LANDLOK® 450, PYRAMAT® 25, PYRAMAT® 75 AND ARMORMAX®

COMPARATIVE PERFORMANCE OF EROSION SYSTEMS USED IN CHANNEL DESIGN

GENERAL:

Soil loss through water borne forces is a major problem facing the world today. Soil loss can historically be attributed to natural erosive processes that have occurred over thousands of years. However, in more modern times, the construction and agricultural activities associated with a developing world have accelerated this process, such that the issues of erosion, subsequent water pollution, increases in ground salinity levels and finally, global warming threats have reached such critical levels that there may be a catastrophic change in the way in which mankind exists. Such outcomes have focused business and government on measures, to mitigate such effects.

The use of appropriate ground stabilisation treatments in combination with appropriate vegetation re-establishment is one very useful technique to minimise soil loss and reduce pollutant entry into natural waterways from earth disturbing construction activities. This note looks at concentrated flows in channels and discusses appropriate treatment methods available to protect existing channels against long term erosion of the channel and control such flows in a structured manner such that the flow path remains stable for long periods of time.

This technical note does not detail the design theory associated with the use of such products in channels. There is a good technical references provided (Reference 1), should the reader wish to fully understand this process. This reference will describe the general theory of "maximum permissible tractive shear stress" and the design approach for varying conditions of flow in channels.

The design approach is of two parts.
Establish the flow conditions.
Determine the degree of erosion protection required.

Flow conditions are a function of channel geometry, design discharge, channel roughness, channel alignment and channel slope.

The required degree of erosion protection can be determined by computing the shear stress on the channel lining (and underlying soil if applicable) at the design discharge and flow duration comparing that stress to the maximum permissible value for the type of lining/soil that makes up the channel boundary.

In simplistic terms, the stress that is generated on the lining can be conceptualized as the mass of water being driven along the channel as a function of channel slope and gravity. To define an appropriate erosion protection measure in terms of velocity regimes is not favoured, as this approach does not account for the extremely differing stresses that can be generated (for varying flow depths), on the channel boundary condition for a constant velocity condition.

SYDNEY
P: (02) 9725 4321
F: (02) 9725 4304

BRISBANE
P: (07) 3865 7000
F: (07) 3865 4444

PERTH
P: (08) 9459 4300
F: (08) 9459 4311

MELBOURNE
P: (03) 9791 1772
F: (03) 9791 1776

ADELAIDE
P: (08) 8384 8894
F: (08) 8384 3886

E: info@globalsynthetics.com.au | **www.globalsynthetics.com.au**

A simplified equation for the calculation of shear stresses is given as:

$\tau d = \gamma \, d \, So$

where ,

τd = the shear stress in the channel at maximum depth

γ = the density of water, 9810 N/m3

d = the maximum depth of flow in the channel for the design discharge, m

So = average bottom slope of the channel, m/m

In general terms the depth of flow will obviously be a major influence on calculated stresses.

Where the calculated shear stresses indicate that grass/vegetative lining is appropriate and where the environment will support grass growth then this option is a preferred option. When the calculated shear stresses exceed such values then a more substantial approach has generally been used.

Historically, to stabilise channels there has been an approach to use "hard armour traditional" solutions to prevent erosion of channels. Such products typically have been concrete, rock and wire mesh baskets.

In more recent years there has been the promotion of various products such as jutemesh, mulch, nets, coconut fibre blankets and synthetic blankets that purport to assist in preventing erosion.

Of critical importance in the use of any treatment to prevent erosion will be the selection of product type and the relevance of the product to perform under long term conditions of use. If the selection is made to use a degradable product then notwithstanding the information provided by the manufacture, selection should only be based upon short term performance with limiting shear stress values adopted, appropriate to vegetated channels. Such degradable products will eventually lose integrity (maybe less than 1 year) with the channel boundary conditions exposed. In worst case examples this will be exposed insitu soils.

If synthetic products are used then both the structure type and product type will influence product performance. Open weave synthetic nets will have little relevance in protecting insitu soils until vegetation is established. In countries such as Australia there will be many areas where it is unlikely that vegetation will be established in the long term. Synthetic products that may be closed faced and offer good protection against soil loss until vegetation is established may not be constructed to withstand the calculated stresses or environmental considerations such as UV deterioration.

Shown in the table below are some probable allowable shear stresses for various product types that may be considered for potential applications of erosion protection. The values adopted are either from manufacturer's data sheets or suggested values from The FHWA HEC 15 Publication- Design of Roadside Channels with Flexible Linings-Third Edition.

TYPICAL INDICATIVE SHEAR CAPACITY TABLE FOR VARIOUS EROSION CONTROL SYSTEMS

PRODUCT/APPLICATION	APPROX. MAX. VELOCITY (M/SEC)	LIMITING SHEAR STRESS (Pa)	FUNCTIONALITY
Bare Soil- Cohesive PI=10		4	Exposed to Erosion
Hydro-seeding	0.6	20	Exposed to erosion until vegetation established
Hydro-mulching	0.6	20	Exposed to erosion until vegetation established
Open Meshes/Nets	1.2	70	Exposed to erosion until vegetation established
Degradable Erosion Blankets	1.8* Long term perfomance	100	Long term performance limited to vegetative cover. Initial protection of soils is good until product degrades. (1 year typical).
Natural Vegetation	1.8	100	Good when established vegetation
Rock D_{50} = 25mm		20	Unslightly and expensive. Poor cleaning and filtering of water.
Rock D_{50} = 50mm		40	Unslightly and expensive. Poor cleaning and filtering of water.
Rock D_{50} = 150mm		120	Unslightly and expensive. Poor cleaning and filtering of water.
Rock D_{50} = 300mm		230	Unslightly and expensive. Poor cleaning and filtering of water.
Geocell Confinement Products	2.7	500	Expensive and labour intensive to install
Fabric Formed Concrete Revetments		1200	Hard armour solution, expensive and unattractive
Interlocking Concrete Blocks	7.9	1200	Hard armour solution, expensive and unattractive
Rock Mattress (170mm-300mm)	5.2	200	Expensive and difficult to vegetate.
LANDLOK® TURF REINFORCEMENT MAT TYPE 450	5.5	480*	Easy to install. Immediate soil cover and good long term performance. Promotes vegetation.
PYRAMAT® 25 TURF REINFORCEMENT MAT	6.1	580*	Easy to install. Immediate soil cover and good long term performance. Close weave so no entrapment of wildlife. Promotes vegetation. High tensile strength >29kN/m
PYRAMAT®75 HIGH PERFORMANCE TURF REINFORCEMENT MAT	7.6	718*	Easy to install. Immediate soil cover and good long term performance. Close weave so no entrapment of wildlife. Promotes vegetation. Very high tensile strength > 58kN/m
ARMORMAX® HIGH PERFORMANCE TURF REINFORCEMENT MAT + GROUND ANCHORS	7.6	766*	Easy to install. Immediate soil cover and good long term performance. Close weave so no entrapment of wildlife. Use with patented ground anchor system for increased FOS and shallow near vertical slope stabilisation and shallow failure planes. Promotes vegetation. Very high tensile strength > 58kN/m

* Values are short term fully vegetated.

REFERENCES
1.Design of Roadside Channels with Flexible Linings- Hydraulic Engineering Circular Number 15, Third Edition. US Federal Highways Authority.
2.Propex Literature (various)- manufacturer of the Landlok®, Pyramat®75 and Armormax® product range. Propex are the owners of the trade names Landlok®, Pyramat®75 and Armormax®.

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