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Material Test Report

on

Better Mud

for

**Conformance with Requirements of ASTM C494-19
Type S, Specific Performance
Admixtures for Concrete**

NTL Project 21-1286

**Better Mud
PO Box 2228
Kyle, Texas 78640**

October 7, 2022

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1. OBJECTIVE

To ascertain the conformance of Better Mud chemical admixture for concrete as specified in ASTM C494-19, “Standard Specifications for Chemical Admixtures for Concrete”.

2. SCOPE

The properties of concrete containing **Better Mud** are compared to those of a reference concrete prepared and tested as directed in ASTM C494-19, “Standard Specification for Chemical Admixtures in Concrete” and other supporting documents. Reported below are the concrete test results along with the chemical and physical properties of the cement and aggregates used in the concrete mixes. For this study, Better Mud was added at a dosage rate of **14 fl.oz per cubic yard of concrete**.

3. APPLICABLE STANDARDS

ASTM C494-19	Specification for Chemical Admixtures for Concrete
ASTM C33	Specification for Concrete Aggregates
ASTM C39	Test for Compressive Strength of Cylindrical Concrete Specimens
ASTM C78	Test for Flexural Strength of Concrete
ASTM C138	Test for Unit Weight, Yield and Air Content of Concrete
ASTM C143	Test for Slump of Hydraulic Cement Concrete
ASTM C150	Specification for Portland Cement
ASTM C157	Test for Length Change of Hardened Hydraulic Cement Concrete
ASTM C192	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Test for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C403	Test for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C666	Test for Resistance of Concrete to Rapid Freezing and Thawing

4. MATERIALS

- a. Better Mud
 - i. Residue by Oven Drying 27.7%
 - ii. Relative Density 1.216
- b. Cement: Type I, Lehigh Cement See Appendix A-1 for details
- c. Fine Aggregate: Natural Sand (Midwest) See Appendix A-2 for details
- d. Coarse Aggregate: Crushed Limestone See Appendix A-2 for details
- e. Neutralized Vinsol Resin Formulated per ASTM C494

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5. TEST DATA

Mix Dates: Mix 1: October 2021 Mix 2: October 2021 Mix 3: October 2021

Reference

	<u>MIX 1</u>	<u>MIX 2</u>	<u>MIX 3</u>	<u>AVG</u>
<u>Mix Data</u>				
Cement Factor, lb/yd ³	522	519	518	520
Fine Aggregate, lb/yd ³	1350	1350	1350	1350
Coarse Aggregate, lb/yd ³	1750	1750	1750	1750
Water, lb/yd ³	293	293	293	293
Water/Cement Ratio	0.561	0.564	0.566	0.564

Better Mud

	<u>MIX 1</u>	<u>MIX 2</u>	<u>MIX 3</u>	<u>AVG</u>
<u>Mix Data</u>				
Cement Factor, lb/yd ³	520	519	518	519
Fine Aggregate, lb/yd ³	1350	1350	1350	1350
Coarse Aggregate, lb/yd ³	1750	1750	1750	1750
Better Mud, fl.oz/yd ³	14.0	14.0	14.0	14.0
Water, lb/yd ³	293	293	293	293
Water/Cement Ratio	0.562	0.565	0.566	0.564

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6. TEST RESULTS

	Reference			
	<u>MIX 1</u>	<u>MIX 2</u>	<u>MIX 3</u>	<u>AVG</u>
<u>Freshly-Mixed Properties</u>				
ASTM C143 - Slump, in	3.00	3.75	4.00	3.50
ASTM C231 - Air Content, %	1.9	1.8	2.0	1.9
ASTM C138 - Unit Weight, lb/ft ³	146.2	145.4	145.0	145.5
ASTM C403 - Time of Set, hr:min				
Initial (500 psi)	4:30	5:05	4:40	4:45
Final (4000 psi)	5:55	7:15	6:15	6:30
<u>Hardened Properties</u>				
ASTM C39 - Compressive Strength, PSI (4 x 8-in cylindrical specimens)				
3 days	4,070	3,750	3,880	3,900
7 days	5,020	4,390	4,860	4,760
28 days	5,920	5,290	5,550	5,590
6 months	6,470	5,550	5,910	5,980
1 year	6,790	6,270	6,460	6,510
ASTM C78 - Flexural Strength, PSI (6 x 6 x 22-in specimens)				
3 days	600	620	650	625
7 days	710	670	740	705
28 days	800	760	780	780
ASTM C157 - Length Change, % (3 x 3 x 11.25-in specimens)				
14 days	-0.032	-0.034	-0.035	-0.034
ASTM C666 – Freeze-Thaw (Procedure A) (3 x 3 x 11.25-in specimens)				
Durability Factor @ 300 cycles	97.2	97.1	97.8	97.4

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6. TEST RESULTS (continued)

	Better Mud			
	<u>MIX 1</u>	<u>MIX 2</u>	<u>MIX 3</u>	<u>AVG</u>
<u>Freshly-Mixed Properties</u>				
ASTM C143 - Slump, in.	3.50	4.00	4.00	3.75
ASTM C231 - Air Content, %	2.1	1.6	2.1	1.9
ASTM C138 - Unit Weight, lb./ft ³	145.6	145.4	145.0	145.3
ASTM C403 - Time of Set, hr:min				
Initial (500 psi)	4:40	5:00	5:05	4:55
Final (4000 psi)	6:05	7:15	6:30	6:35
<u>Hardened Properties</u>				
ASTM C39 - Compressive Strength, PSI (4 x 8-in cylindrical specimens)				
3 days	3,920	3,700	3,650	3,760
7 days	4,570	4,470	4,770	4,660
28 days	5,970	5,490	5,960	5,810
6 months	6,140	5,900	6,390	6,140
1 year	6,430	6,610	6,890	6,640
ASTM C78 - Flexural Strength, PSI (6 x 6 x 22-in specimens)				
3 days	680	630	620	645
7 days	710	700	690	700
28 days	810	790	730	775
ASTM C157 - Length Change, % (3 x 3 x 11.25-in specimens)				
14 days	-0.029	-0.032	-0.033	-0.031
ASTM C666 – Freeze-Thaw (Procedure A) (3 x 3 x 11.25-in specimens)				
Durability Factor @ 300 cycles	96.7	97.5	96.2	96.8

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7. SUMMARY AND COMPARISON WITH REQUIREMENTS

<u>Parameters</u>	<u>ASTM C494, Type S</u>	<u>Better Mud</u>
ASTM C403 - Time of Setting, hr:min		
Initial	Between 1:00 earlier and 1:30 later	0:10 later
Final	Between 1:00 earlier and 1:30 later	0:05 later
ASTM C39 - Compressive Strength, PSI		
Minimum % of Control		
3 days	90	96
7 days	90	97
28 days	90	104
6 months	90	103
1 year	90	102
ASTM C78 - Flexural Strength, PSI		
Minimum % of Control		
3 days	90	103
7 days	90	99
28 days	90	99
ASTM C157 - Length Change, %		
Maximum % of Control	135	91
or		
Maximum Increase Over Control	0.010	0.000
ASTM C666 – Freeze-Thaw Resistance, DF		
Minimum Durability Factor		
300 Cycles	80	96.8

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8. CONCLUSION

The test results listed above from the Better Mud concrete admixture have met the requirements for a Type S, Special Performance Chemical admixture as specified in ASTM C494-19, "Standard Specifications for Chemical Admixtures in Concrete".

Respectfully submitted,

NELSON TESTING LABORATORIES



Mark R. Nelson
President

Notes: The results listed within this report relate only to the materials submitted for testing. This report shall not be reproduced, except in full, without written approval of this laboratory. The test materials not consumed in this testing will be discarded 14 days from the date of this report unless we receive written notification requesting otherwise. When applicable, Nelson Testing Laboratories uses the simple acceptance/simple rejection decision rule to determine in-tolerance and out-of-tolerance conditions and no measurement uncertainty was applied in that determination.

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9. APPENDIX – Cement

Cement

Lehigh Cement – Logansport, IN (Type I)

Physical Characteristics

Fineness, ASTM C204, m ² /kg.	415
Autoclave Expansion, ASTM C151, %	0.27
Setting Time by Vicat Test, ASTM C191, min. Initial Set	111
Air Content of Mortar, ASTM C185, %	8.0
Compressive Strength, ASTM C109, psi 28 days	5980

Chemical Composition, ASTM C144, % by weight

Silicon Dioxide, SiO ₂	19.4
Aluminum Oxide, Al ₂ O ₃	5.3
Ferric Oxide, Fe ₂ O ₃	1.9
Calcium Oxide, CaO	62.3
Sulfur Trioxide, SO ₃	2.8
Magnesium Oxide, MgO	3.2
Ignition Loss	2.9
Tricalcium Silicate, C ₃ S	52.5
Tricalcium Aluminate, C ₃ A	10.6
CO ₂	1.4

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10. APPENDIX – Aggregates

Fine Aggregate:

Natural Sand (Midwest)

Physical Characteristics, ASTM C33 and ASTM C494

<u>Gradation</u>	<u>% Passing</u>
Sieve Size No. 4	100.0
Sieve Size No. 8	88.4
Sieve Size No. 16	73.7
Sieve Size No. 30	59.9
Sieve Size No. 50	20.0
Sieve Size No. 100	2.7
Specific Gravity	2.67
Absorption, %	0.8

Coarse Aggregate:

Crushed Limestone
(Vulcan-McCook, Illinois)

Physical Characteristics, ASTM C33 and ASTM C494

<u>Gradation</u>	<u>% Passing</u>
Sieve Size 1 ½-in	100.0
Sieve Size 1-in	100.0
Sieve Size ½-in	59.1
Sieve Size No. 4	4.2
Sieve Size No. 8	2.6
Specific Gravity	2.66
Absorption, %	0.7

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11. APPENDIX – FT-IR Scan

