Milliken®
Concrete Cloth™

Technical Note
Concrete Cloth Screw Connection to Steel Shear Test - Phase 2

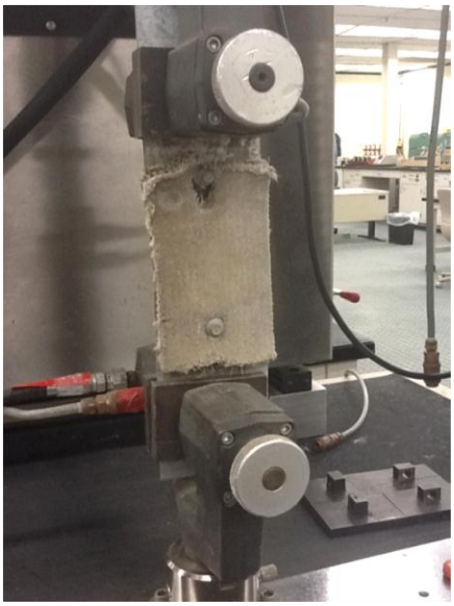
Purpose:
Determine the connection strength of Concrete Cloth when connected to steel by screws, whether there is a difference between the strength of a connection when the Concrete Cloth was oriented in the machine or cross machine direction, and whether the addition of washers has any effect on the strength of a connection. This connection strength is for use in applications such as attaching Concrete Cloth to the invert of a corrugated metal pipe, or wrapping a pipe with Concrete Cloth.

Procedure:
3 inch by 5 inch pieces of Concrete Cloth CC8 were connected at each end to 3 inch by 5 inch plates of galvanized steel by means of self-tapping screws centered at 1 inch from the end to form a test specimen as in the Phase 1 testing. The 5 inch dimension of the Concrete Cloth was oriented for a first set of specimens in the machine direction and for a different set of specimens in the cross machine direction and the direction of orientation was recorded. The test specimens were prepared the same way as the specimens that were tested in Phase 1. The specimens were mounted into an MTS Sintech 10/G electro-mechanical tensile testing machine the same way as in Phase 1 and measurements were made the same way as in Phase 1. The 16 gauge galvanized steel plates (called Metal 2 in Phase 1) and the McMaster-Carr Sealing Hex Head Sheet Metal Screw, Weather Resist Coated Steel, Silver, #10 Size, 1" Length (called Screw 2 in Phase 1) were used for all the Phase 2 specimens. The screw location was precisely 1 inch from the free edge of the Concrete Cloth and in the middle of the width of the Concrete Cloth piece or 1.5 inches from the center to the free edge as in Phase 1.

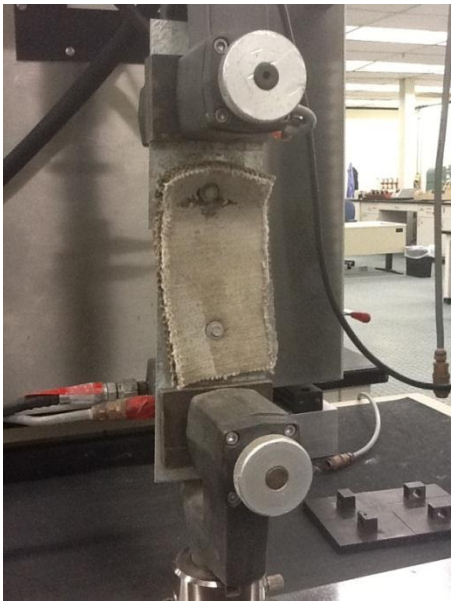
For both the machine direction and cross machine direction samples, specimens were prepared and tested with and without a washer installed at the head of the screw. The washer used for these tests had a 1.25 inch outside diameter and a 0.25 inch inside diameter.

Observations:
For each of the four possible orientation combinations (machine direction or cross machine direction)/washer (or no washer), five specimens were tested after the Concrete Cloth CC8 was hydrated and cured. In all of the tests where the Concrete Cloth was oriented in the machine direction, the Concrete Cloth failed in bearing. The bearing of the screws on the Concrete Cloth, after cracking the concrete, essentially elongated and tore through the three-dimensional fiber matrix of the Concrete Cloth. In the tests where the Concrete Cloth was oriented in the cross machine direction, the failure was different. In these tests a crack perpendicular to the direction of the tensile force developed in the Concrete Cloth. This appears to be consistent with a tensile failure of the Concrete Cloth than a bearing failure. On the following page there are typical photographs of the failed specimens. Below is a tabulation of the results.

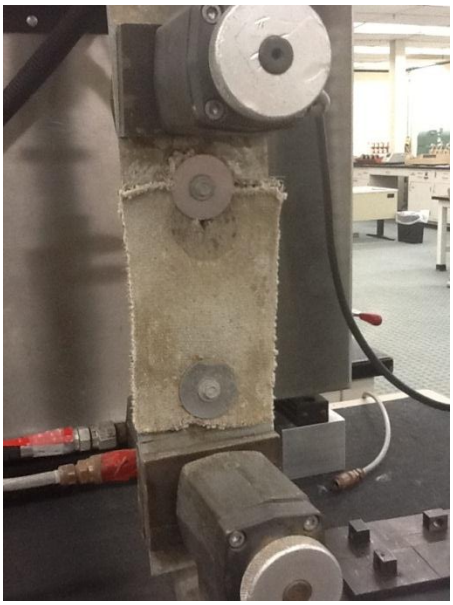
Direction, washer or not	Mean Peak Load, Lbs.	Standard Deviation, Lbs.	Elongation at Peak Load, inches	Standard Deviation of the Elongation, inches
Machine no washer	255	22	0.32	0.03
Machine with a washer	350	28	0.45	0.15
Cross Machine no washer	236	11	0.30	0.17
Cross Machine with a washer	343	20	0.69	0.32



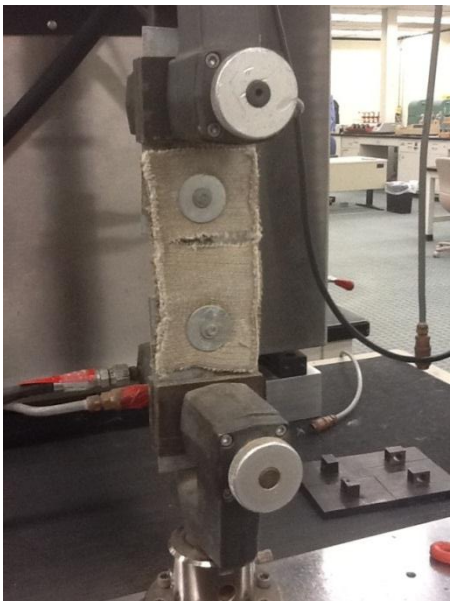
Machine Direction, Screw 2, No Washer



Cross Machine Direction, Screw 2, No Washer

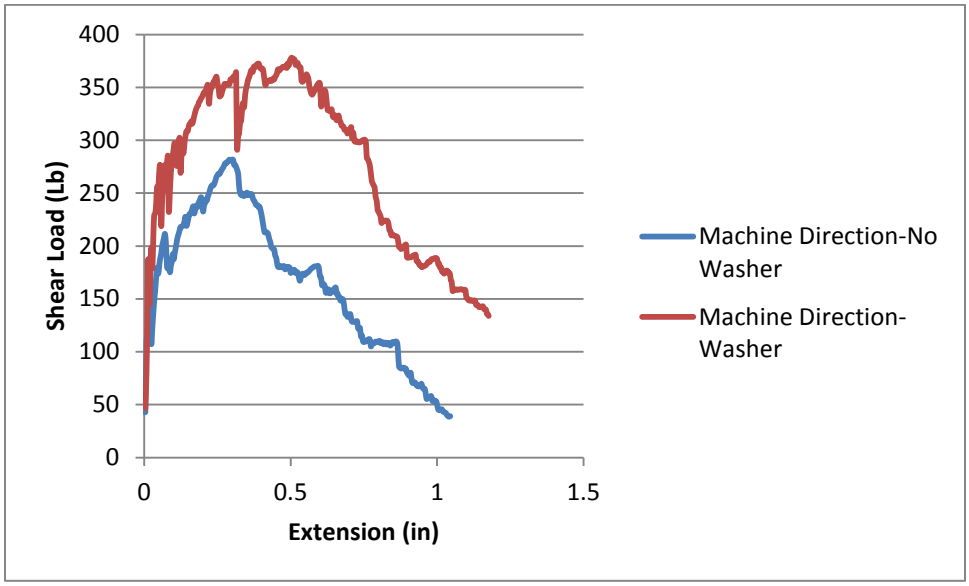


Machine Direction, Screw 2, Washer



Cross Machine Direction, Screw 2, Washer

A sample plot of load versus elongation shows that considerable energy is absorbed by the Concrete Cloth both before and after the peak load, similar to the results in Phase 1.



Conclusions:
Concrete cloth can be mechanically fastened to galvanized steel plate when used to patch or cover a steel culvert repair installation. The peak load in the machine direction and the cross machine direction are about the same, however the failure mode is different. The addition of a washer substantially increased the peak load in both directions.

Recommendations:
For determination of how many screws are needed to connect Concrete Cloth to galvanized steel to carry a certain load, the orientation of the Concrete Cloth may change the mode of failure. Therefore, it is recommended that both the calculation of bearing stress and tensile stress in the Concrete Cloth be checked, since varying geometries and numbers of screws will change whether bearing stress or tensile stress controls in the design. This is especially true in the cross machine direction. Whenever shear forces are a concern or a tensile load is applied to a Concrete Cloth screw connection, it is recommended that washers, with diameter appropriate to the loading requirements of the application, be used. These results are for illustrative purposes, as the actual connection strength is dependent upon the means of fastening or installing, screwing and curing. All will have an effect on the final joint result.

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