
3. PLACE GROUT INLET THROUGH HOLE. THE GROUT INLET SHOULD EXTEND 6" ABOVE THE FRAMING.
4. PLACE 4" CLEAR DUCT AND ATTACH TO SCAFFOLDING (AS IN PREVIOUS TEST) USING BAND CLAMPS AND SCREWS. DUCT MAY REST ON SMALL BLOCKS.
5. PLACE 1-12X0.5 TENDON IN EACH DUCT (LOCATED IN THE CENTER OF THE DUCT).
6. MIX CONCRETE AND POUR INTO FORMWORK ENSURING THAT THE CONCRETE DOES NOT POUR INTO THE GROUT INLET. LEVEL THE CONCRETE WITH THE TOP OF THE FORMWORK.
7. ALLOW THE CONCRETE TO CURE BEFORE GROUTING.
8. GROUT DUCT TO THE FULL HEIGHT OF THE DUCT. GROUT ONE DUCT WITH STD. MIX AND THE OTHER WITH MB GROUT. IMMEDIATELY AFTER GROUTING, CORK THE TOP OF THE DUCT WITH THE PT STRAND CENTERED IN THE CORK
9. AFTER GROUTING, RECORD BLEED AS DEFINED IN THE SPECIFICATION SECTION 938.