



Geotextile reinforced soil (GRS)

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Figure 1. A piece of geotextile fabric is laid on the compacted fill.



Ed Proteau photo

A gully-crossing problem near Holberg on Vancouver Island has generated an innovative technique to stabilize road-cut slopes and construct road-fill slopes within steeply sloping terrain.

Road fills are conventionally used to reduce the environmental impact and long-term maintenance costs associated with full-bench endhaul construction on forest roads. Decreasing the amount of material moved and the height of the cutslope improves both drainage and slope stability. However, traditional retaining wall systems are expensive to purchase, transport, and construct. These systems require careful site layout and ongoing engineering control during construction, and may not tolerate shifts associated with soil movement and settlement.

To overcome the drawbacks of traditional retaining wall systems used in forest road construction, Terratech Consulting Ltd., a BC-based geotechnical engineering firm, working with Western Forest Products (WFP) on a branch road near Holberg, BC, created a geotextile reinforced soil (GRS) fill for a problem gully crossing.

This article provides a summary of the design and construction process.

Site conditions

The problem gully near Holberg had the following characteristics:

- steeply sloping (at 90%) 5 m-deep with a S6 stream classification
- special management area requiring 100% end-hauling
- full-bench cut into and out of the gully
- steep, high bedrock outcrops fractured heavily on the surface

Equipment and materials

GRS fill materials consisted of welded wire forms, rolls of Mirafi® HP370 geotextile, and HC drain—all of which are easily transportable. A few hand tools (shovels and rakes, carpenter’s level, bolt cutters, razor knives, and wire-bending tools) were required to assemble the GRS structure. An M32 tank drill, a Komatsu® 400 excavator, a D6R bulldozer, a 25-ton articulated rock truck, and two large vibratory plate compactors were used to construct the fill.

Costs

Materials were relatively inexpensive and represented only 15% of the gully crossing’s total cost. WFP believes that the GRS technique was no more expensive than any of the crossing options considered, safer to construct, and gave the best road alignment.

Materials (including transport to site)	\$10,800
Equipment and labour to construct	\$53,700 (including pilot trail construction)
Engineering	\$5,500
Estimated total cost (taxes included)	\$70,000 (or \$560 per m ² of fill face)

Design

The planning and design included identification and evaluation of alignment options, and a geotechnical assessment and design of the GRS structure in co-ordination with the geometric road design. The design incorporates three simple rules:

1. Keep reinforcement spacing less than 0.3 m.
2. Provide good compaction of the mineral soils.
3. Provide internal drainage within and behind the GRS fill.

Drainage was provided with a free-draining geotextile fabric and rock fill, outsloped layers and drains to collect and direct water in the fill to the face, and a sump drained by a culvert in the top row of the fill to handle high winter stream flows.

Construction

The construction process involved:



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Figure 2. Wire forms are set slightly inwards from the row below.



structures for forest roads

- a field survey to establish proposed road centreline based on the road design,
- excavation of a road to the gully edge,
- excavation of a pilot trail into the gully, and
- scaling of fractured rock from the exposed rock faces in the gully.

Excavated materials were stockpiled in stable locations close by. After the outside edge of the road grade was located, the excavator dug vertically downwards from this line to create a flat bench within the bedrock at the gully centreline. This bench formed the initial foundation for the GRS wall.

The bench was given a 6% adverse grade parallel to the road centreline and then compacted. A wire form was placed on the bench and trimmed to conform to the bedrock. Small aggregate was spread under the wire to fill in gaps and straighten the form. A piece of geotextile fabric was laid on the compacted fill with half of its width draped down the front of the wire form (Figure 1). A 30-cm lift of fill was placed on the fabric and finished with a slight outslope. Oversize rock and woody debris were sorted out by hand or by the excavator, and discarded. A plate compactor was used to compact the lift. Wet weather and lack of fines precluded the need to add water during compaction. The hanging geotextile fabric was then pulled over the compacted lift and sliced at all strut locations so that it was tight against the face of the form. The excavator placed a slightly outsloped second lift of material up to the top of the wire form. The row was finished by compacting the second lift.

Subsequent rows were placed at the same 6% grade, with wire forms set slightly inwards from the row below (Figure 2). The 3 m-long wire forms were custom-fitted to the exposed bedrock by joining together forms and (or) trimming to length. A simple bending tool was used to manually twist the 10 cm wire extensions, which are fabricated at one end of the forms, through the adjacent form, thereby creating a strong connection. As the height of the wall increased, the width and length of the fill increased. The extra width allowed room for more geotextile in the lifts and this, in turn, improved the overall global stability of the GRS structure. **Al Bradley** (FPIInnovations, Feric Division roads researcher) notes that, “this type of fill structure’s environmental footprint was minimal because of the use of *in-situ* materials and because the fill face was vertical rather than needing to be sloped and thereby extending far down the steep gully.” The extra length and width also permitted two compactors to be used simul-


taneously with the smaller, more manoeuvrable compactor working near the wall face.

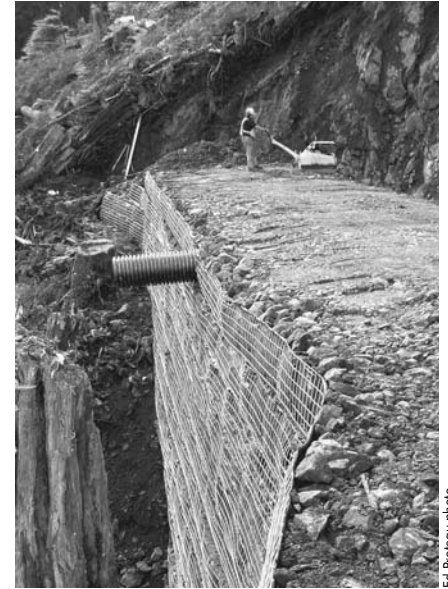
Rows continued to be added until the desired road elevation was obtained. The 50 cm diameter culvert was installed in the top row with a hole for it cut through the geotextile and wire form face (Figure 3). The crossing was finished with guard logs, and with small shot rock used to fill inside of the road (creating a shallow ditch and sump) and add a 0.5 m thick running surface. The completed fill was 8 m high at mid-gully, 30 m long, and supported a 6 m wide roadway. Construction took 7 days after the pilot trail was completed—6 days to build the GRS fill and 1 day to add a road surfacing course, fill the inside ditch, and place guard logs.

Conclusion

Geotextile reinforced soil provides a minimal environmental footprint and a practicable alternative to minimize costly full-bench endhauling while providing a safe and long-lasting product. In addition, GRS fills:

- allow high load-carrying capacity (e.g., load-bearing bridge abutments)
- withstand a significant amount of total and differential settlement
- sustain a vertical (or even slightly outwards leaning face) slope even without a facing unit
- resist corrosion and bacterial action
- prevent erosion if vegetated

Bradley notes that, “one disadvantage of GRS fills is that they require a lot of manual labour to construct; however, construction is relatively straightforward to learn and both labourers and machine operators rapidly improvised methods to speed construction.” The construction costs in most situations are lower than those of traditional retaining wall systems. Thus, forest managers have another option when deciding on road alignment options and road-building techniques. Although this road-building process is not ideal for every gully crossing, it may be optimal when the life-cycle costs of full-bench endhaul sections are too high. **Calvin VanBuskirk**, of Terratech, and Bradley will co-author a FERIC Advantage report on GRS road techniques this year that will provide further details on the Holberg structure. 



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Figure 3. The 50 cm diameter culvert was installed in the top row with a hole for it cut through the geotextile and wire form face.

More information

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