Milliken®
Concrete Cloth™
USER GUIDE

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CONCRETE CANVAS™

Milliken™
Milliken Concrete Cloth (CC) is a flexible, cement impregnated three-dimensional fiber matrix that hardens when hydrated to form a thin, durable, and water proof concrete layer. CC allows concrete construction without the need for delivery trucks or mixing equipment. Simply position the Concrete Cloth and just add water. The material can be hydrated either by spraying or by being fully immersed in water. Once set, the fibers reinforce the concrete, preventing crack propagation. CC is available in three thicknesses
- CC5, 5 mm or 0.2 inches,
- CC8, 8 mm or 0.3 inches,
- CC13, 13 mm or 0.5 inches.

CC is suitable for use in a wide range of applications ranging from artwork to civil engineering applications where cast-in-place concrete, shotcrete, other concrete lining products and riprap might be typically used. The table below is intended to help a user select the thickness needed.

<table>
<thead>
<tr>
<th>Application</th>
<th>CC5</th>
<th>CC8</th>
<th>CC13</th>
<th>Thickness Selection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ditch, Channel, Streambank, &amp; Swale Lining</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>CC8 for water velocities up to 25 ft/sec, areas expecting foot traffic with medium to stiff supporting soils, and moderate grit and gravel abrasion expected; CC13 for more extreme conditions.</td>
</tr>
<tr>
<td>Slope Protection, or Protection of Exposed Erodible Rock Faces</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>CC5 for steep slopes with no foot traffic or stiff supporting soils or rock exist; CC8 for slopes expected to take foot traffic; CC13 for greater durability or to take heavier traffic; CC can be used with soil nails and soil anchors.</td>
</tr>
<tr>
<td>Shoreline Protection</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>CC8 is capable of handling some wave attack while CC13 should be considered for severe conditions and those instances where blowing sand may effectively sandblast the CC during high winds.</td>
</tr>
<tr>
<td>Secondary Containment Liner Protection</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>Consider soil support conditions and whether CC will be needed to resist potential puncture loads. As a general rule CC8 is used when foot traffic is anticipated and CC13 is used when occasional vehicle traffic is anticipated.</td>
</tr>
<tr>
<td>Pipe Protection</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>All thicknesses may be used depending upon protection requirements.</td>
</tr>
<tr>
<td>Corrugated Metal Pipe (CMP) Invert Repairs</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>CC8 for low water velocities and low volume of grit and gravel abrasion; CC13 for more extreme conditions.</td>
</tr>
<tr>
<td>Dust and Vegetation Suppression</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>CC5 for helicopter landing pads with anchors and relatively stiff soil support. CC5 to stop vegetation from growing under stairways and under fences. CC8 and CC13 should be used for more severe conditions.</td>
</tr>
<tr>
<td>Mud Slab, Mud Mat, or Subfooting</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>For temporary applications where the goal is simply to stay out of the mud, CC5 is most commonly used. CC8 and CC13 are used where requirements are more rigorous.</td>
</tr>
<tr>
<td>Utility Line Protection or Cable Covering</td>
<td>○</td>
<td>○</td>
<td>●</td>
<td>All thicknesses may be used depending upon protection requirements.</td>
</tr>
<tr>
<td>Sandbag or Gabion Reinforcement</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>All thicknesses may be used depending upon protection requirements.</td>
</tr>
<tr>
<td>Sidewalk, Walkway, Flooring, or Temporary Roadway</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>Consider soil support conditions and whether CC will be needed to resist puncture loads. As a general rule CC8 is for foot traffic and CC13 for occasional vehicle traffic. A CBR of 10 or more is needed for significant traffic.</td>
</tr>
<tr>
<td>Retaining Wall Swales and Toe Protection</td>
<td>○</td>
<td>●</td>
<td></td>
<td>See Ditch, Channel, Streambank, and Swale Lining above</td>
</tr>
<tr>
<td>Scour Protection around piers, culvert inlets &amp; outlets</td>
<td>○</td>
<td>●</td>
<td></td>
<td>All thicknesses may be used depending upon protection requirements, scour susceptibility of soils, and hydraulic conditions.</td>
</tr>
<tr>
<td>Boat Ramps</td>
<td>○</td>
<td>●</td>
<td></td>
<td>Typically the forces exerted by propellor wash require CC13.</td>
</tr>
</tbody>
</table>

Note: ● = Primary Recommendation; ○ = Recommended in some cases.
**Example CC Applications**

**Ditch Lining Application**
Concrete Cloth provides a permanent protection solution for ditch lining adjacent to roadways and areas where high flow conditions may cause erosion. The material conforms to the subgrade and can be used in hard to reach locations where other solutions are not feasible or are cost prohibitive. This application may utilize any of the three Concrete Cloth thicknesses, but most common is the CC8 or the CC5 for lightly loaded, lower flow applications.

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**Canal Slope Lining Application**
Concrete Cloth can be used to protect slopes above concrete channels or ditches. The ability to add on to existing structures providing needed protection where erosion is occurring results in a remediation or augmentation solution.

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**Steep Slope Swale or Spillway Application**
In many applications the ability to control runoff running down a slope face is critical to the long term stability of that slope. Concrete Cloth can be used to create a downslope swale for exactly this purpose.
**Example CC Applications**

**Slope Protection Application**
Concrete Cloth can provide a protection layer covering soil erosion prone slopes. The permanent and hard shell covering protects the underlying soils from the effects of wind and water erosion. This application may utilize any of the three Concrete Cloth thicknesses. CC8 was used to prevent further erosion of the slope shown below.

**Steep Slope Erosion Control Application**
Many stormwater outlet structures do not possess any downstream protection or stormwater control. Concrete Cloth can provide a structure to direct this waterflow while protecting the underlying soils from erosive forces from high water velocities.

**Shoreline Protection Application**
Shoreline protection is another potential use of Concrete Cloth. The permanent protection provides a physical barrier to wave action forces. Note that proper drainage behind the Concrete Cloth is necessary to prevent buildup of uplift forces on the backside of Concrete Cloth.
Example CC Applications

Boat Ramp Application
Concrete Cloth cures underwater and thus provides a means to protect soils underwater without dewatering. The Concrete Cloth is fabricated into a panel then deployed into standing water (lake) for hydration. The material conforms to the subgrade which needs to be prepared before installation. Additionally, anchoring of the panel may be required to prevent prop wash or other water currents from dislodging the installed panel. This application may utilize the thickest material, the CC13 style.

Segmental Retaining Wall Applications
Concrete Cloth can be used to create swales above retaining walls and provide toe protection in front of these structures preventing undermining the base course leveling pad.

Liner Protection Application
In secondary containment applications the geomembrane may be protected from damage using Concrete Cloth. Concrete Cloth is easily installed around tanks or pond areas to provide a permanent protection solution.
Edge Treatments
Concrete Cloth installations require the edges be tucked in or anchored to prevent undermining of the installed protection layer. This may be accomplished using anchor trenches, or simply small ditching prior to hydration as shown below.

Soil Anchors
Concrete Cloth can be anchored with soil nails or soil anchors to prevent uplifting of the installed panel during high flow conditions. These may be regular soil anchors or soil nails installed prior to hydration. The Concrete Cloth, once hydrated, provides protection for the underlying soils.
CC Cutting & Fastening

**Cutting Soft, Unhydrated CC**
When a small number of CC cuts are anticipated a utility knife or “snap off” disposable blade may be used. It is held against a straight edge such as a carpenter’s level or piece of wood.

**Cutting Soft, Unhydrated CC in Batch Rolls**
Batch rolls can also be cut with a hand saw before being unrolled.

**Cutting Soft, Unhydrated CC**
When a large number of cuts are anticipated they can be made with a grinder with a smooth blade.

**Cutting Soft, Unhydrated CC in Batch Rolls**
Or with a gas (or electrical) powered cut-off saw.

**Cutting Hardened Set/Cured CC**
Once hydrated CC can be cut with a tile or concrete saw.

**Fastening CC to Concrete, Metal, etc.**
When fastening CC to metal, self-tapping screws work well. The addition of a washer is recommended when higher strength connections are needed.
**CC Fastening**

**Fastening Using Screws**
Attaching CC to steel using screws can be accomplished with a simple hand drill, adding a washer if greater connection strength is needed.

**Fastening To Concrete**
When attaching CC to concrete, adhesives or concrete anchors have both been used successfully.

**Fastening With Soil Anchors**
Soil anchors can be used to stabilize a steep slope while CC provides erosion protection. Soil anchors easily punch through soft un-hydrated CC. Soil anchors can be load tested in place to provide assurance that any uplift force or load required is provided. Soil anchor caps bear on the CC transferring load from CC to the anchor.

**Fastening Using Adhesive**
When attaching CC to steel with an adhesive, a single bead is adequate but if the adhesive is also intended to act as a sealant to reduce the amount of water passage between the steel and the CC a snake line should be considered. It is suggested that the seam should be weighted down or mechanically fixed during hydration.

**Fastening CC To CC**
Hog rings have also been used to attach adjacent rolls/strips of CC.
CC Fastening

**Fastening a Lap Joint**
The most common lap joint is made using screws after the CC is overlapped 4 inches.

**Fastening and Sealing a Lap Joint**
Adhesives or sealants laid in a swirl pattern may be used to limit the amount of water passage at the overlap.

**Fastening With Pins/Spikes**
Pins, long spikes have also been used to join pieces of CC to one another and to attach the CC to the underlying soil.

**Paint and Coating CC**
CC can be painted or stained to improve the aesthetics. Artists have used different paint systems. Coatings can be applied to make CC impermeable and to provide color. Below are photos showing CC5 made into plant pots and then painted with a urethane based paint. Contact Milliken for more details.
Concrete Cloth™ Hydration Instructions

“The Thumb Test”
To determine whether CC has been sufficiently hydrated simply press your thumb into the wet CC and release. If water is present in the new depression CC has been sufficiently hydrated; if no water is observed then more water needs to be applied.

Re-spray the CC again after 1 hour if:
• Installing CC5
• Installing CC on a steep or vertical surface
• Installing in warm climates

Notes:
• CC cannot be over hydrated and an excess of water is always recommended.
• Minimum ratio of water:CC is 1:2 by weight. (Minimum water volumes: for CC5, ~0.2 gal/sq ft (7 L/sqm); for CC8, ~0.3 gal/sq ft (11 L/sqm); for CC13, ~0.5 gal/sq ft (18 L/sqm))
• Do not spray high pressure water directly onto the CC as this may wash a channel in the material.
• CC can be hydrated using fresh or salt water.
• CC will hydrate and set underwater.
• CC has a working time of 1-2 hours after hydration. Do not move CC once it has begun to set.
• Working time will be reduced in hot climates.
• CC will attain about 80% of its strength in 24 hours, but will continue to gain strength over time.
• If CC is not fully saturated, setting may be delayed and strength reduced. If CC is found to be underhydrated, re-wet.

Hydration at low temperatures (<40°F or <5°C)
1. If the ground surface temperature is between 32 and 40°F (0 and 5°C) and rising, Concrete Cloth should be covered with plastic sheeting to retain heat immediately after hydration. CC may exhibit a delayed set at very low temperatures. If the surface temperature is expected to fall below 32°F (0°C) in the 8 hours following hydration, spraying the material with warm water (>60°F or >15°C) mixed with an accelerant, followed by covering with plastic sheeting, may be suitable. Contact Milliken & Company for more information.
2. It is not recommended to install CC if the ground surface temperature is likely to fall below 25°F (-4°C) within 24 hours of initial hydration.
3. It is not recommended to install CC on frozen ground as the ground may move significantly when it thaws, creating voids underneath the set Concrete Cloth.
**Thicknesses, Roll Sizes, Handling, Storage, etc.**

CC is available in three thicknesses. All three thicknesses are available in bulk rolls. The number of square feet per bulk rolls varies so that the weight is kept under 3400 pounds. CC5 and CC8 can also be purchased in batch or portable rolls weighing about 140 pounds. Batch rolls can easily be handled by 2 to 4 laborers.

<table>
<thead>
<tr>
<th>CC</th>
<th>Thickness inch (mm)</th>
<th>Roll Width feet (m)</th>
<th>Dry Weight lbs/sq ft (kg/sqm)</th>
<th>Batched Roll Coverage sq ft (sqm)</th>
<th>Batched Roll Length ft (m)</th>
<th>Bulk Roll Coverage sq ft (sqm)</th>
<th>Bulk Roll Lenght ft (m)</th>
<th>Bulk Roll Weight Unset lbs (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC5</td>
<td>0.20 (5)</td>
<td>3.28 (1)</td>
<td>1.43 (7.0)</td>
<td>100 (10)</td>
<td>30 (10.0)</td>
<td>2153 (200)</td>
<td>656 (200.0)</td>
<td>3080 (1397)</td>
</tr>
<tr>
<td>CC8</td>
<td>0.31 (8)</td>
<td>3.61 (1.1)</td>
<td>2.46 (12.0)</td>
<td>55 (5)</td>
<td>15 (4.5)</td>
<td>1345 (125)</td>
<td>373 (113.6)</td>
<td>3300 (1497)</td>
</tr>
<tr>
<td>CC13</td>
<td>0.51 (13)</td>
<td>3.61 (1.1)</td>
<td>3.89 (19.0)</td>
<td>n/a (n/a)</td>
<td>n/a (n/a)</td>
<td>861 (80)</td>
<td>239 (72.7)</td>
<td>3345 (1517)</td>
</tr>
</tbody>
</table>

The table above also gives the dimensions of the three thicknesses and the weight per square foot, roll width, and roll length of each roll size. All thicknesses can be supplied in custom lengths for an additional charge.

**Packaging and Storage**

CC bulk rolls come individually wrapped and palletized. It is important to check the wrapping when CC rolls arrive at the jobsite and that any tears be taped. Unopened CC8 and CC13 rolls can be stored in a dry location and should be fit for use for up to 2 years. CC5 rolls are fit for use for up to 1 year.

**Handling**

Bulk rolls are supplied on 6 inch inner diameter cardboard tubes and batch rolls on 3 inch inner diameter cardboard tubes. Bulk rolls can be handled using a spreader bar suspended by a fork lift, skid steer loader, small excavator or other equipment.