Application of Vetiver Grass Technology in the Stabilisation of Road Infrastructure in the Wet Tropical Region of Australia

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Location of work site

TYPICAL ROAD EMBANKMENT AND DRAINAGE PROBLEMS

HIGHLY ERODIBLE AND INFERTILE SOIL

Fragile and highly erodible

Severe erosion on unprotected cut slope

Chemical Analyses of a Typically Poor Soil in the Wet Tropical Region of Australia

Analyses	Units	Concentrations
pH		7.3
Electrical Conductivity	dS/m	0.01
Chloride	mg/kg	Below quantification
Nitrate-N	mg/kg	Below quantification
Phosphorus	mg/kg	4.0
Calcium	meq/100g	1.4
Magnesium	meq/100g	2.2
Sodium	meq/100g	0.04
Potassium	meq/100g	0.11

Typical example of highly erodible tropical soil of north Queensland

The soil is highly sodic and very infertile with little nutrients or organic matter

TYPICAL ROAD EMBANKMENT AND DRAINAGE PROBLEMS

EROSION OF CUT BATTERS

Severe erosion on newly cut batter in the wet season

New batter, severely eroded within weeks in the wet season

Severe erosion on old batter

TYPICAL ROAD EMBANKMENT AND DRAINAGE PROBLEMS

EROSION OF FILL BATTERS

Badly eroded fill batter

If unprotected this road shoulder will be easily eroded by high intensity storms

Conventional concrete shoulder dykes are expensive and ineffective in protecting road shoulders on this highly erodible environment.

Hard rock protection are commonly used but it is also ineffective

Hard rock structures often failed due to undermining

TYPICAL ROAD EMBANKMENT AND DRAINAGE PROBLEMS

EROSION ON STEEP BATTERS AT CULVERTS INLETS AND OUTLETS

Steep batter at culvert outlets is highly erodible

Highly erodible batter at culvert outlets

Highly erodible batter at culvert outlets

Highly erodible batter at culvert outlets

Highly erodible batter at culvert outlets

Highly erodible batter at culvert outlets

Undermining of concrete shute

This concrete shute will collapse due to erosion and undermining.

TYPICAL ROAD EMBANKMENT AND DRAINAGE PROBLEMS

GULLY EROSION

Roadside gully erosion

If let unchecked gully erosion can eventually undermine road pavement

Unless repaired this gully will shortly undermine the road in the background

TYPICAL ROAD EMBANKMENT AND DRAINAGE PROBLEMS

TUNNEL EROSION

Underground piping threatens the stability of road pavement.

If unchecked this pipe will eventually cause the road to collapse

RESULTS OF TRIALS

CUT AND FILL BATTER PROTECTION

Fill batter stabilisation

Three months after planting

Three months after planting

Three months after planting

Seven months later

Highly erodible cut batter prior to vetiver planting

Three months after planting

General view, three months after planting

General view, seven months after planting

Completely stabilised seven months after planting

Hydromulching three months after planting

Hydromulching seven months after planting

RESULTS OF TRIALS

GULLY EROSION CONTROL

Gully erosion stabilisation

Gully erosion stabilisation

RESULTS OF TRIALS

SUBSTITUTION OF CONCRETE SHOULDER DYKES WITH VETIVER HEDGES

Expensive concrete shoulder dyke built to protect culvert out let

Vetiver hedges planted on edge of road shoulder provide same protection but cheaper and more effective

Vetiver hedges planted on edge of road shoulder to protect culvert inlet

Vetiver hedges planted on edge of road shoulder to protect culvert inlet, note no erosion

Vetiver hedge traps loose road gravel, reinforcing the road shoulder

Collect and divert surface runoff to concrete shute

Concrete shute inlet

Vetiver outlet used to drain off water accumulated along shoulder dykes

Vetiver outlet along concrete shoulder dyke

RESULTS OF TRIALS

EROSION CONTROL IN WIDE TABLE DRAINS

On highly erodible soil, rock check dams along wide table drain do not work as water just cut through the side.

On wide table drain, short rows of vetiver planted on contour line , spread water flow, reduced flow velocity and trapped sediment.

Short rows of vetiver planted on wide table drain will spread water flow, reduce flow velocity and trap sediment.

Short rows of vetiver planted on wide table drain will reduce erosion

Short rows of vetiver planted on wide table drain will reduce erosion

General layout

A series of well laid out vetiver rows provide effective erosion and sediment control on wide table drain.

RESULTS OF TRIALS

PROTECTION OF RIP-RAP ROCK AND ROCK CHECK DAM

The deep root of the vetiver row stops water from undermining the rock cover of this shute

The deep root of the vetiver row stops water from undermining this rock check dam

The thick hedges spread water flow and the deep root stops water from undermining the rock cover

The thick hedges can be used to divert water flow into more protected surface

APPLICATIONS IN NEW ROAD CONSTRUCTION

PLANTING MATERIAL

Left: **A good quality tube stock with at least 3 advanced shoots and well developed roots is recommended**

Right**: This immature tube is not acceptable**

Good quality planting material was delivered and kept fresh in stockpile area close to road work

APPLICATIONS IN NEW ROAD CONSTRUCTION

Stabilisation of steep batters above culvert inlets and outlets

Typical erosion on unprotected batters of culvert inlets and outlets

Typical erosion and sedimentation problem on unprotected batters of culvert inlets and outlets

Steep batter protected by vetiver hedges

Steep batter protected by vetiver hedges

Steep batter protected by vetiver hedges

Close up view of steep batter protected by vetiver hedges

Close up view of steep batter protected by vetiver hedges

Close up view of steep batter protected by vetiver hedges

Three weeks after planting

APPLICATIONS IN NEW ROAD CONSTRUCTION

Stabilisation of road batters

Batter protected by vetiver contour planting at between 0.5 and 1.0m Vertical Interval

Three weeks after planting

Three weeks after planting

APPLICATIONS IN NEW ROAD CONSTRUCTION

Protection of rock structures

Undermining of rock structures on erodible soil is prevented by the deep and extensive root system of vetiver grass

Three weeks after planting

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Three weeks after planting

Surface erosion around rock structures at culvert inlets and outlets built on erodible soil is minimised by spreading concentrated flow

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Three weeks after planting

These hedges will spread and slow runoff water from this steep slope

These hedges will spread and slow runoff water from this steep slope

COSTS SUMMARY

AND

CONCLUSION

Cost Summaries

Road Batter Protection	AUD Per linear metre	AUD Per square metre of batter face
Vetiver hedges on Cut Batters	18.40	21.40
Vetiver hedges on Fill Batters	15.50	18.20
Culvert Protection		
Vetiver hedges		18.20
Grouted rock pitching		65.75
	Saving	73%
Road Shoulder Protection		
Vetiver hedges	15.50	
Traditional concrete shoulder dykes	38.00	
	Saving	60%
Table Drain Scour Protection		
Vetiver contour hedges	15.50	
Traditional hard rock check dams	42.00	
	Saving	64%
Miscellaneous Protection Work		
Vetiver hedges generally	15.50	
Steel wire rock mattress		43.00
	Saving	64%

CONCLUSIONS

- Vetiver hedge can be rapidly established in arid conditions and poor soils with little if any nutrients.
- Once established vetiver hedges are maintenance free and withstand arid and dry season conditions including bush fires.
- Provides protection to steep cuts and fill batters resulting in substantial savings in earthwork costs.
- Encourages sheet flow and reduced water run-off velocities resulting in natural vegetation re-growth and prevention of erosion.
- Eliminates undermining of hard rock structures
- Effective alternative to hard rock check dams
- Effective prevention of gully erosion
- Very cost effective, with savings ranging from 73% for culvert protection to 64% for table drain and is miscellaneous protection works and 60% for road shoulder protection.
- In highly erodible soils, the most important advantage of vetiver technology over conventional structures is that rock structures themselves are not stable and required constant maintenance to protect the road works which will add to the overall operating costs of infrastructure in the long term.


THANK YOU