NELSON TESTING LABORATORIES

EXPERIENCED | INNOVATIVE | AUTHENTIC

# EUCLID CHEMICAL COMPANY

# FLOORING STUDY

**Euclid Chemical Company**
**19218 Redwood Road**
**Cleveland, Ohio 44110**

**February 11, 2015 (*updated March 1, 2016)**

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Euclid Chemical Company
19218 Redwood Road
Cleveland, Ohio 44110

REPORT OF TESTS

SUBJECT: **Physical Analysis of Floor Topping Materials**

PROJECT: **Euclid Chemical Flooring Study**

MATERIALS: Delivered to NTL in September 2014

NTL PROJECT #: 14-1247

PAGE: 1 of 20

TEST METHODS: ASTM C 39, “Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens”

ASTM C 78, “Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)”

ASTM C 109, “Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)”

ASTM C 138, “Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete”

ASTM C 143, “Standard Test Method for Slump of Hydraulic-Cement Concrete”

ASTM C 157, “Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete”

ASTM C 403, “Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance”

ASTM C 469, “Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression”

ASTM C 496, “Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens”

ASTM C 535, “Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine”

REPORT OF TESTS (continued)

ASTM C 642, “Standard Test Method for Density, Absorption, and Voids in Hardened Concrete”

ASTM C 672, “Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals”

ASTM C 944, “Standard Test Method for Abrasion Resistance of Concrete or Mortar Surfaces by the Rotating-Cutter Method”

ASTM C 1202, “Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration”

ACI 544.2, “Impact Resistance”

Chaplin Abrasion Test

LA Abrasion Test

TEST DATA

| | |
|---|---|
| Test Conditions: | 73 deg. F. |
| Curing: | Wet Cure |
| Mix Dates: | October 2014 |

Mix Information:

EucoFloor 404 (Water Addition Rate – 8.0%)
Control (Concrete)

February 11, 2015 (*updated March 1, 2016)
Euclid Chemical – Flooring Study - Summary
NTL Project #14-1247


TEST RESULTS (SUMMARY)

| | EucoFloor 404 | Control |
|---|---|---|
| PLASTIC | | |
| ASTM C138 – Unit Weight | 171.4 lbs/ft$^3$ | 150.0 lbs/ft$^3$ |
| ASTM C143 – Slump | 10.0-in | 5.0-in |
| ASTM C403 – Set Time | | |
| Initial | 230 minutes | 275 minutes |
| Final | 285 minutes | 405 minutes |
| HARDENED | | |
| ASTM C39 – Compressive Strength | | |
| 1 day | 10,350 psi | 1,910 psi |
| 3 day | 12,020 psi | 3,980 psi |
| 7 day | 14,240 psi | 4,870 psi |
| 28 day | 18,000 psi | 6,360 psi |
| 90 day | 18,840 psi | 6,700 psi |
| ASTM C109 – Compressive Strength | | |
| 1 day | 10,220 psi | n/a |
| 3 day | 11,030 psi | n/a |
| 7 day | 14,860 psi | n/a |
| 28 day | 16,360 psi | n/a |
| 90 day | 17,350 psi | n/a |

TEST RESULTS (SUMMARY)

| | EucoFloor 404 | Control |
|---|---|---|
| HARDENED | | |
| ASTM C78 – Flexural Strength | | |
| 3 day | 1,446 psi | 599 psi |
| 7 day | 1,507 psi | 731 psi |
| 28 day | 1,640 psi | 868 psi |
| 90 day | 1,737 psi | 974 psi |
| ASTM C157 – Length Change | | |
| 7 day | -0.023% | -0.001% |
| 28 day | -0.030% | -0.002% |
| 90 day | -0.034% | -0.008% |
| ASTM C469 – Modulus of Elasticity | | |
| 3 day | $5.20 \times 10^6$ psi | $3.49 \times 10^6$ psi |
| 7 day | $5.65 \times 10^6$ psi | $4.07 \times 10^6$ psi |
| 28 day | $6.46 \times 10^6$ psi | $4.51 \times 10^6$ psi |
| 90 day | $6.47 \times 10^6$ psi | $4.98 \times 10^6$ psi |
| ASTM C642 – Absorption After Immersion | | |
| 3 day | 0.82% | 5.88% |
| 28 day | 0.76% | 4.06% |
| 90 day | 0.70% | 2.90% |
| ASTM C672 – Salt Scaling | | |
| 50 cycles | 0.000 lbs/ft$^2$ | 2.222 lbs/ft$^2$ |
| ASTM C1202 – Rapid Chloride Permeability | | |
| 3 day | 2,905 coulombs | 7,993 coulombs |
| 28 day | 122 coulombs | 3,430 coulombs |
| 90 day | 38 coulombs | 2,846 coulombs |

TEST RESULTS (SUMMARY)

| | EucoFloor 404 | Control |
|---|---|---|

IMPACT

ACI 544.2 – Impact

Drops until cracking *(*signifies no cracking)*

| | | |
|---|---|---|
| 3 day | 50 drops* | 4 drops |
| 28 day | 50 drops* | 10 drops |
| 90 day | 50 drops* | 11 drops |

ABRASION

ASTM C944 – Abrasion

Abrasion depth after 6 minutes

| | | |
|---|---|---|
| 3 day | 0.003-in | 0.042-in |
| 28 day | 0.001-in | 0.031-in |
| 90 day | 0.001-in | 0.030-in |

Chaplin Abrasion Test

Abrasion depth after 15 minutes

| | | |
|---|---|---|
| 3 day | 0.009-in | 0.030-in |
| 28 day | 0.007-in | 0.022-in |
| 90 day | 0.002-in | 0.022-in |

LA Abrasion Test

Loss after 2,000 revolutions

| | | |
|---|---|---|
| 3 day | 45.9% | 82.1% |
| 28 day | 36.6% | 69.4% |
| 90 day | 33.9% | 62.4% |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **EucoFloor 404**
Lot #: 407404
Water Addition: 8.0%

PLASTIC

| | |
|---|---|
| ASTM C138 – Unit Weight | 171.4 lbs/ft$^3$ |
| ASTM C143 – Slump | 10.0-in |

ASTM C403 – Set Time

| | |
|---|---|
| Initial | 230 minutes |
| Final | 285 minutes |

HARDENED

ASTM C39 – Compressive Strength

Average of three 3 x 6-in cylinders

| | |
|---|---|
| 1 day | 10,350 psi |
| 3 day | 12,020 psi |
| 7 day | 14,240 psi |
| 28 day | 18,000 psi |
| 90 day | 18,840 psi |

ASTM C109 – Compressive Strength

Average of three 2 x 2-in cubes

| | |
|---|---|
| 1 day | 10,220 psi |
| 3 day | 11,030 psi |
| 7 day | 14,860 psi |
| 28 day | 16,360 psi |
| 90 day | 17,350 psi |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **EucoFloor 404 (continued)**

ASTM C78 – Flexural Strength

Average of three 6 x 6 x 22-in beams

| | |
|---|---|
| 3 day | 1,446 psi |
| 7 day | 1,507 psi |
| 28 day | 1,640 psi |
| 90 day | 1,737 psi |

ASTM C157 – Length Change

Average of three 3 x 3 x 11 ¼-in specimens

Modified for initial measurement at 24 hours after casting

| | |
|---|---|
| 7 day | -0.023% |
| 28 day | -0.030% |
| 90 day | -0.034% |

ASTM C469 – Modulus of Elasticity

Average of three 4 x 8-in specimens

| | |
|---|---|
| 3 day | $5.20 \times 10^6$ psi |
| 7 day | $5.65 \times 10^6$ psi |
| 28 day | $6.46 \times 10^6$ psi |
| 90 day | $6.47 \times 10^6$ psi |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **EucoFloor 404 (continued)**

ASTM C642 – Absorption After Immersion

Average of three 3 x 6-in cylinders

| | |
|---|---|
| 3 day | 0.82% |
| 28 day | 0.76% |
| 90 day | 0.70% |

ASTM C672 – Salt Scaling

Average of two 8 x 10 x 3-in specimens

| | |
|---|---|
| 50 cycles | Rating 0 – No Scaling<br>Mass Loss - 0.000 lbs/ft$^2$ |

ASTM C1202 – Rapid Chloride Permeability

Average of two 4 x 2-in specimens

| | |
|---|---|
| 3 day | 2,905 coulombs |
| 28 day | 122 coulombs |
| 90 day | 38 coulombs |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **EucoFloor 404 (continued)**

IMPACT

ACI 544.2 - Impact

Average of three 6-in diameter by 2-in tall specimens

A 2.5-in diameter steel ball supported with a 10-lb compacting hammer was dropped from a height of 18-inches onto the test specimens. The specimens were observed for cracking after each drop. The testing continued until cracking was observed in the specimens or the number reached 50 drops.

| | |
|---|---|
| 3 day | no cracking at 50 drops |
| 28 day | no cracking at 50 drops |
| 90 day | no cracking at 50 drops |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **EucoFloor 404 (continued)**

ABRASION

ASTM C944 – Abrasion

Average of three areas tested from 22 x 22 x 4-in specimens

3 day

| | |
|---|---|
| Wear after 2 minutes | 0.001-in |
| Wear after 4 minutes | 0.002-in |
| Wear after 6 minutes | 0.003-in |

28 day

| | |
|---|---|
| Wear after 2 minutes | 0.000-in |
| Wear after 4 minutes | 0.001-in |
| Wear after 6 minutes | 0.001-in |

90 day

| | |
|---|---|
| Wear after 2 minutes | 0.000-in |
| Wear after 4 minutes | 0.001-in |
| Wear after 6 minutes | 0.001-in |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **EucoFloor 404 (continued)**

ABRASION

Chaplin Abrasion Test

22 x 22 x 4-in specimens

3 day

| | |
|---|---|
| Wear after 15 minutes | 0.009-in |

28 day

| | |
|---|---|
| Wear after 15 minutes | 0.007-in |

90 day

| | |
|---|---|
| Wear after 15 minutes | 0.002-in |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **EucoFloor 404 (continued)**

ABRASION

LA Abrasion Test

Average of nine 2-in cube specimens

Specimens tested under ASTM C535 with a Los Angeles abrasion machine modified to include twelve 2-in diameter steel balls along with the nine cube specimens during testing.

3 day

| | |
|---|---|
| Loss after 500 revolutions | 14.5% |
| Loss after 1,000 revolutions | 26.1% |
| Loss after 1,500 revolutions | 36.7% |
| Loss after 2,000 revolutions | 45.9% |

28 day

| | |
|---|---|
| Loss after 500 revolutions | 14.3% |
| Loss after 1,000 revolutions | 21.2% |
| Loss after 1,500 revolutions | 29.5% |
| Loss after 2,000 revolutions | 36.6% |

90 day

| | |
|---|---|
| Loss after 500 revolutions | 12.0% |
| Loss after 1,000 revolutions | 20.2% |
| Loss after 1,500 revolutions | 27.5% |
| Loss after 2,000 revolutions | 33.9% |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **Control (Concrete)**

Mix Design:
508 lbs/yd$^3$ - Portland Cement - Type I (Lafarge)
10 lbs/yd$^3$ - Silica Fume (Eucon MSA)
1400 lbs/yd$^3$ - Concrete Sand – ASTM C 33 (Quikrete)
1600 lbs/yd$^3$ - Coarse Aggregate – ASTM C 33 #57 (McCook Crushed Limestone)

Water Addition: 0.55 w/c ratio

PLASTIC

ASTM C138 – Unit Weight: 150.0 lbs/ft$^3$

ASTM C143 – Slump: 5.0-in

ASTM C403 – Set Time

| | |
|---|---|
| Initial | 275 minutes |
| Final | 405 minutes |

HARDENED

ASTM C39 – Compressive Strength

Average of three 3 x 6-in cylinders

| | |
|---|---|
| 1 day | 1,910 psi |
| 3 day | 3,980 psi |
| 7 day | 4,870 psi |
| 28 day | 6,360 psi |
| 90 day | 6,700 psi |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **Control (continued)**

ASTM C78 – Flexural Strength

Average of three 6 x 6 x 22-in beams

| | |
|---|---|
| 3 day | 599 psi |
| 7 day | 731 psi |
| 28 day | 868 psi |
| 90 day | 974 psi |

ASTM C157 – Length Change

Average of three 3 x 3 x 11 ¼-in specimens

Modified for initial measurement at 24 hours after casting

| | |
|---|---|
| 7 day | -0.001% |
| 28 day | -0.002% |
| 90 day | -0.008% |

ASTM C469 – Modulus of Elasticity

Average of three 4 x 8-in specimens

| | |
|---|---|
| 3 day | $3.49 \times 10^6$ psi |
| 7 day | $4.07 \times 10^6$ psi |
| 28 day | $4.51 \times 10^6$ psi |
| 90 day | $4.98 \times 10^6$ psi |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **Control (continued)**

ASTM C642 – Absorption After Immersion

Average of three 3 x 6-in cylinders

| | |
|---|---|
| 3 day | 5.88% |
| 28 day | 4.06% |
| 90 day | 2.90% |

ASTM C672 – Salt Scaling

Average of two 8 x 10 x 3-in specimens

| | |
|---|---|
| 50 cycles | Rating 5 – Severe Scaling<br>Mass Loss – 2.222 lbs/ft$^2$ |

ASTM C1202 – Rapid Chloride Permeability

Average of two 4 x 2-in specimens

| | |
|---|---|
| 3 day | 7,993 coulombs |
| 28 day | 3,430 coulombs |
| 90 day | 2,846 coulombs |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **Control (continued)**

IMPACT

ACI 544.2 - Impact

Average of three 6-in diameter by 2-in tall specimens

A 2.5-in diameter steel ball supported with a 10-lb compacting hammer was dropped from a height of 18-inches onto the test specimens. The specimens were observed for cracking after each drop.

| | |
|---|---|
| 3 day | cracked at 4 drops |
| 28 day | cracked at 10 drops |
| 90 day | cracked at 11 drops |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **Control (continued)**

ABRASION

ASTM C944 – Abrasion

Average of three areas tested from 22 x 22 x 4-in specimens

3 day

| | |
|---|---|
| Wear after 2 minutes | 0.023-in |
| Wear after 4 minutes | 0.034-in |
| Wear after 6 minutes | 0.042-in |

28 day

| | |
|---|---|
| Wear after 2 minutes | 0.020-in |
| Wear after 4 minutes | 0.026-in |
| Wear after 6 minutes | 0.031-in |

90 day

| | |
|---|---|
| Wear after 2 minutes | 0.016-in |
| Wear after 4 minutes | 0.023-in |
| Wear after 6 minutes | 0.030-in |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **Control (continued)**

ABRASION

Chaplin Abrasion Test

22 x 22 x 4-in specimens

3 day

| | |
|---|---|
| Wear after 15 minutes | 0.030-in |

28 day

| | |
|---|---|
| Wear after 15 minutes | 0.022-in |

90 day

| | |
|---|---|
| Wear after 15 minutes | 0.022-in |

TEST RESULTS (INDIVIDUAL)

MATERIAL: **Control (continued)**

ABRASION

LA Abrasion Test

Average of nine 2-in cube specimens

Specimens tested under ASTM C535 with a Los Angeles abrasion machine modified to include twelve 2-in diameter steel balls along with the nine cube specimens during testing.

3 day

| | |
|---|---|
| Loss after 500 revolutions | 25.1% |
| Loss after 1,000 revolutions | 47.4% |
| Loss after 1,500 revolutions | 65.4% |
| Loss after 2,000 revolutions | 82.1% |

28 day

| | |
|---|---|
| Loss after 500 revolutions | 20.9% |
| Loss after 1,000 revolutions | 38.0% |
| Loss after 1,500 revolutions | 54.6% |
| Loss after 2,000 revolutions | 69.4% |

90 day

| | |
|---|---|
| Loss after 500 revolutions | 21.6% |
| Loss after 1,000 revolutions | 37.2% |
| Loss after 1,500 revolutions | 50.2% |
| Loss after 2,000 revolutions | 62.4% |

Respectfully submitted,

NELSON TESTING LABORATORIES

Mark R. Nelson
President