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Schutzbauten

Debris Flow and Shallow Landslide Mitigation

Shallow Landslides - *some times holding back is a good thing*

A catchment fence with downslope drainage installed to protect a cemetery from shallow landslides.

The utility of flexible net systems for mitigating the effects of shallow landslides, earth slumps and mudflows has long been known from incidental events that occur along side rockfall events, into traditional catchment fences. Yet it is only more recently that such systems are being specifically constructed for this purpose.

The cross-over of rockfall catchment fences to the mitigation of soil/earth mass wasting processes is facilitated by the founding characteristics of these systems, namely their:

- ability to accommodate large energies, displacements and volumes of material;
- flexibility to conform to topography;
- minimal material and foundation requirements.

Furthermore, since the primary interception structure of the systems is a mesh or net, water can drain freely from the slope while the material is contained. This means that drainage systems downslope of the catchment fence will not be clogged with debris, which is often a secondary affect of shallow landslides that has large consequences for infrastructure and general maintenance.

After the initial dynamic impact, material is retained by the cable nets and allowed to freely drain.

Flexible net systems are an effective and cost efficient method of reducing the effects of shallow landslides, earth slumps and mudflows.

Unlike rockfall catchment fences that are designed, certified and installed as modular systems with minimal design input parameters, shallow landslide barriers require more site specific information.

Each system is designed based on information provided by the field engineer regarding the physical characteristics of the material, the site geometry and the nature of the mass wasting event. This evaluation on a site-to-site basis is the only way to arrive at a technically correct solution and safe system.

Shallow landslide barriers can be installed on steep slopes where stabilization methods would require more invasive techniques and often be too costly or unpractical.

Following an event, the material can either be removed through access from behind the system or by opening the nets in the affected sections. It is not necessary to dismantle the entire system and most components can be re-used.

In general, there are several advantages of flexible net systems over more traditional mitigation measures:

- less invasive with regards to disturbing the natural slope;
- lower material costs;
- lower installation costs;
- quicker installation;
- easy of maintenance;
- environmental friendly.

Debris Flows - *taking the debris out of the flow*

Depending on the nature of debris flow, varying mesh sizes can be used to filter out the desired fraction of debris. In this example, a fine mesh has been applied to the primary net structure to help retain the smaller particles.

The application of flexible net systems to debris flow mitigation is similar to that of shallow landslides in that each system is designed for a specific site based on the local geotechnical and geomorphological characteristics, as well as the anticipated characteristics of the flow itself. Thus, debris flow systems are better suited for nuisance sites where information from past events can be collected.

The primary goal is not only to stop the debris from traveling further downslope but also a large emphasis is on dewatering the material so that a natural dam forms behind the barrier. This reduces the loading on the system and aids in the retention of subsequent pulses of debris.

Flexible net systems are useful tools for dewatering saturated flows.

When compared to shallow landslide systems, there are normally much larger dynamic and static forces acting on the debris flow structures due to the fact that most installations are planned where debris flows act as relatively fast-flowing, confined flows. As such, the structures tend to be taller but much narrower than shallow landslide systems and are situated in a topographically controlled channel.

Along with the dewatering properties, the flexibility of the system leads to lower forces acting on the structure. Subsequently, these systems use much less material than a rigid and/or non-permeable system designed to withstand similar forces.

For narrow gullies, no posts are required. The net structure is hung on transverse bearing ropes that are fitted with energy dissipating brake elements. Under ideal circumstances, the gully is bedrock controlled. In unconsolidated material, care must be taken that proper anchoring is available which may sometimes require lateral foundations.

The below structure spans a 30 m gully and stands 6 m tall. It is intended to have a retention capacity of approximately 3000 m^3.

In this example, a 4 m tall debris flow system is used to protect a railway in a partially unconfined deposition area.

The hinge connection between the primary upright and the support brace, in this case made with a 70 mm pin.

Unique to Trumer systems is the Lambda-Frame that eliminates the need for upstream retaining ropes while at the same time provides very sturdy support to the net and bearing ropes which minimizes the reduction of net height during an event and the elongation of the system. Another large benefit is that the system can be installed at topographically unconfined sites.

Systems spanning approximately 12 m can often be built without the use of posts. Wider systems require either standard I-beam posts or reinforced posts with concrete foundations. With or without posts, debris flow systems by Trumer are simple and quick to install. They are designed to use as few components as possible to aid installation and maintenance after an event.

Special attention is given to connection points between movable components to ensure they are robust and functional. This includes bearing rope connections to anchors that are always made with both thimbles and high-strength shackles to pivot points on posts that use over-sized pins.

All steel components are hot-dipped galvanized and wire ropes are offered in both heavily galvanized as well as Zn-Al galvanization in the highest class.

The Omega-Net packages allow for quick installation using no shackles to connect the bearing ropes. Once the bearing ropes are tensioned, the nets open like a curtain.

The hinged base plates for the posts and braces are connected to the foundation using short bar anchors or bolts.

Debris flow systems share many of the same advantages over traditional mitigation structures as the shallow landlside systems:

- less invasive and require less room;
- lower material and installation costs;
- quicker installation;
- easy of maintenance;
- environmental friendly.

Multiple bearing ropes are used to ensure that the structure can withstand the static loading and dynamic impacts over the entire height of the structure.

To help dissipate energy during dynamic loading of the systems, special brake elements are used that plastically deform. The brake elements are found only at anchor points, at the perimeter of the system for ease of installation and maintenance.

A variety of anchor systems can be used including standard bar anchors, wire rope anchors or anchor block foundations. These connection points can also be fitted with monitoring equipment or triggers for alarms.

Wire rope anchors can be used to provide flexible anchorage. All connections are completed using high strength shackles and heavy-duty round thimbles for ease of installation and maintenance.

Where there is no bedrock available for anchoring bearing ropes, a concrete foundation with tie-back anchors can be used. Also note, the alarm triggers installed on the brake elements.

TRUMER Schutzbauten

Europe

Trumer Schutzbauten GmbH
Weissenbach 106
5431 Kuchl
Austria

Tel.:+43 6244 20325
Fax: +43 6244 20325-11
E-mail: office@trumer.cc

www.trumer.cc

Trumer Schutzbauten GmbH
Fronmüllerstrasse 71
90763 Fürth
Germany

Tel.:+49 911 97095-62
Fax: +49 911 97095-13
E-mail: deutschland@trumer.cc

www.trumer.cc

North America

Trumer North America
14900 Interurban Ave S., Suite 271 #19
Seattle, Washington 98168
United States

Tel.: 1-855-732-0325
E-mail: usa@trumer.cc

www.trumer.us

Trumer Schutzbauten Canada
720 - 999 West Broadway
Vancouver, BC
Canada, V5Z 1K5

Tel.: 604-732-0325
Toll Free: 1-855-732-0325
E-mail: canada@trumer.cc

www.trumer.ca