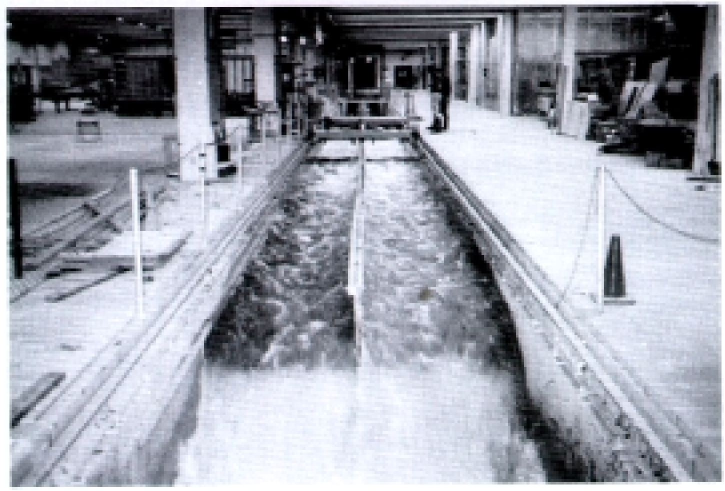
FACTS

NORTH AMERICAN GREEN QUANTIFIES EROSION CONTROL AND TURF REINFORCEMENT PROPERTIES OF THE P300P CHANNEL LININGS AND C350 PROTOTYPE



North American Green just completed two of the three phases of channel liner testing at Utah State University on the polypropylene P300P and a prototype matting we call the "C350". The purpose for these tests was to determine the materials' capabilities to: control channel erosion during Phase 1 of a natural channel before vegetation establishment; provide root reinforcement for mature vegetation in Phase 3 of a natural grass-lined channel. Phase 2 testing, with grass growing through (instead of rooted into) the fiber matrices of the P300P and C350 will be completed this spring. By quantifying the performance of the P300P and C350 in each phase of natural vegetated channel development, we can provide the engineer a complete systematic approach to designing permanent reinforced grass channels. Although we do not have all the data back from the Phase 1 and 3 tests at this time, here is how the tests were conducted and a brief summary on how each material performed.

The tests were conducted by forming two side-by-side channels (two replications for each material) in a 50 foot test flume using a sandy loam soil (with prepared seed bed), and then installing the erosion control materials on top (matting, sod, reinforced sod). Water was forced down these channels from a 3 feet diameter pipe backed by 35 feet of head pressure. This set-up allowed us to discharge from 10 to 75 cubic feet of water per second at average velocities over 20 feet per second down the test channels. Each test consisted of a series of .5 hour flow events, with a final run extending several hours. After each flow event, soil loss measurements were taken to determine product performance.

Channel lining failure was defined as significant lining degradation and/or a loss of .5 inches of soil from the channel cross section (for mattings on bare soil). These are the same failure criteria North American Green used in similar tests previously performed at Colorado State University. It is our belief that a loss of over .5 inches of soil constitutes a performance failure of the lining material because the top .5 inches of soil generally represents the seed bed during Phase 1 on the channel surface. If the seed bed is washed away, the channel will need significant repair work to assure proper development. With these criteria in mind, let's see how each channel lining material performed.

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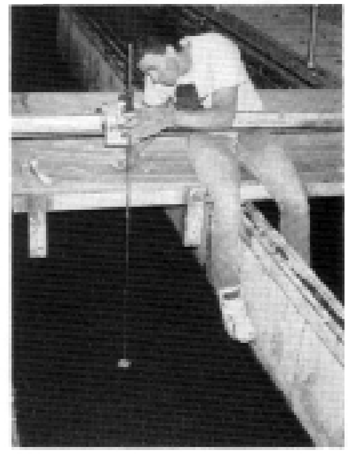
MATTINGS ON UNVEGETATED CHANNEL (CHANNEL PHASE 1)



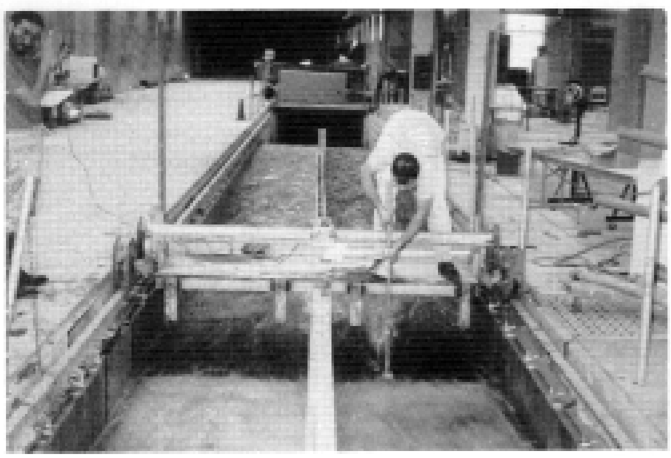
The P300P and C350 (a new coconut/synthetic erosion control/turf reinforcement prototype matting) did very well at controlling soil loss from the test channels at relatively high velocities and extended flow periods. Both materials controlled soil loss below the present failure criteria at average velocities between 9 and 10 feet per second (similar to our findings at Colorado State). Quite impressive considering the unprotected control channels suffered soil loss failures at 1.5 fps.

After a soil loss failure was reached on each material, two final tests were performed to determine material durability under both a super high velocity and an extended flow period. Both the P300P and C350 survived a 10 feet per second flow period of 16.5 hours without significant damage. Though a soil loss failure had been reached in the previous run, the linings did continue to provide protection for the channel surface throughout the extended flow period.

Under the short duration, super-high velocity tests, differences in the P300P and C350 mattings materialized. The C350 showed signs of damage at average velocities over 13 feet per second. The P300P, on the other hand, resisted structural degradation up to over 20 feet per second.

Although North American Green would not recommend the use of either matting at velocities higher than those found to cause excessive soil loss, the super-high velocity test gives us a reference point for material survivability — an answer to the question "if design velocities were ever exceeded, could the matting be reused after repairing the channel?"

SOD VS. REINFORCED SOD (CHANNEL PHASE 3)



Since the P300P and C350 mattings are (or will be) marketed as erosion control and turf reinforcement materials, both products were also tested for their root reinforcement capabilities. To develop reinforced sod, the P300P and the three-dimensional structural netting of the C350 (without the coconut fiber) were installed under Bluegrass sod in field plots which were allowed to grow in for three months to a height of 3 to 6 inches. As a control, unreinforced Bluegrass sod was also cut and grown in the field before testing. Since little soil loss was expected from the sod plots, significant lining (sod) damage was the defined failure point.

As expected, damage to both unreinforced sod plots occurred long before it did on either the P300P or C350 reinforced sod plots. In fact, a failure point for the reinforced sod plots was never actually reached. The unreinforced Bluegrass sod began tearing away from the channel at average velocities of 12-13 feet per second during .5 hour flow events. Both the P300P and C350 reinforced sod plots resisted damage at average velocities of over 19 fps in short duration flows. Reinforced sod plots also showed little damage during extended duration flows from 5-15 hours at velocities from 12-13.5 fps. Therefore, it seems both the P300P and the C350 mattings are effective turf reinforcement materials and can function to increase the permissible velocity of natural vegetation by at least 1.5 times.

PHASE 2 TESTING

With Phase 1 and Phase 3 tests done, data from Phase 2 testing will fulfill the ultimate goal of a complete reinforced grass channel design system. Phase 2 plots were installed in the field at Utah State by placing the P300P and C350 on top of test sections of soil and Bluegrass seed.. By this coming spring, the plots will be well developed with a good uniform growth of grass up through each test material. Sections of these plots will then be cut and installed in the laboratory flume and subjected to similar tests as described above.

CONCLUSIONS

The results so far have been described in terms of average velocities. To make this information more congruent to the North American Green channel lining design system, we will be converting this data from velocity to tractive force (lbs/sq ft). However, the velocities do give us a good initial reference to the performance of these materials. It is apparent that both the P300P and C350 are effective high velocity channel linings for protecting the channel surface in Phase 1 before vegetation establishment, and that these two materials can also provide substantial reinforcement for the root systems of grasses, ultimately boosting the grasses resistance to high velocity flows.