

PRODUCT SPECIFICATION RESOURCE

Contains specifications and test reports for ConduCrete Pro manufactured by SAE Inc.

ConduCrete Pro is designed and manufactured to comply with Part 7 of IEC 62561 and NSF / ANSI / CAN 60, and as such is a reliable and safe low permeability conductive compound that produces low resistance when used as part of an earth termination system.



CONDU
 **CRETE** PRO

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ConduCrete Pro Technical Specifications | CC55-Pro

Physical Properties

Property	Typical Value		Unit	Test Method
Dry Density (Powder)	1400 1.4 87.4		kg/m ³ g/cm ³ lb/ft ³	SAE Inc. Standard 106 (dependent on compaction)
Wet Density (Hardened State)	1730 1.73 108		kg/m ³ g/cm ³ lb/ft ³	SAE Inc. Standard 106
Slurry Density	kg/m ³	g/cm ³	lb/ft ³	
Actual slurry density values will vary depending on water content. Contact SAE Engineering for more information.	1529	1.529	95.4	SAE Inc. Standard 106
Dry Volume (Powder)	m ³		ft ³	
55 lb bag 2200 lb supersack 1 lb bag	0.023 0.764 3.5 x 10 ⁻⁴		0.802 27.027 0.012	SAE Inc. Standard 106
Slurry Volume	m ³		ft ³	
Actual slurry volume values will vary depending on water content. Contact SAE Engineering for more information.	0.025		0.886	SAE Inc. Standard 106
Hygroscopic Property (Water Absorption)	25.4		%	SAE Inc. Standard 110
Water Permeability	2.0 x 10 ⁻⁸		cm/sec	ASTM D5084 (2.6 psi) Mix ratio of 3 US gallons per 55 lb bag
Electrical Corrosion Resistance Copper Steel Galvanized Steel	95-100 95-100 95-100		%	SAE Inc. Standard 100

Property	Typical Value	Unit	Test Method
Compatibility Copper Steel Galvanized Steel	Yes Yes Yes		SAE Inc. Standard 100
Environmental Impact	Neutral		Ontario Regulation 558/00 (Leachate Testing) and NSF / ANSI / CAN 60
Carbon Consumption Rate	0.5	kg/ amp-year	SAE Inc. Standard 111
Physical State (Uncured)	Grey Powder		
Physical State (Cured)	Grey Solid		
Odor	None		
Working Time	Approx 30-60	minutes	
Setting Time	24	hours	
Cure Time	28	days	

Compressive Strength Properties

Property	Cure Time			Test Method
Compressive Strength (psi)	1 day	8 days	28 days	
Actual compressive strength values will vary depending on water content. Contact SAE Engineering for more information.	3713	5526	5961	CAN / CSA.A23.2-19
Compressive Strength (MPa)	1 day	8 days	28 days	
Actual compressive strength values will vary depending on water content. Contact SAE Engineering for more information.	25.6	38.1	41.1	CAN / CSA.A23.2-19

Electrical Properties

Property	Typical Value	Unit	Test Method
Resistivity	< 5.0	$\Omega \cdot \text{cm}$	Modified ASTM G187-05
Conductivity	> 0.2	S/cm	Modified ASTM G187-05

IEC 62561, Part 7

ConduCrete meets IEC 62561, Part 7: Lightning Protection System Components, Requirements for Earthing Enhancing Compounds.

NSF / ANSI / CAN 60

ConduCrete meets NSF / ANSI / CAN 60: Drinking Water Treatment Chemicals - Health Effects.

<http://info.nsf.org/Certified/PwsChemicals/Listings.asp?Company=C0169859&>

Leachate (TCLP) and NSF / ANSI / CAN 60 Results

Leachate Data (TCLP Procedure) based on Ontario Regulation 558/00. ConduCrete was tested to NSF / ANSI / CAN 60, section 8 for backfill applications.

Constituent	ConduCrete TCLP Concentration (mg/L)	USEPA Maximum Contaminant Level (mg/L)	ConduCrete NSF 60 Concentration (mg/L)	NSF 60 Acceptance Criteria (mg/L)
Arsenic	BDL	0.010	BDL	0.001
Barium	0.384	2.000	0.000089	0.200
Boron	0.158	2.000*		
Cadmium	BDL	0.005	BDL	0.0005
Lead	BDL	0.015	BDL	0.0005
Mercury	BDL	0.002	BDL	0.0002
Selenium	BDL	0.50	BDL	0.005
Silver	BDL	0.100**	BDL	
Uranium	BDL	0.030	BDL	
Fluoride	BDL	2.000**		
Nitrate (as Nitrogen)	BDL	10.000		
Nitrite (as Nitrogen)	BDL	1.000		
Free Cyanide	BDL	0.200		

BDL means the result is "Below the Detection Level" of the analytical procedure

* No MCL established; value shown is USEPA's Lifetime Drinking Water Health Advisory

** No MCL established; value shown is USEPA's Secondary Drinking Water Standard

Soil Analysis Results

Determination of Anions in Soil Procedure was based on SW846-9056A and Determination of Free Cyanide in Soil was based on EPA OIA-1677.

Constituent	ConduCrete Pro Concentration (µg/g)
Fluoride	BDL
Nitrate (as Nitrogen)	BDL
Nitrite (as Nitrogen)	BDL
Free Cyanide	BDL

BDL means the result is "Below the Detection Level" of the analytical procedure

Published Date: June 2023

Resistance of Bare and Galvanized Steel Encased in ConduCrete Pro to Electrolytic Corrosion

1. INTRODUCTION

This study was conducted in order to quantify the effect that ConduCrete Pro encasement has on the corrosion prevention of direct buried steel and galvanized steel. The corrosion of steel and galvanized steel in direct contact with wet, salty soil was compared to the corrosion of steel and galvanized steel encased in ConduCrete Pro then buried in wet, salty soil.

2. PROCEDURE

Four rectangular pieces of 1/8" steel (approximately 1 3/4" x 3/4") were cut using an angle grinder and weighed using an electronic balance. A 1/4" hole was drilled into one end of each sample. Three coats of Rustoleum Cold Galvanizing Compound were applied to two of the samples, numbered 5 and 7, while samples 1 and 3 were left ungalvanized. Lengths of Dual Insulated Wire (HMWPE and Kynar) were attached to each sample by bolting single barrel mechanical lugs to the sample using the 1/4" drilled hole. The connections on the samples buried directly in soil were protected by covering the connections points with heat shrink tubing. Rectifier leads were soldered to the end of the samples with no surround material, numbered 1 and 5. The mass of the system (i.e. sample, wire and lead) was measured using an electronic balance accurate to +/- 0.01 g. Samples 1 and 5 were left bare in the soil, while samples 3 and 7 were encased in ConduCrete Pro. The ConduCrete Pro surround was allowed to cure for 4 weeks prior to the start of the experiment. Each of the samples were placed in pails and surrounded by top soil. A length of steel rebar was placed in each container approximately six inches from the anode. One liter of water and twenty grams of sodium sulfate was added to each container. Each pair of samples was connected in a series circuit to an individual channel of a 30 V rectifier, to ensure an equal current load.

Figure 1: Samples to be encased in ConduCrete Pro prior to the Experiment, bare steel (left) and galvanized steel (right)

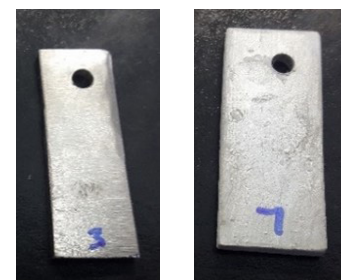
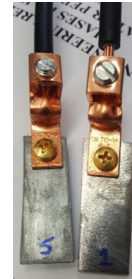
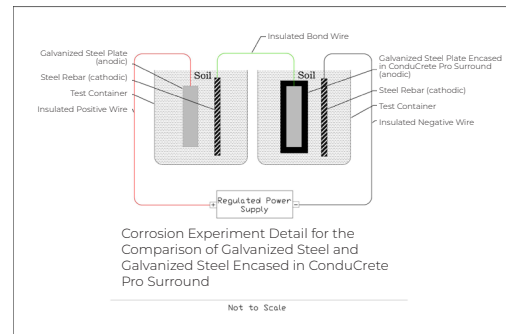
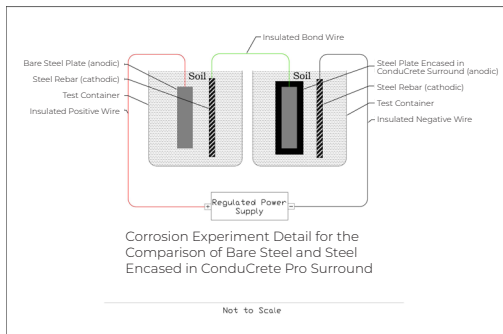


Figure 2: Samples to be in direct contact with the soil prior to the Experiment, galvanized steel (left) and bare steel (right)



The power source was set to provide 3 mA throughout the duration of the test. Schematics of the layouts can be seen below in Figure 3. Two hundred and fifty milliliters of water was added to each pail once a week to ensure that the soil remained moist. Resistance readings were taken throughout the experiment. All samples were removed from the soil after one month, cleaned, and weighed using an electronic balance accurate to ± 0.01 g.

Figure 3: Schematics of the circuit configuration for both sets of samples



3. RESULTS AND ANALYSIS

The resistance data was recorded throughout the experiment and can be seen below in Tables 1 and 2.

Table 1: Resistance Data for the Galvanized Steel Samples

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
June 12 2018	4.885	0.003	1628.33
June 13 2018	4.786	0.003	1595.33
June 14 2018	4.529	0.004	1132.25
June 15 2018	4.764	0.004	1191.00
June 18 2018	4.750	0.002	2375.00
June 19 2018	4.748	0.003	1582.67
June 20 2018	7.746	0.003	1582.00

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
June 21 2018	4.670	0.004	1167.50
June 22 2018	4.771	0.003	1590.33
June 25 2018	4.519	0.004	1129.75
June 26 2018	5.153	0.003	1717.67
June 27 2018	4.171	0.003	1390.43
June 28 2018	5.021	0.003	1673.67
June 29 2018	5.276	0.003	1758.67
July 3 2018	5.146	0.002	2573.00
July 4 2018	5.287	0.002	2643.50
July 5 2018	5.086	0.001	5086.00
July 6 2018	5.178	0.002	2589.00
July 9 2018	5.865	0.002	2932.50
July 10 2018	6.929	0.005	1385.80
July 11 2018	7.725	0.003	2575.00

Table 2: Resistance Data for the Bare Steel Samples

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
June 12 2018	5.298	0.003	1766.00
June 13 2018	5.041	0.002	2520.50
June 14 2018	4.956	0.003	1652.00
June 15 2018	5.356	0.003	1785.33
June 18 2018	4.725	0.002	2362.50
June 19 2018	5.056	0.003	1685.33
June 20 2018	5.192	0.003	1730.67
June 21 2018	5.148	0.003	1716.00
June 22 2018	5.280	0.003	1760.00
June 25 2018	5.062	0.004	1265.50
June 26 2018	5.542	0.003	1847.33
June 27 2018	5.091	0.003	1697.00
June 28 2018	5.254	0.003	1751.33

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
June 29 2018	5.015	0.003	1671.67
July 3 2018	5.013	0.002	2506.50
July 4 2018	5.042	0.002	2521.00
July 5 2018	5.439	0.001	5439.00
July 6 2018	5.184	0.003	1728.00
July 9 2018	5.470	0.001	5470.00
July 10 2018	7.264	0.005	1452.80
July 11 2018	8.029	0.003	2676.33

After one month the experiment was completed and the samples were removed from the soil for analysis. The samples were cleaned with acetone to remove any residual ConduCrete Pro and weighed using an electronic balance accurate to ± 0.01 g. As shown in Table 3 and Figures 4 and 5 the bare steel sample in soil had experienced significant corrosion and consumption of steel. It can also be seen on the galvanized steel sample in soil that almost all of the galvanized coating had been consumed and that consumption of the steel itself had begun. In comparison the bare steel and galvanized steel samples encased in ConduCrete Pro experienced negligible changes in mass, the samples actually increased in mass slightly due to residual ConduCrete Pro that was unable to be removed, and there was no visible corrosion.

Table 3: Summary of Mass Change for Each Sample

Sample	Initial Mass (g)	Final Mass (g)	Mass Difference (g)	Percentage Difference (%)
Bare Steel #1 (Soil)	21.39	20.15	-1.24	-5.79
Bare Steel #3 (ConduCrete Pro)	19.44	19.47	+0.03	+0.15
Galvanized Steel #5 (Soil)	20.79	19.37	-1.60	-7.70
Galvanized Steel #7 (ConduCrete Pro)	24.24	24.26	+0.02	+0.08

Figure 4: Uncoated Samples, Bare Steel (left) and Galvanized Steel (right), after Experiment



Figure 5: ConduCrete Pro encased Samples, Bare Steel (left) and Galvanized Steel (right), after Experiment



4. CONCLUSIONS

This experiment compared the consumption rates of bare and galvanized steel in damp salty soil at low current to the consumption rates of bare and galvanized steel encased in ConduCrete Pro surround in damp salty soil at low current. The bare and galvanized steel samples that were in direct contact with the damp soil both experienced a fairly significant loss in mass at the completion of the test. The bare steel in direct contact with the soil had 5.79% of the sample consumed and the galvanized steel in direct contact with the sample had 7.70% of the sample consumed after one month. In comparison the bare and galvanized steel samples encased in ConduCrete Pro both experienced no loss of mass at the completion of the test, both samples actually gained mass due to residual ConduCrete Pro that was unable to be removed from the samples. The bare steel encased in ConduCrete Pro had a 0.15% increase in mass and the galvanized steel encased in ConduCrete Pro had a 0.08% increase in mass after one month. Therefore, this experiment demonstrates that applying ConduCrete Pro significantly and effectively reduces the rate of corrosion of both bare and galvanized steel in buried grounding applications.

These results are the summary of results generated from testing conducted by SAE Inc. located in Barrie, ON. Testing was performed from June 2018 to July 2018.

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Report Data Reviewed and APPROVED by

Rylan Boyd, P.Eng. | Engineering Manager | SAE Inc

Resistance of Copper Encased in ConduCrete Pro to Electrolytic Corrosion

1. INTRODUCTION

This study was conducted in order to quantify the effect that ConduCrete Pro encasement has on the corrosion prevention of buried copper electrodes. The corrosion of copper in direct contact with wet, salty soil was compared to the corrosion of copper encased in ConduCrete Pro then buried in wet, salty soil.

2. PROCEDURE

Two rectangular copper strips (approx. 3" x 3/4") were weighed using an electronic balance. A 1/2" hole was punched into one end of each sample. Lengths of Dual Insulated Wire (HMWPE and Kynar) were attached to each sample by bolting single barrel mechanical lugs to the samples using the 1/2" hole. One of the strips was left bare, and the other one was encased in a ConduCrete Pro cylinder. The ConduCrete Pro sample was made using a water to ConduCrete Pro ratio of 0.5 milliliters of water per gram of ConduCrete Pro. The cylinder was allowed to cure for 13 days, half of the regularly recommended cure time. Each of the samples were placed in a pail and surrounded with soil. A length of steel rebar was placed in each container approximately six inches from the copper. One litre of water and 20 g of sodium sulfate was added to each container. The two samples were connected in series in a DC circuit and energized by a 30 V rectifier to ensure equal current load across each sample. The power source was set to supply 3 mA for the duration of the experiment. A schematic of the layout can be seen below in Figure 1. Water was added to the samples on a regular basis to ensure the soil was moist. Resistance readings were taken throughout the experiment.

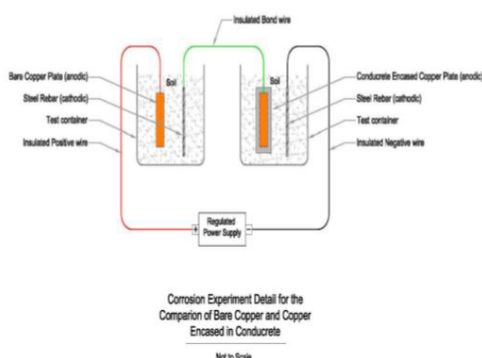


Figure 1: Schematic of the circuit configuration

3. RESULTS AND ANALYSIS

The resistance data for the first month of the experiment was recorded and can be seen in Table 1 below.

Table 1: Resistance Data from the First Month of the Experiment

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
May 18 2016	6.54	0.003	2180
May 19 2016	5.39	0.003	1797
May 20 2016	5.30	0.003	1767
May 24 2016	5.14	0.003	1713
May 25 2016	4.75	0.003	1583
May 27 2016	4.53	0.003	1510
May 30 2016	4.60	0.003	1533
May 31 2016	4.92	0.003	1640
June 1 2016	5.10	0.003	1700
June 2 2016	4.73	0.003	1577
June 3 2016	5.01	0.003	1670
June 6 2016	5.11	0.003	1703
June 7 2016	5.17	0.003	1723
June 8 2016	5.42	0.003	1807
June 9 2016	5.37	0.003	1790
June 10 2016	5.14	0.003	1713
June 13 2016	5.03	0.003	1677
June 14 2016	5.17	0.003	1723
June 15 2016	4.88	0.003	1627
June 16 2016	4.88	0.003	1627
June 17 2016	4.70	0.003	1567
June 20 2016	4.68	0.003	1560

After 33 days, the sample of bare copper was removed from the soil for examination. It was found that corrosion had occurred only at the site of connection between the copper and the wire. The hardware used for the connection had been exposed to the soil over the course of the experiment, resulting in a loss of 3.62 g of material, as seen in Figure 2 below.

Figure 2: The Connection Hardware before (left) and after One Month of the Experiment (right)



Due to the fact that corrosion occurred only at the site of connection, the copper plate itself experienced no loss of mass. The ConduCrete Pro sample had not yet been removed from the soil and therefore it was decided to continue the experiment for an additional month. The hardware was replaced with a soldered connection protected by a shrink tube to ensure no corrosion occurred at the connection site. The resistance data was recorded throughout the second month and can be seen in below 2.

Table 2: Resistance Data from the Second Month of the Experiment

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
June 21 2016	5.85	0.003	1950
June 22 2016	5.63	0.003	1877
June 23 2016	5.70	0.003	1900
June 24 2016	5.83	0.003	1943
June 27 2016	5.31	0.003	1770
June 29 2016	5.73	0.003	1910
June 30 2016	6.06	0.003	2020
July 4 2016	6.05	0.003	2017
July 5 2016	5.71	0.003	1903
July 6 2016	5.69	0.003	1897
July 7 2016	5.85	0.003	1950
July 8 2016	6.35	0.003	2117
July 11 2016	11.00	0.003	3667
July 12 2016	9.20	0.003	3067
July 13 2016	8.13	0.003	2710
July 14 2016	7.65	0.003	2550
July 18 2016	7.89	0.003	2630
July 19 2016	8.02	0.003	2673

Date	Voltage (V)	Current (A)	Circuit Resistance (Ω)
July 20 2016	8.19	0.003	2730
July 21 2016	7.82	0.003	2607
July 22 2016	7.39	0.003	2463

After the additional month, the bare copper sample was once again removed from the soil. Figure 3 and Figure 4 show the sample before and after the experiment. It is clear from these images that all of the copper directly in contact with the soil was consumed.

Figure 3: Bare Sample before
Second Half of Experiment



Figure 4: Bare Sample after
Second Month of
Electrolysis



The ConduCrete Pro encasing the copper sample was then removed from the soil for examination. The ConduCrete Pro sample itself appeared unaffected after two months of electrolysis in the soil, as seen in Figure 5. The copper sample was then removed from the cylinder for examination. Images of the copper sample before and after the experiment can be seen in Figure 6 below. The copper encased in the ConduCrete Pro appeared unaffected. This result was verified by weighing the copper using an electronic balance. The copper sample directly in contact with soil, not encased in ConduCrete Pro, lost almost 95% of its mass during the second month of the experiment running at 3 mA, whereas the copper sample encased in ConduCrete Pro experienced no loss of mass, in fact it gained mass due to residual ConduCrete Pro that was unable to be removed from the sample. A summary of the data from the experiment can be seen in Table 3 below.

Figure 5: ConduCrete Pro before the Experiment (left) and after the Experiment (right)



Figure 6: Copper Encased in ConduCrete Pro before (left) and after (right) the Experiment

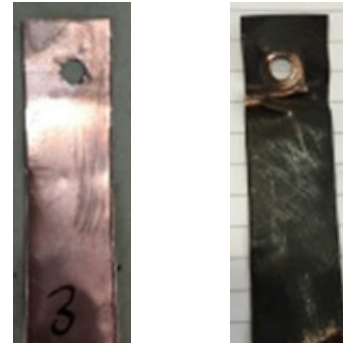


Table 3: Summary of Mass Change for Each Sample

Sample	Initial Mass (g)	Final Mass (g)	Mass Difference (g)	Percentage Difference (%)
Copper #5 (Bare)	4.26	0.22	-4.04	-94.8
Copper #3 (ConduCrete Pro)	4.28	4.30	+0.02	+0.47

4. CONCLUSIONS

This experiment compared the corrosion rate copper when buried in direct contact with soil versus encased in ConduCrete Pro then buried in soil. As seen in Table 3 above, the bare copper sample directly in contact with the soil experienced a 94.8% loss in mass while the copper sample encased in ConduCrete Pro was unaffected by the electrolysis process and lost no copper mass. These results agree with previous experimentation and demonstrates that ConduCrete Pro effectively prevents the corrosion of buried copper.

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ConduCrete Pro Compressive Strength Analysis

1. INTRODUCTION

This study was conducted in order to quantify the compressive strength of ConduCrete Pro when mixed with various water ratios and at various ages.

2. PROCEDURE

This section summarizes the method of preparation of cylinder samples of ConduCrete Pro sent for compressive strength testing. The compressive strength of all samples was tested by Terraprobe Inc. in Barrie, Ontario.

Preparation

2016 Set

The preparation will yield 4 samples or two sets (2 cylinders/set) for testing. A ratio of 3.0 US gallons per bag of ConduCrete Pro is assumed. Half of a bag of dry ConduCrete Pro (12.5 kg or 27.5 lb.) was mixed with 1.5 US gallons of water.

2021 Set

The preparation will yield 12 samples or six sets (2 cylinders / set) for testing. Three different ratios of water were used: 1.6 US gallons per 55 lb bag of ConduCrete Pro, 2.0 US gallons per 55 lb bag of ConduCrete Pro, and 2.5 US gallons per 55 lb bag of ConduCrete Pro. Half a bag of dry ConduCrete Pro (12.5 kg or 27.5 lb) was mixed with 0.8, 1.0, and 1.25 US gallons of water respectively.

For testing the compressive strength of ConduCrete Pro, cylindrical test specimens of size 4 x 8-in. (100 x 200-mm) were cast and stored until the ConduCrete Pro hardened in accordance with the requirements of ASTM C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field. A strength test result is always the average of at least two specimens tested at the same age.

3. RESULTS AND ANALYSIS

The ConduCrete Pro samples were tested in accordance with current standard CAN/CSA A23.2-14.

Table 1: Compressive Strength Results (psi)

Water Ratio	Compressive Strength (psi)						
	24 hours	48 hours	72 hours	96 hours	7 days	8 days	28 days
3.0 US gallons per 55 lb bag	-	-	-	-	2451	-	4003
2.5 US gallons per 55 lb bag	1421	2052	2364	2480	-	2886	3575
2.0 US gallons per 55 lb bag	2922	3532	3851	4047	-	4598	5192
1.6 US gallons per 55 lb bag	3713	4322	4619	4815	-	5526	5961

Table 2: Compressive Strength Results (MPa)

Water Ratio	Compressive Strength (MPa)						
	24 hours	48 hours	72 hours	96 hours	7 days	8 days	28 days
3.0 US gallons per 55 lb bag	-	-	-	-	16.9	-	27.6
2.5 US gallons per 55 lb bag	9.8	14.15	16.3	17.1	-	19.9	24.65
2.0 US gallons per 55 lb bag	20.15	24.35	26.55	27.9	-	31.7	35.8
1.6 US gallons per 55 lb bag	25.6	29.8	31.85	33.2	-	38.1	41.1

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ConduCrete Pro Permeability Testing

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084 | Constant Volume

Sample Name	ConduCrete Pro
Mix Ratio	3 US gallons of water per 55 lb bag of ConduCrete Pro
Type	Tube
Permeant Fluid	De-aired distilled water
Orientation	Vertical
Sample Preparation	Extruded from cylinder mold and placed into permeameter at as received density and moisture content
Assumed Specific Gravity	2.35

Parameter	Initial	Final	Unit
Height	7.43	7.43	inches
Diameter	4.01	4.01	inches
Area	12.63	12.63	inches ²
Volume	93.8	93.8	inches ³
Mass	2596	2649	grams
Bulk Density	105	107	pcf
Moisture Content	31.3	33.9	%
Dry Density	80.1	80.1	pcf
Degree of Saturation	88	96	%

B Coefficient Determination

Cell Pressure, psi	91.95	Increased Cell Pressure, psi	96.96	Cell Pressure Increment, psi	5.01
Sample Pressure, psi	89.34	Corresponding Sample Pressure, psi	91.01	Sample Pressure Increment, psi	1.67
				B Coefficient	0.33

B value did not increase with increase in pressure. Final degree of saturation > 95%.

Flow Data

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R _t	Permeability K, @ 20°C, cm/sec
		Cell	Sample	Z ₁	Z ₂	Z ₁ -Z ₂						
Dec 6 2016	1	92.0	89.3	26.5	26.3	0.2	208	17.7	2.1E-08	19.5	1.013	2.1E-08
Dec 6 2016	2	92.0	89.3	26.5	26.3	0.2	226	17.7	1.9E-08	19.5	1.013	2.0E-08
Dec 6 2016	3	92.0	89.3	26.5	26.3	0.2	246	17.7	1.8E-08	19.5	1.013	1.8E-08
Dec 6 2016	4	92.0	89.3	26.5	26.3	0.2	261	17.7	1.7E-08	19.5	1.013	1.7E-08

PERMEABILITY AT 20° C: 2.0×10^{-8} cm/sec (@ 2.6 psi effective stress)

These results are the summary of results generated from testing conducted by GeoTesting Express located in Acton, MA. Testing was performed from December 2, 2016 to December 12, 2016.

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Report Data Reviewed and APPROVED by



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Water Absorption of ConduCrete Pro

1. INTRODUCTION

This study was conducted in order to determine the water absorption of ConduCrete Pro. ConduCrete Pro is hygroscopic, and attracts moisture, which may reduce the resistivity of the material.

2. PROCEDURE

Three 4" x 8" cylinders of ConduCrete Pro were poured and cured for 28 days. The samples were removed from the moulds and weighed at the completion of the 28-day cure then fully immersed in potable tap water. After 24 hours they were removed from the water, wiped with a towel, air dried for 15 minutes and then weighed. They were then re-placed in the water for a further 24 hours after which they were removed, dried and re-weighed. This procedure was repeated ten more times until constant weight was obtained. At this time, the material was determined to be completely saturated with water.

3. RESULTS AND ANALYSIS

The results which are given in Table 1.0 below are expressed two different ways. The quantity of water absorbed may be expressed as percentage of the dry weight using the equation:

$$\text{Water Uptake of Dry ConduCrete Pro (\%)} = \frac{[\text{Saturated Mass} - \text{Dry Mass}]}{\text{Dry Mass}} \times 100$$

Alternately, the percentage of moisture in the fully saturated material may be calculated using the equation:

$$\text{Water Uptake of Saturated ConduCrete Pro (\%)} = \frac{[\text{Saturated Mass} - \text{Dry Mass}]}{\text{Saturated Mass}} \times 100$$

Once the water absorption was complete the ConduCrete Pro samples were placed into an oven at 105 °C for 54 hours until they reached constant mass, this was determined to be the dry weight of the samples.

Table 1: Water Absorption of ConduCrete Pro

Sample	Dry Mass (g)	Saturated Mass (g)	Water Uptake of Dry ConduCrete Pro (%)	Water Uptake of Saturated ConduCrete Pro (%)
1	2054	2578	25.5	20.3
3	2062	2587	25.5	20.3
3	2056	2576	25.3	20.2
Average	2057	2580	25.4	20.3

4. CONCLUSIONS

ConduCrete Pro that has been allowed to cure for 28 days will absorb 25.4% of its dry weight when immersed in potable tap water. When fully saturated, ConduCrete Pro will contain 20.3% water. When conditions change this free water can be removed by drying or by various chemical or physical processes such as electrolysis.

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A handwritten signature in black ink, appearing to read "Rylan Boyd".

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ConduCrete Leachate Data

ConduCrete is a mixture of Portland cement and powdered carbon and contains no aggregates. Portland cement is a common ingredient in borehole grouts, and powdered carbon presents no environmental concerns. SAE Inc. has received NSF/ANSI Standard 60: Drinking Water Treatment Chemicals – Health Effects certification¹ for ConduCrete indicating that this product has been certified to be safe for use in drinking water wells. A table of toxicity characteristic leaching procedure (TCLP) results for ConduCrete is below. TCLP is a soil sample extraction method for chemical analysis employed as an analytical method to simulate leaching through a landfill. Because the testing methodology is used to determine if a waste is characteristically hazardous, similar conditions are not expected in a typical groundwater environment, and the results would overestimate the amount of leaching that would occur.

The TCLP results are compared to the Maximum Contaminant Level (MCL) established by the U.S. Environmental Protection Agency (USEPA) for each constituent in the table below. The MCL is the highest level of a contaminant that is allowed in drinking water. For those constituents detected in the leachate, none exceeded USEPA regulatory standards for drinking water. Certification to NSF/ANSI Standard 60 ensures that ConduCrete meets USEPA drinking requirements. Additionally, because of TCLP conditions, these constituents would not be expected to present a risk for migration in a typical groundwater environment.

Constituent	ConduCrete TCLP Concentration (mg/L)	USEPA Maximum Contaminant Level (mg/L)
Arsenic	BDL	0.010
Barium	0.384	2.000
Boron	0.158	2.000*
Cadmium	BDL	0.005
Lead	BDL	0.015
Mercury	BDL	0.002
Selenium	BDL	0.050
Silver	BDL	0.100**
Uranium	BDL	0.030

Constituent	ConduCrete TCLP Concentration (mg/L)	USEPA Maximum Contaminant Level (mg/L)
Fluoride	BDL	2.000**
Nitrate (as Nitrogen)	BDL	10.000
Nitrite (as Nitrogen)	BDL	1.000
Free Cyanide	BDL	0.200

BDL means the result is "Below the Detection Level" of the analytical procedure

* No MCL established; value shown is USEPA's Lifetime Drinking Water Health Advisory

** No MCL established; value shown is USEPA's Secondary Drinking Water Standard

¹ Certification available at: <http://info.nsf.org/Certified/PwsChemicals/Listings.asp?Company=C0169859&Standard=060>

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Fault Current Withstand

1. INTRODUCTION

A design concept was developed to take advantage of the development by several suppliers of electrically conductive concrete. While originally intended for self-heating parking lot ramps and other de-icing applications, preliminary calculations showed that slabs of concrete, similar to parking lot curbstones, could increase the contact area with resistive soils. Figure 1 below shows the practical implementation.

Figure 1: ConduCrete Pro Grounding Curbstone



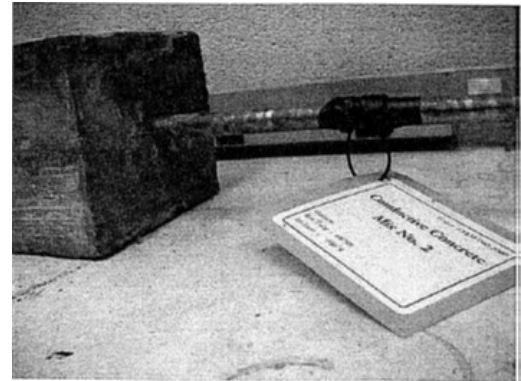
2. PRECAST VERSUS ONSITE PREPARATION

Normally, ConduCrete Pro is used to cover bare copper conductors, laid in horizontal trenches. After restoring the fill, the material absorbs water from the environment and cures in a process known as “dry grouting”. This process would not be practical on a rock surface.

When the slabs are precast, there is better quality control, lower on-site labour cost and lower delivery cost. It is intended that the 30-lb slabs be lifted out of the back of a pickup truck and pasted to the rock surface with a small amount of conductive grout.

After executing a confidentiality agreement with the supplier, twenty ConduCrete Pro slabs and other test pieces were prepared at the Kinectrics Concrete Laboratory by slurry method. The samples were wet-cured for 90 days to achieve full strength. Figure 2 shows the end of a typical slab, with 150 x 150mm cross section and 1.4-m overall length.

Figure 2: ConduCrete Pro Grounding Curbstone



3. RESISTIVITY TESTS

Table 1: January 5, 2001 Results on Bucket-Slurry Samples as per ASTM G57-95a

Sample	Average Resistivity (Ω -m)
2	8.38
3	7.95
4	8.12

The resistivity after the 90-day cure was adequate. On March 29, 2001, six of the cured grounding curbstones were tested with a four-terminal resistance meter. The standard test method used, ASTM G57, is included in Appendix A. The values, given in Table 2, show a variation from 4.4 to 6.0 Ω at 20-A test current.

Table 2: Four-Terminal Low-Voltage Resistance Tests on ConduCrete Pro Curbstones

Sample	Test Voltage (V)	Test Current (A)	Resistance (Ω)
1	17.4	2.58	6.7
	64.8	10.1	6.6
	121.2	20.1	6.0
2	119.9	22.2	5.4
3	112.9	24.4	4.6
4	100.8	15.4	6.5
5	97.2	20.5	4.7
6	96.7	21.8	4.4

4. MECHANICAL TESTS

4.1 Introduction

A laboratory testing program was undertaken to physically characterize and assess a commercial product known as ConduCrete Pro manufactured by SAE Inc. The details of the lab testing and results are reported herein.

The following laboratory tests were performed on a slurry mixture of SAE product:

- Compressive strength
- Flow
- Density (fresh and hardened)
- Settlement/shrinkage

Several precast samples (4" x 4" x 48") were made embedded with a 1 inch diameter copper pipe. Additional smaller samples were cast for accelerated freeze-thaw assessment to be tested later.

The manufacturer recommended that the SAE product required a surcharge loading of 250 psf applied to the slurried product during curing. The requirement was to ensure "the best possible electrical conductivity performance by pressing the carbon particles together." This, however, was not done due to practical and cost limitations for this indoor testing program.

4.2 Results of Laboratory Testing

The samples were prepared in a high efficiency Pumpcrete mixer. Samples were tested and prepared in four batches of the pre-bagged SAE ConduCrete Pro product. The nominal design mix proportions used in the four batches are recorded. The Safety Data Sheet, SDS, for ConduCrete Pro was reviewed for handling and mixing purposes.

The average compressive strength is about 15 MPa that appears to be adequate for handling and transport purposes. The flexural tensile strength, though not measured, is about 1-2 MPa. The settlement and shrinkage of the samples was about 2 to 5% depending on the actual design mixture. The hardened density averaged about 1700 kg/m³.

The slurry mixture had maximum flow of 150 to 170 mm, with an average of 160 mm or 6 inches. The fresh density averaged 1682 kg/m³. The air entrainment was less than 1.5% on average ranging from 1 to 2% for each batch respectively.

Also, two sets of measurement for electrical conductivity were taken by SAE Inc. staff. The average value ranged from 8.18 ohm-m after 28 days of curing to 10.24 ohm-m after 90 days of curing in fully saturated and 23 °C lab conditions.

For a typical SAE installation in the field, a "dry packing" method is used, for the pre-bagged material. This consists of digging a trench, laying a copper grounding cable, and spreading the SAE dry powder in-place and backfilling the trench. However, for some deep grounding installations, a slurry grout mixture is prepared and pumped into large boreholes.

In contrast, a lab-controlled compaction testing was performed. The optimum moisture content was 24% for maximum compaction density. The maximum (wet) density was 1674 kg/m³. The equivalent dry density was 1350 kg/m³. The slurry mixture is about 20% greater density after hardening, commonly referred to as “setting –up”. Also, typically, to add 24% of free water uniformly to the dry pre-bagged product may not be practical or very feasible under normal field conditions. The slurry mixture is adequate for this trial purpose. Several trial field samples were cast in-place using wooden forms (i.e. 48” long by 6” wide by 5 ¼” high) and a ½” diameter copper pipe 60” long.

In general, the ConduCrete Pro lab results reported are “less than” physical properties of typical MPa concrete using a coarse aggregate with freeze-thaw resistant capability for Southern Ontario.

Due to the fine silt-sized particle gradation of ConduCrete Pro, the freeze-thaw performance and its durability requires additional testing. It may have a high potential to suffer from freeze-thaw activity.

Also, as observed from the power system fault resistance testing, typically a hairline crack developed as the moisture in the sample vapourized to steam under rapid electrical loading to failure. The crack was observed generally to be <1/8” wide, with a depth of >1.5” to the top surface of the embedded ½” diameter copper pipe, and along the entire length of the 48” specimen. The development of the single crack will affect the long-term freeze-thaw durability by allowing water and ice formation within the exposed sample under outdoor conditions.

For the short duration that these samples were stored (presently >100 days) under saturated laboratory conditions, no visible signs of corrosion, or other deterioration was observed on the copper pipe. The copper pipe surface was roughened using coarse sandpaper prior to casting. The long-term corrosivity of embedded parts in ConduCrete Pro was not assessed in this present study.

Figures 3 and 4 show the typical lab testing and sample preparation undertaken. Some additional laboratory testing is on-going.

4.3 Conclusion and Recommendations from Mechanical Testing

ConduCrete Pro performed well under the basic physical lab testing. The slurry mixture was convenient and easily workable during placement. This is a practical and feasible approach for pre-casting these curbstones. The curbstone samples are easy to handle and to transport. Dry packing does not appear necessary to make these curbstones.

Several primary recommendations are as follows:

- Perform accelerated lab freeze-thaw testing on the field samples and water adsorption testing
- Long-term freeze-thaw monitoring and exposure in the field using the pre-cast curbstone samples (i.e. one brand new curbstone and another with the “failed” cracked curbstone)
- Modify or optimize the design mixture of ConduCrete Pro based on the freeze-thaw results
- Optimize the shape of the pre-cast curbstone and/or water resistant coatings
- Assess the corrosivity of the ConduCrete Pro and embedded copper rod, or wire mesh, at the contact and bond surfaces including any freeze-thaw effects at this interface

Other secondary issues regarding further testing and assessments are:

- Variation in electrical conductivity due to moisture content in the curbstone
- Introduction of fly ash or other replacement filler to enhance the freeze-thaw performance
- Develop a suitable conductive grouting mixture (i.e. pre-cast curbstone adhering to exposed rock surfaces)
- Surcharging ConduCrete Pro to maximize the electrical conductivity performance
- Develop a set of specifications and requirements for Quality Control and Quality Assurance testing of commercially produced ConduCrete Pro curbstones

5. FAULT CURRENT TESTS

Fault current tests were carried out to find out whether the slabs would crack or explode under typical surge conditions. Figure 1 shows the test setup. A potential of up to 1680 V_{rms} was applied to the central conductor, and the median current through the ConduCrete Pro to the copper electrode on the bottom was found to be 685 A. The tests showed that 1.4-m sections would dissipate nearly 1 MJ in 30 ac cycles while reducing current density from 50 kA/m² down to 3 kA/m². Under the ac fault conditions, the ConduCrete Pro slabs have a desirable negative temperature coefficient of about 2% per °C. The bulk temperature increased approximately 10° during the most severe tests.

Table 3: Power System Fault Resistance Tests on ConduCrete Pro Curbstones

Sample	Test Voltage (V)	Test Current (A)	Resistance (Ω)	Duration (milliseconds)
1	618	130	4.8	50
	1236	338	3.7	166
	1241	390	3.2	505
	1682	573	2.9	158
	1682	685	2.4	505
2	1678	552	3.0	505
3	1682	688	2.5	500
4	1686	577	2.9	500

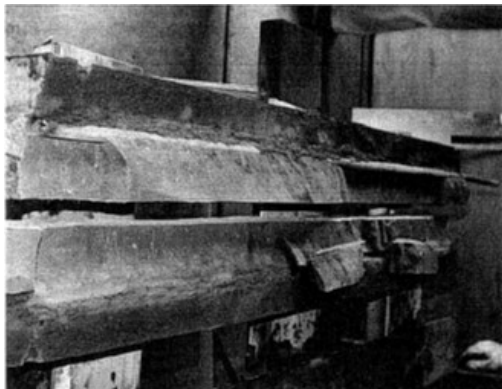
After the most severe test, a single thin crack, extending the length of the block, was found in three of the four samples. Figure 3 shows a typical crack. It was possible to split the concrete along this crack using a chisel and hammer. Figure 4 shows that the concrete remained well bonded to the central copper pipe.

The cracks did not affect the sample resistances, but they could be a long-term problem from freeze-thaw damage. Improvements to the ConduCrete Pro resistivity or to the sample geometry would be recommended to improve the performance.

Figure 3: Crack in Wet ConduCrete Pro Electrode after Power System Fault Current



Figure 4: Inside of ConduCrete Pro Electrode after Power System Fault Current



These results are the summary of results generated from testing conducted by Kinectrics Inc. located in Toronto, ON. Testing was performed from December 2000 to April 2001.

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Electrical Resistivity Evaluation of ConduCrete Pro under Applied Loads

1. INTRODUCTION

- 1.1 This test method is based on the standard test method ASTM G187-05 "Standard Test Method for Measurement of Soil Resistivity Using the Two-Electrode Soil Box Method", with modifications specified in this document to provide information about ConduCrete Pro under load conditions.
- 1.2 The test procedure involves the measurement of the electrical resistance of the powder material through a loading fixture which was designed by SAE Inc. for testing purposes.

2. EQUIPMENT REQUIRED

- 2.1 Loading fixture: consists of a top portion and a bottom portion, both being cylindrical columns having flat faces which are perpendicular to the axis of load application. The faces of the columns are held inside a snugly fitting transparent plastic sleeve to contain the powder during application of the load and lowering of the upper platen.
- 2.2 Programmable DC power supply: for measurement of the resistance of the sample and fixture
- 2.3 Twelve-ton Hydraulic Shop Press

3. TEST SETUP

- 3.1 The fixture column has a diameter of 47.61 mm (1.87 inches) which provided a test area of 1780 mm². The upper column was measured to have a weight of 3617.95 g, measured before testing on a calibrated balance.
- 3.2 One loading condition and three replicates were tested. Electrical resistance measurements were taken at 0 minutes, 1.5 minutes and 3.0 minutes after the load has been applied.

- 3.3 The test load is 1780 N (400 lbf / 1000 kPa) on the applied area of 1780 mm².
- 3.4 A “short circuit” resistance was determined as the electrical resistance of the fixtures with the platens in direct contact, under the specified load condition.
- 3.5 This resistance was subtracted from the measured resistance to provide a corrected resistance, of the powder sample itself.
- 3.6 Resistivity of the material is calculated as follows:

$$\rho = \frac{AR}{d}, \text{ ASTM G187-05 equation (1)}$$

where,

p = Resistivity, ohm·cm

R = Resistance, ohms

A = Cross-sectional area, cm²

d = Thickness of the material under load (distance between electrodes), cm

4. PROCEDURE

- 4.1 Weigh out 10.0 g of sample ConduCrete Pro
- 4.2 Assemble the brass platans/acrylic die fixture (both brass platans in acrylic sleeve).
- 4.3 To get the “short circuit” resistance of the fixture, place the entire fixture between the platens of the 12-ton hydraulic shop press and connect leads to the DC power supply. Place a nonconductive sheet between the top brass plug and the top platen of the test stand. Lower the top platen of the test stand and apply a given pressure of 1000 kPa, record the resistance and release.
- 4.4 Remove the sample fixture and the top brass platan and funnel the ConduCrete Pro sample into the acrylic sleeve and replace the brass platan. Replace the entire fixture into the press and include the nonconductive sheet.
- 4.5 Lower the top platen and apply a given pressure of 1000 kPa, record the sample height and release. The applied pressure of 1000 kPa equates to a pressure of 145 pounds per square inch on the sample material.
- 4.6 Following the same test method as above apply a pressure of 1000 kPa, hold this force for a given period of time, and record the resistance and height of the sample and release. The resistance reading is the total resistance of the sample under pressure.
- 4.7 The measured sample resistance is calculated by subtracting the short circuit resistance from the total resistance.
- 4.8 Calculation of resistivity: Resistivity is defined mathematically as the product of sample area and resistance divided by sample height:

$$\rho = \Omega \times \frac{\text{area}}{\text{height}}$$

- 4.9 Calculate the resistivity by multiplying the measured resistance by the sample area. Divide this product by the measured sample height.

Example: **Dimensional Analysis**

$$\text{Resistivity } (\rho) = \text{ohm } (\Omega) \times \frac{\text{cm}^2}{\text{cm}} = \text{ohm} \times \text{cm} = \text{resistance} \times \text{length}$$

- 4.10 Using metric units, the final resistivity measurement should be reported in units of “ohm centimeters”.

5. RESULTS

Tables 1 and 2 below provide a detailed report of the data including measured resistances, short circuit resistances and sample heights under load.

Table 1: Short Circuit Resistances under Loading Conditions

Applied Load (kPa)	Resistance at Measurement Times (Ω)			Average Resistance (Ω)
	0 min	1.5 min	3.0 min	
1000	0.126	0.126	0.126	0.126

Table 2: Electrical Resistivity with an Applied Load of 1000 kPa

Sample	Applied Load (kPa)	Time (min)	Resistance (Ω)	Corrected Resistance ¹ (Ω)	Sample Height (mm)	Resistivity ($\Omega \cdot \text{cm}$)	Average Resistivity ($\Omega \cdot \text{cm}$)
1	1000	0.0	0.223	0.097	4.2	4.125	4.125
	1000	1.5	0.223	0.097	4.2	4.125	
	1000	3.0	0.223	0.097	4.2	4.125	
2	1000	0.0	0.220	0.094	5.2	3.218	3.218
	1000	1.5	0.220	0.094	5.2	3.218	
	1000	3.0	0.220	0.094	5.2	3.218	
3	1000	0.0	0.243	0.117	5.5	3.797	3.797
	1000	1.5	0.243	0.117	5.5	3.797	
	1000	3.0	0.243	0.117	5.5	3.797	

6. CONCLUSIONS

ConduCrete Pro was measured to have an average electrical resistivity of $3.713 \Omega \cdot \text{cm}$ at an applied load of 1000 kPa.

¹ The corrected resistance is the measured resistance less the average short circuit resistance listed for that load in Table 1. This assumes perfect contact between the platens and the material causing additive resistance, and no interfacial effect is taken into account which may not be applicable in some applications.

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Performance Benefits of Enhanced Electrodes

Reduction in Surge Impedance vs. Bare Wire

Below summarizes impedance and resistance testing completed on a bare wire and a ConduCrete Pro enhanced wire.

Table 1: Reduction in Surge Impedance vs. Bare Wire

Trench	SAE Resistance Testing		Independent 3rd Party Impedance Testing		
	Average Resistance measured with LEM (Ω)	Average Resistance measured with AEMC 3731 Ground Resistance Tester (Ω)	Electrode Impedance 25' Counterpoise Testing (V/A)	Electrode Impedance 75' Counterpoise Testing (V/A)	Electrode Impedance 280' Counterpoise Testing (V/A)
Bare Wire 2/0	63.5	67.7	71.1	74.7	36.4
ConduCrete Pro Enhanced Wire 2/0	11.2	11.4	14.1	14.7	16
R-Value Reduction	82%	83%	80%	80%	56%

The significant impedance reduction seen in the ConduCrete Pro enhanced wire indicates the increased surface area and superior connection to surrounding soil (or rock) will greatly improve surge dissipation characteristics.

Report Testing by
Kurtis Martin-Sturmey | METSCO Energy Solutions

Report Data APPROVED by
William A. Chisholm, Ph.D. | METSCO Energy Solutions

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SAFETY DATA SHEET

SECTION 1 | PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Identifier
Synonyms
Product Description
Recommended Use

ConduCrete

ConduCrete, ConduCrete DM100, ConduCrete CP, ConduCrete Pro, ConduPlug
Grey Conductive Carbonaceous Concrete
Grounding and Cathodic Protection Systems

COMPANY IDENTIFICATION

Supplier

SAE Inc
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SECTION 2 | HAZARDS IDENTIFICATION

2.1 CLASSIFICATION OF THE MIXTURE

Skin Irritation Cat. 2; H315
Eye Damage Cat. 1; H318
Specific Target Organ Toxicity, Single Exposure, Cat. 3; H335
Carcinogenicity Cat. 1; H350 (inhalation)



LABELLING

Symbols



Signal Word

Danger

Hazard Statements

H315: Causes skin irritation
H318: Causes serious eye damage
H335: May cause respiratory irritation
H350: May cause cancer by chronic inhalation

Precautionary Statements

Prevention

P260: Do not breathe dusts
P264: Wash hands thoroughly after handling
P270: Do not eat, drink, or smoke when using this product
P271: Use only outdoors or in a well-ventilated area

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Response

P302 + P352: IF ON SKIN: Wash with plenty of water.
P321: Specific treatment: Caustic burns must be treated promptly by a doctor.
P332 + P313: If skin irritation occurs: Get medical advice / attention.
P362 + P364: Take off contaminated clothing and wash it before reuse.
P305 + P351 + P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P304 + P340: IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P402: Store in a dry place.

Other Hazards

Dusts from this product, when combined with water or sweat, produce a corrosive alkaline solution.

SECTION 3 | COMPOSITION / INFORMATION ON INGREDIENTS**3.1 MIXTURE**

Chemical Name	CAS No.	Wt. %	GHS Classification
Calcined Petroleum Coke	64743-05-1	50-90	Not classified
Portland Cement	65997-15-1	10-50	Skin Irritation 2: H315 / Eye damage 1: H318 / STOT SE 3: H335
Calcium Oxide	1305-78-8	0.03-1.5	Skin irritation 2: H315 / Eye damage 1: H318
Crystalline Silica	14808-60-7	0.01-0.75	Carc. 1: H350

SECTION 4 | FIRST AID MEASURES**4.1 PRECAUTIONS**

First aid providers should avoid direct contact with this chemical. Wear chemical protective gloves, if necessary. Take precautions to ensure your own safety before attempting rescue, (e.g. wear appropriate protective equipment).

4.2 EYE

Do not rub eyes. Immediately flush eyes with running water for several minutes while forcing eyelids open during flushing. Remove contact lenses, if present and easy to do. Continue rinsing. If irritation persists or if concerned seek medical attention. Take care not to rinse contaminated water into the unaffected eye or onto face.

4.3 SKIN

Wash affected areas with non-abrasive pH neutral soap and lukewarm running water and remove contaminated clothing. Launder contaminated clothing before reuse. Seek medical attention for rashes, burns, irritation, dermatitis, and prolonged unprotected exposures to wet cement, cement mixtures, or liquids from wet cement. Burns should be treated promptly by a doctor.

4.4 INHALATION

If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing. Seek medical help if coughing or other symptoms persist. If large amounts were inhaled immediate medical attention is required. Call a poison control center or doctor. If the individual is not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway.

4.5 INGESTION

Rinse mouth. Do NOT induce vomiting. Get medical attention if symptoms occur. If large amounts were ingested obtain medical attention immediately or transport victim to an emergency treatment center.

4.6 MOST IMPORTANT SYMPTOMS AND EFFECTS, BOTH ACUTE AND DELAYED

4.6.1 Inhalation

High concentration of airborne dusts are severely irritating to the upper respiratory tract with symptoms such as coughing, sneezing and shortness of breath. Long-term inhalation exposure to dusts containing respirable size crystalline silica can cause silicosis and lung cancer.

4.6.2 Eye Contact

Severely irritating in contact with eyes. Causes eye damage which may be permanent and may cause blindness. Solid particles react with moisture in the eye to form clumps of moist compound which may be difficult to remove.

4.6.3 Skin Contact

Dusts from this product, when combined with water or sweat, produce an irritating alkaline solution and burning of the skin. Symptoms include pain, burns, skin dryness, cracking and eczema.

4.6.4 Ingestion

Severely irritating to the mouth, throat, and gastro-intestinal system if swallowed. Symptoms may include severe pain and burning of the mouth, throat, esophagus and gastrointestinal tract with nausea, vomiting and diarrhea. If aspiration into the lungs occurs during vomiting, severe lung damage may result.

4.7 INDICATION OF ANY IMMEDIATE MEDICAL ATTENTION AND SPECIAL TREATMENT NEEDED

Corrosive material; get immediate medical advice / attention if inhaled, if swallowed or if in eyes.

SECTION 5 | FIRE FIGHTING MEASURES

5.1 FLASH POINT

Carbonic matter: May burn if exposed to temperature above 1290 °F (700 °C)

5.2 SUITABLE EXTINGUISHING MEDIA

Use extinguishing media appropriate to the surrounding fire conditions. Water Fog, Dry Chemical, Foam, or Carbon Dioxide.

5.3 UNSUITABLE EXTINGUISHING MEDIA

Do not use water jet as an extinguisher, as this will spread the fire or cause scattering of the corrosive solution.

5.4 SPECIAL HAZARDS

Products of combustion may contain carbon monoxide, carbon dioxide and sulfur oxides. Bulk powder of this product may heat spontaneously when damp with water. Corrosive: reacts with water releasing heat and forming an alkaline solution. Firefighters must wear full protective equipment including self-contained breathing apparatus with chemical protection clothing when exposed to decomposition products.

5.5 EXPLOSION DATA

Powders and dusts may cause an explosion hazard under certain conditions: these conditions are unlikely during normal use.

SECTION 6 | ACCIDENTAL RELEASE MEASURES

6.1 PERSONAL PRECAUTIONS, PROTECTIVE EQUIPMENT AND EMERGENCY PROCEDURES

Wear adequate personal protective equipment, including an appropriate respirator as indicated in Section 8 if there is a risk of exposure to dust / fume at levels exceeding the exposure limits. Isolate spill area, preventing entry by unauthorized persons. Do not touch spilled material. Do not breathe dusts.

6.2 ENVIRONMENTAL PRECAUTIONS

Avoid waste releases to the environment and prevent material from entering sewers, natural waterways or storm water management systems.

6.3 METHODS AND MATERIALS FOR CONTAINMENT AND CLEANING UP

Move containers from spill area. Avoid dust generation and prevent wind dispersal. Material can be picked up by sweeping, shoveling, mopping or vacuuming. Vacuum dust with equipment fitted with a HEPA filter and place in a closed labelled waste container.

6.4 REFERENCE TO OTHER SECTIONS

See Section 8 for information on selection of personal protective equipment. See Section 13 for information on disposal of spilled product and contaminated absorbents.

SECTION 7 | HANDLING AND STORAGE

7.1 PRECAUTIONS FOR SAFE HANDLING

Before handling, it is important that engineering controls are operating, protective equipment requirements and personal hygiene measures are being followed. People working with this material should be trained regarding its hazards and its safe use. Do not breathe dusts. Wash hands and exposed skin thoroughly after handling. Use only outdoors or in a well-ventilated area. Contaminated work clothing should not be allowed out of the workplace. Prevent eye contact. Wear eye protection. Do not use this product in a confined space without adequate local exhaust ventilation.

7.2 CONDITIONS FOR SAFE STORAGE

Store in a dry, well-ventilated area, away from incompatible materials, such as strong oxidizing agents; other strong oxidants. Keep containers closed. Protect from moisture / humidity and from damage or water. Do not store near food and beverages or smoking materials.

ConduCrete must be stored in unopened bags clear of the ground in cool, dry conditions. Storage should be such that no dampness or moisture is allowed to reach ConduCrete either from the ground, walls or from the environment. This becomes particularly important during the humid season and in coastal regions when atmospheric air conditions higher amount of moisture in it. Do not store ConduCrete in a building where walls, roof and floor are not completely weatherproof. Do not stack against the wall. Do not store ConduCrete bags on the floor; place on a wooden pallet or plastic sheet.

Plastic is effective as a barrier to keep the ConduCrete from absorbing moisture. Do not keep bags on the ground for temporary storage at work site. Pile on raised by platform e.g. skid and cover with plastic. If no skid is available place ConduCrete on plastic sheet. ConduCrete bags can be torn or otherwise damaged by careless or rough handling, by sharp edges, by nails sticking out of the wooden pallets, by dropping from excessive heights, by the forks of forklift trucks, etc. ConduCrete bags being transported on trucks should also be protected from rain, drizzle, sea spray, and splashes from puddles and potholes, etc. Shelf life is limited by direct contact with moisture and/or elevated levels of humidity.

SECTION 8 | EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 CONTROL PARAMETERS

Occupational Exposure Limits

Ingredient	ACGIH TLV (8-hr. TWA)	U.S. OSHA PEL (8-hr. TWA)	Ontario (Canada) TWA
Calcined Petroleum Coke (Particles not otherwise specified)*	10 mg/m ³ (total dust) 3 mg/m ³ (respirable)	15 mg/m ³ (total dust) 5 mg/m ³ (respirable)	10 mg/m ³ (total dust) 3 mg/m ³ (respirable)
Portland Cement (respirable)*	1 mg/m ³	15 mg/m ³ (total dust) 5 mg/m ³ (respirable)	1 mg/m ³
Calcium Oxide	2 mg/m ³	5 mg/m ³	2 mg/m ³
Crystalline Silica (Quartz)	0.025 mg/m ³ (respirable)	0.05 mg/m ³ quartz (respirable)	0.1 mg/m ³ (respirable) Designated Substance

* value for particulate matter containing no asbestos and less than 1% crystalline silica

8.2 OTHER EXPOSURE LIMITS

Ingredient	NIOSH REL	NIOSH IDLH (Immediately Dangerous to Life or Health)
Portland Cement	10 mg/m ³	5000 mg/m ³
Calcium Oxide	2 mg/m ³	25 mg/m ³

8.3 EXPOSURE CONTROLS

8.3.1 Engineering Controls

Dust should be controlled at point of operation. General mechanical and local exhaust ventilation to maintain airborne concentrations below occupational exposure limits. Handle in accordance with good industrial hygiene and safety practice. Ensure regular cleaning of equipment, work area and clothing. If engineering controls and work practices are not effective in controlling exposure to this material, then wear suitable personal protective equipment including approved respiratory protection. Have equipment available for use in emergencies such as spills or fire.

8.3.2 Personal Protection

Workers must comply with the Personal Protective Equipment requirements of the workplace in which this product is handled.

8.3.3 Eye / Face Protection

Wear approved safety glasses with side-shields or chemical safety goggles. Wear a face-shield or full-face respirator when needed to prevent exposure to airborne dusts. The use of contact lenses is not recommended.

8.3.4 Skin Protection

Wear chemical protective gloves, suit, and boots to prevent skin exposure. Evaluate resistance under conditions of use and maintain protective clothing carefully. Contact safety supplier for specifications.

8.3.5 Respiratory Protection

Approved respiratory protective equipment (RPE) is required if other controls are unable to maintain occupational exposure below the legislated limits. An approved respirator, NIOSH N95 rating or higher, must be available in case of accidental releases. Proper respiratory selection should be determined by adequately trained personnel and based on the contaminant(s), the degree of potential exposure and published respirator protection factors.

A respiratory protection program that meets the regulatory requirement, such as OSHA's 29 CFR 1910.134, ANSI Z88.2 or Canadian Standards Association (CSA) Standard Z94.4, must be followed whenever workplace conditions warrant a respirator's use.

8.3.6 Other Protection

Have a safety shower and eyewash station readily available in the work area.

Every attempt should be made to avoid skin and eye contact. Do not get powder inside boots, shoes, or gloves. Do not allow wet, saturated clothing to remain against the skin. Promptly remove clothing and shoes that are dusty or wet. Wash clothing and shoes thoroughly before reuse.

Do not eat, drink, or smoke where this material is handled, stored and processed. Wash hands thoroughly before eating, drinking, and smoking. Remove contaminated clothing and protective equipment before entering eating areas.

8.3.7 Environmental Exposure Controls

Emissions from ventilation or work process equipment should be monitored to ensure they comply with the requirements of environmental protection legislation.

SECTION 9 | PHYSICAL / CHEMICAL PROPERTIES

9.1 INFORMATION ON BASIC PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Solid, grey powder
Odor	Odorless
Odor Threshold	Not applicable
pH	12-13 (slurry)
Melting Point / Freezing Point	Not applicable
Initial Boiling Point and Boiling Range	Not applicable
Flash Point	Not applicable
Flammability	Not flammable or combustible
Auto-ignition temperature	>1292 °F, >700 °C
Upper / Lower Flammability or Explosive Limits	Not applicable
Explosive Properties	Not applicable
Oxidizing Properties	Not applicable
Sensitivity to Mechanical Impact	Not applicable
Sensitivity to Static Discharge	Not applicable
Vapor Pressure	Not applicable
Vapor Density	Not applicable
Density	64 lbs/ft ³ , 1021 kg/m ³ (powder) (dependent on compaction)
Solubility	Slightly soluble in water
Partition Coefficient (n-octanol / water)	Not applicable
Decomposition Temperature	>2400 ° F, >1316 °C
Viscosity	Not applicable

SECTION 10 | STABILITY AND REACTIVITY

10.1 REACTIVITY

Reacts slowly with water forming hydrated compounds, releasing heat and forming an alkaline solution. Once cured ConduCrete has a neutral pH.

10.2 CHEMICAL STABILITY

This product is stable in a closed container under normal conditions of storage and use.

10.3 POSSIBILITY OF HAZARDOUS REACTIONS

Aqueous solutions are alkaline and may corrode aluminum.

10.4 CONDITIONS TO AVOID

Avoid unintentional contact with water / moisture and with strong acids, strong oxidizing agents and other incompatible materials. Avoid generation of dust. Avoid extreme heat and open flames. May burn if exposed to temperature above 1290 °F (700 °C).

10.5 INCOMPATIBLE MATERIALS

Oxidants	Incompatible with strong oxidizing agents
Strong Acids	Incompatible with strong acids; may react vigorously
Water	Reaction generates heat
Aluminum	Calcium oxide is corrosive to aluminum metal May react with Ammonium salts

10.6 HAZARDOUS DECOMPOSITION PRODUCTS

In contact with water and moisture, generates corrosive calcium hydroxide.

SECTION 11 | TOXICOLOGICAL INFORMATION

11.1 LIKELY ROUTES OF EXPOSURE

Eye and skin contact. Inhalation of dust.

11.2 ACUTE TOXICITY DATA

Data not available for the mixture.

11.2.1 Skin Corrosion / Irritation

Based on information for Portland cement and calcium oxide: Causes skin irritation. May cause caustic burns when in prolonged contact with the skin. Irritating or corrosive to mouth, throat and gastro-intestinal tract.

11.2.2 Serious Eye Damage / Irritation

Based on information for Portland cement and calcium oxide: Causes serious eye damage and possible blindness. Damage may be permanent if treatment is not immediate.

11.2.3 Specific Target Organ Toxicity Single Exposure

Breathing dusts causes respiratory irritation. Inflammation of the respiratory passages, ulceration and perforation of the nasal septum and pneumonia has been attributed to the inhalation of dust containing calcium oxide.

11.2.4 Aspiration Hazard

This material is corrosive; if aspiration into the lungs occurs during vomiting, severe lung damage may result.

11.3 CHRONIC TOXICITY

11.3.1 Specific Target Organ Toxicity Repeated Exposure

Prolonged and repeated breathing of dust may cause lung disease. The extent and severity of lung injury correlates with the length of exposure and dust concentration. Inflammation of the respiratory passages, ulceration and perforation of the nasal septum and pneumonia has been attributed to the inhalation of dust containing calcium oxide.

May contain crystalline silica. Long-term exposure to fine airborne crystalline silica dust may cause silicosis, a form of pulmonary fibrosis that can cause shortness of breath, cough and reduced lung function. Exposure may also cause chronic obstructive pulmonary disease (COPD) and weight loss. In severe cases, there may be effects on the heart and death from heart failure. Particles with diameters less than 1 micrometer are considered most hazardous.

11.3.2 Respiratory and/or Skin Sensitization

Not known to be a respiratory or skin sensitizer. Based on information for Portland cement: causes exertional dyspnea (breathing difficulty), wheezing, chronic bronchitis. Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged contact may cause skin sensitizing.

Based on information for calcium oxide: repeated or prolonged contact with skin may cause dermatitis.

11.3.3 Germ Cell Mutagenicity

Not available.

11.3.4 Reproductive Effects

Not available.

11.3.5 Developmental Effects

Not available.

11.3.6 Carcinogenicity

Portland cement, a component of ConduCrete, contains crystalline silica which is considered a hazard by inhalation. The International Agency for Research on Cancer (IARC) has classified crystalline silica as a Group 1 substance, carcinogenic to humans. This classification is based on the findings of laboratory animal studies (inhalation and implantation) and epidemiology studies that were considered sufficient for carcinogenicity.

11.3.7 Interaction with Other Chemicals

Not available.

SECTION 12 | ECOLOGICAL INFORMATION

12.1 ECOTOXICITY

The environmental hazard of the product is considered to be limited.

12.2 PERSISTENCE AND DEGRADABILITY

High persistence in soil as degradation is not expected to be a significant fate in organisms or the environment.

12.3 BIOACCUMULATION POTENTIAL

Low bioaccumulation potential as negligible water solubility restricts route of exposure to the aquatic environment.

12.4 MOBILITY IN SOIL

Mobility is insignificant due to negligible water solubility and vapor pressure. May incorporate within soil for extended periods of time.

12.5 OTHER ADVERSE EFFECTS

None. Attempts to quantify unalkylated PAH, sulfur, and metal leachate values remained below detection limits under freshwater test conditions.

SECTION 13 | DISPOSAL CONSIDERATIONS

13.1 WASTE DISPOSAL

Reuse or recycle material and containers whenever possible to minimize the generation of waste. All Federal, Provincial / State, and Local regulations regarding health and pollution must be followed for disposal.

13.2 CONTAMINATED PACKAGING

Since emptied containers may retain product residue, follow label warnings even after container is emptied.

SECTION 14 | TRANSPORT INFORMATION

This product is not classified as a Hazardous Material under U.S. DOT or Canadian TDG regulations. This material is not classified as dangerous under ADR, RID, ADNR, IMDG and IATA regulations.

SECTION 15 | REGULATORY INFORMATION

SAFETY, HEALTH AND ENVIRONMENTAL REGULATIONS / LEGISLATION SPECIFIC FOR THE SUBSTANCE OR MIXTURE

15.1 USA

15.1.1 TSCA Status

Substances are listed on the TSCA inventory or are exempt.

15.1.2 California Proposition 65

This product contains, or may contain, trace quantities of a substance known to the state of California to cause cancer. ConduCrete may contain 0.01-0.75 wt% of crystalline silica (CAS No. 14808-60-7).

15.1.3 OSHA HazCom 2012 Hazards

Skin Irritation Cat. 2

Eye Damage Cat. 1

Specific Target Organ Toxicity, Single Exposure, Cat. 3

Carcinogenicity Cat. 1 (inhalation)

15.2 CANADA

This product has been classified in accordance with the hazard criteria of the *Controlled Products Regulations* and the SDS contains all the information required by the *Controlled Products Regulations*.

15.2.1 WHMIS 1988 Classification

D2A - Other toxic effects (mixture containing low amounts of crystalline silica).

E - Corrosive - Mixture containing calcium oxide; pH > 12 (possible skin irritant in slurry form)

15.2.2 NSNR Status

Substances are listed on the DSL or are exempt

SECTION 16 | OTHER INFORMATION

16.1 REVISION DATE

September 9, 2023

16.2 HMIS HAZARD RATINGS

Health: 2

Flammability: 1

Physical Hazard: 0

16.3 NFPA RATINGS



16.4 ADDITIONAL INFORMATION

This safety data sheet is believed to provide a useful summary of the hazards of ConduCrete as it is commonly used but cannot anticipate and provide all the information that might be needed in every situation. It relates specifically to the product designated and may not be valid for the product when used within any other materials or products or in a particular process.

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