

C350 - Time Proven Erosion Control Performance

Numerous physical testing procedures have been utilized in trying to ascertain the functional longevity of turf reinforcement mats (TRMs). The correlation of TRM field longevity through laboratory testing of physical properties (i.e. ASTM D4355 - Xenon-Arc Weatherometer) is difficult. However, by combining physical property testing with long-term field studies, qualitative and quantitative data is obtainable to determine a TRM's past, present and expected future erosion control and turf reinforcement performance. One field application that occurred in Fort Mill, South Carolina exemplifies the benefits of combining both physical property testing and a long-term field study to illustrate the performance and longevity of North American Green's C350 composite TRM (C-TRM).



North American Green's C350 provides long-term erosion protection for South Carolina roadside channels.

Project Background

Through the use of North American Green's Erosion Control Materials Design Software (ECMDS) Version I (1991), channel design parameters, and estimated discharge for a 10 year storm event, it was determined the channel may be subjected to shear forces ranging from 38.3 – 95.8 Pascal (Pa) [0.8 – 2.0 pounds per square foot (lbs/sq ft)] prior to vegetation establishment. Later in the life of the channel, the C350 would have to enhance the vegetation's erosion control

performance to potentially negate design shear forces up to 355 Pa (7.4 lbs/sq ft). Calculations utilized by the channel design module of ECMDS are based on the permissible shear stress channel liner design procedures outlined in the Federal Highway Administration's Hydraulic Engineering Circular Number 15 (1987). The calculations afforded by the program allowed the engineer to evaluate the shear forces expected in the channel and then compare them to the permissible shear of the matting. From these procedures it was determined that the C350 both unvegetated and reinforcing the channels vegetation would provide effective erosion control and turf reinforcement against the shear forces generated by a 10-year storm event.

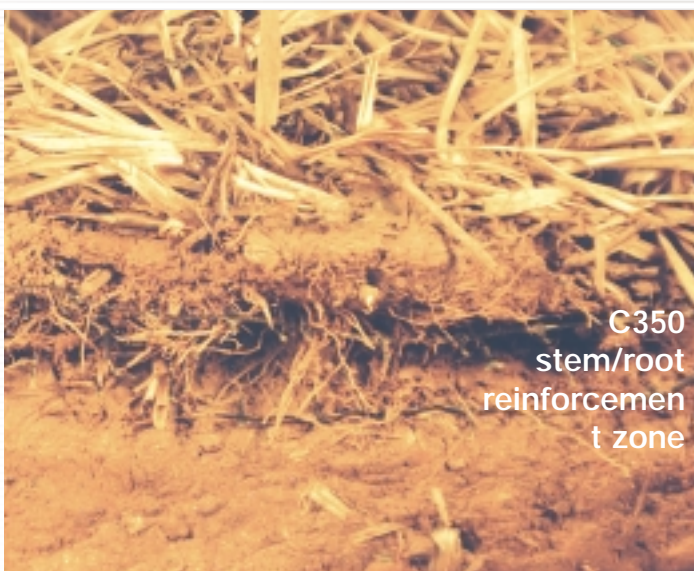
C350 Selected and Installed

Based on these design calculations, erosion control performance, vegetation establishment benefits and surface application of the matting, the project engineer approved the North American Green C350 C-TRM as an equivalent to the previously specified 100% synthetic TRM. The C350 is unique from 100% synthetic mattings because it incorporates a coconut fiber matrix into a permanent, three-dimensional netting structure. C350 installation began in June 1994 for two channels



The C350 has afforded excellent erosion protection while assisting in the development and reinforcement of a dense stand of vegetation (upper portion of photo). However, re-seeding and mulching the section of the channel disturbed for crossroad construction was ineffective at stopping the erosion or allowing a good stand of vegetation to develop (lower portion of photo).

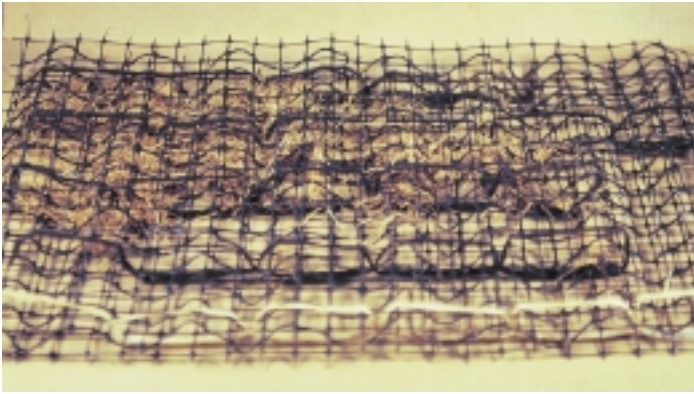
adjacent to Pleasant Road (S-22), and was completed later that same summer as weather conditions allowed. The installation followed typical procedures for surface application of the C350. After applying the necessary soil amendments and seeding the channel surface, the matting was simply rolled out and stapled into place with approximately 4.2 staples per square meter (3.8 staples per square yard). Unlike the originally specified 100% synthetic matting, the C350 did not require soil in-filling. The surface application would provide a higher level of erosion control performance, eliminate the risk of losing the in-filled soil and buoyant seed during flow events, and afford a more economical installation without compromising long-term vegetation reinforcement.



Almost five years after the C350's installation, this close-up view shows the extensive interaction that has occurred between the vegetation's root/stem structures and the C350's permanent three-dimensional netting structure.

Results

The mulching benefits and protection of the seed afforded by the C350's coconut fibers resulted in a dense stand of vegetation by late September of the same year. Several 2-year storm events have subjected the C350 reinforced channels (on both the north and south sides of the roadway) to numerous and varied shear stress discharges since installation. In 1997, almost three years after installation, the site was hit by a 100-year storm resulting in 28 centimeters (11 inches) of rain in less than 12 hours. According to the design engineer, Theron Pickens, P.E., of Campco Engineering, Inc., this storm resulted in discharge likely in excess of the 10-year design storm calculations. Mr. Pickens indicated that the C350 reinforced vegetation provided exceptional erosion protection for the channels. The vegetation did sustain small, localized spots where leaves, stems, and thatch had been removed, but the matting was still intact. More



The C350's permanent net structure still maintains its three-dimensionality (thickness) and strength after nearly five years of weathering and UV exposure in two South Carolina roadside channels.

importantly, there were no visible signs of erosion, channel scour or undermining of the C350. Since the storm, the small areas of damaged vegetation have healed with their root and stem structures continuing to develop into the C350's permanent net structure.

The extensive stem, root and matting interaction that enabled the vegetation to survive the 100-year storm made removal of the vegetation nearly impossible prior to conducting physical properties testing on exhumed samples of the permanent portion of the matting (see photograph below).

Furthermore, after the initial matting installation in 1994, crossroad construction in the summer of 1997 necessitated excavating a portion of the C350 reinforced channel to connect the preexisting channel system with those designed for the crossroad. When the crossroad was finished and the additional channels were to be re-vegetated, C350 was not utilized. The new channels were simply re-seeded and mulched. In testimony to the protection afforded by the C350, subsequent flows have resulted in severe rill and gully erosion in the channel sections where no matting was used. No erosion or undermining has occurred in the previously installed C350 reinforced vegetation sections of the channel (see photograph on previous page).

Physical Testing for Durability and Functional Longevity

To determine how long the C350 will continue providing this high level of reinforcement, physical testing was conducted on C350 samples exhumed from the roadside channels. Comparison of strip tensile (ASTM D 5035) and thickness (ASTM D 5199) from both the initially installed matting and samples collected after nearly five years in the field provide an accurate method for assessing the matting's degradation caused by weathering and ultra-violet (UV) exposure.

It is apparent from the physical testing conducted on the exhumed matting - after almost five years of service - that there was no appreciable loss in any of the matting's important vegetation reinforcement properties (see Table 1). In fact, after five years of weathering the C350 still maintains greater thickness and tensile strength than many currently available TRMs do right "out-of-the-box" (see Table 1). Based on this physical testing on the exhumed samples the expected effective erosion control and turf reinforcement provided by the C350 will continue well into the future.

Summary

The numerous benefits associated with selecting the North American Green C350 for this project have been substantiated after nearly five years of service. The C350 used on this project has proven that it promotes rapid vegetation development and provides both immediate and long-term erosion control and turf reinforcement. Furthermore, the maintenance of its original physical properties after nearly 5 years of service suggest the C350's permanent netting structure will continue functioning as an effective erosion control and vegetation reinforcement matrix for years to come. As a result, the matting's performance advantages have prompted Campco Engineering to change their standard 100% synthetic TRM specification for high flow channel linings to that of a C-TRM, the North American Green C350.

Table 1. - Index / Physical Properties

Materials Tested	Thickness mm (inches) ASTM D5199	Tensile Strength kN/m (lbs/ft) ASTM D5035 Machine Direction
North American Green C350 May 1995 (original sample)	16 (0.63)	6.9 (480)
North American Green C350 Exhumed sample January 1999 (exposed sample)	14.6 (.573)	5.9 (411)
Synthetic Industries Landlok TRM 1060	15.2 (0.60)	3.2 (220)
Synthetic Industries Landlok TRM 450	12.7 (0.5)	2.4 (170)
Synthetic Industries Landlok TRM 435	8.9 (0.35)	2.1 (145)
Akzo Nobel Enkamat Composite Type "C"	7.6 (0.30)	4.1 (280)

NORTH AMERICAN GREEN



LEADING
THE WAY
IN C-TRM
TECHNOLOGY

NORTH AMERICAN GREEN C-TRM TECHNOLOGY

North American Green's C350 Composite Turf Reinforcement Mat (C-TRM) utilizes patented technology to provide ultimate erosion control and permanent vegetation reinforcement. Other turf reinforcement mats made from 100% synthetic fibers often fall short in providing effective erosion control and mulching action, leaving your projects prone to failure before and during vegetation establishment. By combining the natural erosion control effectiveness of organic fibers with the permanent reinforcement properties of a synthetic, three dimensional netting structure, the C350 optimizes performance before, during and after vegetation establishment. Offering complete "3 phase" protection, the C350 is an ideal alternative to other initially worry-free erosion control materials such as rock riprap and concrete. In fact, recent independent testing suggests that C350 reinforced vegetation can provide erosion protection equivalent to 24 inch riprap, at a fraction of the cost. North American Green C350 C-TRM, the "C" stands for Composite, yet more importantly... **Complete!**

- Patented "Composite" Design
- Complete "3 phase" Erosion Protection
- More Effective Immediate Protection Than 100% Synthetic TRMs
- Permanent Protection Equivalent To 24 Inch Riprap...At Much Less Cost



LEADING THE EROSION CONTROL INDUSTRY INTO THE 21st CENTURY

the global authority in erosion control technology

14649 Highway 41 North | Evansville, Indiana 47711
800-772-2040 | 812-867-6632 | Canada: 800-448-2040
www.nagreen.com

