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STAY turf

Performance Report
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Report To Jimboomba Turf Company On The Performance Of "STAYturf" (Identity Code "Stayturf T3")

By

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1. aim of the study

To test the ability of "Stayturf" to withstand high water flow velocities and to prevent soil erosion immediately after laying.

2. performance objectives

- (1) The turf mat maintains its physical integrity after exposure to high water flow velocities.
- (2) The soil under the turf mat shows negligible evidence of erosion under conditions where significant erosion occurs from unprotected areas.

3. background

"Stayturf" is a soil stabilising material consisting of a layer of turf grown on organic matting and stabilised by a polymer mesh. Details of production of "Stayturf" are given in Appendix I.

"Stayturf" is produced in rolls (say 10 m X 2 m) which are laid over the soil area requiring protection and fixed in position with biodegradable (wooden) pegs. This provides immediate physical protection. With appropriate installation and management (see Appendix II for details), roots will grow into the underlying soil material, producing a more permanent biological protection for soil vulnerable to erosion. The study reported here considers the ability of "Stayturf" to provide effective short-term protection. Long-term effectiveness (as with all biological protection methods) will obviously be dependent upon the quality of turf management.

4. the study

Prior to field testing, a trapezoidal earthen channel was designed and excavated on an 18% slope at the Jimboomba Turf Farm. The channel was designed to maximise water flow velocity (and hence shear stress on the “Stayturf” product) for a given flow discharge, and to carry discharges up to 0.5 m³/s (500 litres/second). Design information on the channel is given in Appendix III.

A 10 m X 2 m strip of “Stayturf” was cut and placed in the channel. Water was supplied to the channel from two pumps with a combined nominal discharge of 0.5 m³/s. Water was pumped into a tarpaulin-lined “stilling basin” prior to flow down the channel (see Plate 1). The “Stayturf” was fixed to the tarpaulin at the upper end of the channel using steel “J”-shaped pegs at a spacing of 500 mm. For the first three test flows, the “Stayturf” was additionally stabilised by 200 mm long wooded pegs on a 500 mm grid over the whole surface. For the last test run, over 50% of the wooden stabilising pegs were removed from the “Stayturf”. Full details of the fixing method, and observations made during and after the runs, are given in Appendix IV.

Summary details of the four runs are given below:

Run 1: Nominal flow rate = 0.15 m³/s

Run 2: Nominal flow rate = 0.30 m³/s

Run 3: Nominal flow rate = 0.50 m³/s

Run 4: As for Run 3: two rows of wooded pegs were removed, bottom 3 m of “Stayturf” unpegged.

Measurements made during each run were:

- Depth of flow at three positions along the channel;
- Surface flow velocity (a good estimate of average flow velocity for turbulent flow).

Average discharge during the run was calculated from this data. At the end of each run, observations were made of any damage to the “Stayturf” surface, undercutting at the lower end of the stabilised surface, and soil erosion in the unstabilised channel below the “Stayturf”. At the completion of Run 4, the bottom 3 m of “Stayturf” was peeled back to observe any evidence of erosion below the stabilising mat (see Plate 4) and a survey of the unstabilised channel was made (see Plate 5) to determine the amount of soil erosion in this part of the channel. Flows in the channel and below the area stabilised by “Stayturf” are shown in Plates 2 and 3.

5. results

5.1 Flow Characteristics of the Channel

Flow velocity, flow depth, calculated discharge and Manning's roughness coefficient for the "Stayturf" are given for the four runs in Table 1. The Manning's roughness coefficient is a measure of the surface roughness of the channel. A higher value indicated a greater roughness, with similarly increased resistance to flow.

Runs 1 and 2 were made with the larger pump at low and high throttle opening respectively. Runs 3 and 4 were both made with the large and small pumps at full throttle.

run	flow velocity (m/s)	flow depth (m)	discharge (m ³ /s)	manning's roughness coefficient
1	3.22	0.237	0.303	0.031
2	3.25	0.253	0.342	0.031
3	3.33	0.293	0.448	0.033
4	3.23	0.292	0.430	0.034

Flow velocity did not increase markedly with increasing discharge, and this is reflected in the slight increase in Manning's roughness coefficient with increasing discharge.

Two major conclusions can be made from Table 1:

(1) The methodology has allowed testing of "Stayturf" at flow velocities of up to 3.3 m/s, which is in excess of the maximum design velocities of 2.0 m/s for "sward-forming grasses" and 3.0 m/s for "mat or sward-forming grasses with other UV stabilised mesh" set by the NSW Department of Housing. Calculated surface shear stress at the maximum flow velocity is 235 pa.

(2) The measured values of Manning's roughness coefficient (0.031-0.034 m^{-1/3} s) are approximately constant and consistent with values of 0.025-0.04 obtained by the U.S. Department of Agriculture for grasses with a range of physical characteristics for deep flow at high velocities. This suggests that our measures values can be used for design purposes for "Stayturf" at higher flow velocities. Values for lower flow velocities can be readily obtained on the Griffith University Tilting Flume Facility.

5.2 Performance of “Stayturf”

Performance indicators are listed in Section 2, and these are addressed below:

- (1) There was no evidence of loss of integrity of the “Stayturf” matting during testing.
- (2) There is slight undercutting of the protected area at the bottom end of the “Stayturf”. This was expected and can be eliminated by appropriate installation in practical field situations. In our study, undercutting occurred because of the need to measure soil erosion in the protected channel immediately down slope of the “Stayturf”.
- (3) There is no evidence of soil erosion beneath the “Stayturf” matting. This is well illustrated in Plate 4. This photograph shows the rolled-back “Stayturf” (top one-third of photograph), the protected area of the channel, with some undercutting at the bottom end (middle one-third of the photograph), and the highly eroded unprotected channel in the bottom one-third of the photograph.
- (4) The effectiveness of the “Stayturf” in stopping sediment generation and eliminating off-site pollution from soil erosion can be illustrated from a calculation of soil loss from the unprotected portion of the channel. This was calculated from survey data of channel dimensions (see Plate 5) and an assumed soil bulk density of 1400 kg/m³.

Soil loss from the unprotected channel was 140 kg/m of channel length.

6. implications for erosion control on disturbed lands

Our studies show “Stayturf” to be a very effective method of stabilising areas susceptible to soil erosion by water. It has the advantage over many other biological control treatments of providing immediate protection of fragile areas such as roadside batters, drains and swales. However, there are two very important issues associated with the long-term effectiveness of the material.

- (1) Particularly in areas of concentrated flow and high flow velocities, it is critical to avoid significant leakage of surface water under the mat. At the upslope boundary, it will be necessary to securely pin the mat and possibly bury the top edge to avoid undercutting and tunnelling below the mat. Similarly, mat segments need to be overlapped and pegged. At the downslope boundary, discharge should be onto a grassed area or into a stabilised drain or rock and gravel surface, since runoff from the “Stayturf” area will have a low sediment concentration and hence a strong capacity to erode sediment from an unstabilised area.

(2) Since “Stayturf” is a biological barrier, appropriate agronomic management will be required to maintain effectiveness over time. Such management procedures are outlined in Appendix II. Over time, the wooden pegs holding the mat in place will degrade and there will be some loss in strength of the polymer mesh (wooded pegs are chosen for safety and environmental reasons). However, with good turf management, the growth of roots into the underlying soil should more than counteract this loss of shear strength.

“Stayturf” should be used as an erosion control method to minimise sediment generation, and not as a sediment trap. There are two major reasons for this:

(i) Many disturbed soils are dispersive because of the exposure of subsoil material. This dispersed soil or suspended load cannot be captured in any sediment trap that does not incorporate expensive sediment flocculation technologies. It is this dispersed soil which makes the major contribution to nutrient and sediment pollution of waterways.

(ii) “Stayturf” is certainly capable of entrapping coarse sediment, and this was observed during our experiments. However, the Manning’s roughness coefficient of “Stayturf” is quite low at 0.03-0.035 $m^{-1/3s}$, due to the low-growing nature of the turf. This value is similar to that for bare soil. Hence it is unlikely to enhance deposition of sediment markedly.

Some deposition in the “Stayturf” mat is likely to enhance the vigour of grass growth. However, placement of “Stayturf” in an area of major sediment deposition may bury the grass sward, reducing its vigour and effectiveness.

In conclusion, erosion control on disturbed land should concentrate on minimising the generation of sediment by rainfall and runoff. In conditions where economics allow its use, “Stayturf” is an excellent option, providing immediate and effective soil erosion control.

Table 1. Flow depth, Dw (m), and velocity, V (m s⁻¹), calculated from the above given values for different bottom width and channel slope (S) values of a trapezoidal channel using Mannings's equation for a flow rate of 0.5 m³ s⁻¹ (500 litres/s pump capacity).

S (%)	Wb (m)	n (m ^{-1/3} s)	Dw (m)	Wr (m)	V (m s ⁻¹)	Dr (m)
10	0.30	0.030	0.29	1.01	2.99	0.36
15	0.30	0.030	0.29	1.01	2.99	0.36
20	0.20	0.025	0.25	0.82	4.45	0.31
25	0.20	0.025	0.25	0.82	4.45	0.31

Note:

Wb values in Table 1 are bottom widths of the channel that give the maximum flow velocity, V, at the given bed slopes and flow rate.

Channel depth, Dr + DW + 0.25DW is assumed to be adequate.

The Manning's n values are those recommended for these channel slopes and flow rate in the 'Tensar' document (SPECIFICATION FOR THE INSTALLATION OF 'TANSAR MAT' ON SLOPES, SN/SP 1/5.89) given to us.

The length of the channel is not critical. But 10 metres is adequate.

Caution:

This design assumes that the flow will have the same velocity as given above when it starts to flow in the channel.



Appendix 4

Jimboomba Turf Testing – Preliminary Summary

Material:

Turf/Terra-mat composite. Identity code “STAYTURF T3”.

Test Material Size:

2m by 10m

Fixing Methods:

All tests – Row of Steel “J” Shaped pegs along line at top of turf at interface to tarpaulin, at 500mm spacings.

For tests 1A to 1C inclusive, wooded pegs at 500mm grid over full surface of turf (ie 4 rows).

For test 1D wooden pegs were removed to leave the side rows for the top 6 metres of turf (ie 14 pegs total).

Wooded pegs were 200*25*20mm pine, sharpened at one end. The wooden pegs were inserted to approximately 120mm at approximately 35degree slope (the top facing uphill).

Test 1A:

Large pump running idle

Estimated flow 150 l/sec

Flow time for 8m 2.4s, 2.6s, 2.45s

Flow depth Top 260mm

Mid 230mm

Lower 220mm

No damage to turf

Bottom 1 m of turf rolled back to check for erosion under mat – none detected except for slight undercutting under end of turf.

Runtime 11.30am to 11.40am (10 min).

Test 1B:

Large pump running full throttle

Estimated flow 300 l/sec

Flow time for 8 m 2.36, 2.38, 2.52, 2.40, 2.48, and 2.52.

Flow depth Top 260mm

Mid 260mm



Lower 240mm

No damage to turf

Bottom 1m of turf rolled back to check for erosion under turf – none detected except for slight undercutting under end of turf.

Runtime 11.50 to 12.00 noon.

Run at idle for 2 extra min to check flow (12.00 to 12.02pm).

Test 1C:

Both pumps running full throttle.

Estimated flow 500 l/sec

Flow time for 8m 2.42, 2.50, 2.35, 2.52, 2.24, and 2.37

Flow depth Top 320mm

Mid 300mm

Lower 260mm

No damage to turf

Slight undercutting

Significant erosion of bare soil down slope from turf (150mm depth eroded)

Runtime 12.08pm to 12.17pm (9min – short of fuel)

Test 1D:

Partial removal of wooded pegs

Both pumps running full throttle

Estimated flow 500 l/sec

Flow time for 8m 2.40, 2.50, 2.45, 2.42, and 2.63

Flow depth Top 330mm

Mid 300mm

Lower 245mm

No damage to turf

Bottom 3m of turf rolled back to inspect for erosion under turf – none detected except for slight undercutting at end – probing revealed no erosion under turf not removed.

Significant erosion of bare soil down slope (150mm depth and widening)

Runtime 12.45pm to 12.57pm (12min)