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A83 Trunk Road Route Study

Consultation Response Paper

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1 Introduction

1.1 Project Overview

Jacobs was appointed by Transport Scotland to undertake a study of the A83 Trunk Road to identify and appraise potential options to minimise the effects of road closures, investigate the feasibility of removing traffic pinch points and improve pedestrian safety in villages along the route.

The draft A83 Trunk Road Route Study report was published on 14 December 2012 on the Transport Scotland website and was also presented to the A83 Taskforce. Part A of the report examines the issues at Rest and Be Thankful while the Part B report considers issues along the length of the A83 Trunk Road between Tarbet and Kennacraig.

A further report (Winter and Corby, 2012)[1] was also published in December 2012 and this examines a range of other landslide mitigation options including slope vegetation which forms part of the Red Option proposals in the Jacobs report.

The A83 Taskforce agreed to a period for consultation to allow Taskforce members, local stakeholders and members of the public to comment on the findings of the study. Comments were received to the project e-mail address A83study@transportscotland.gsi.gov.uk

All stakeholders who attended the initial project workshop in August 2012 were notified by e-mail of the consultation period and were invited to send in their comments.

The consultation period closed on 29 January 2013.

1.2 Consultation Feedback

During the consultation period the project team presented the findings of the report at a technical workshop for A83 Taskforce members and local stakeholders and attended a full meeting of Argyll and Bute Council on 24 January 2013.

Consultation correspondence was received from eight members of the public and the following six public bodies or organisations -

- Argyll and Bute Council
- Ardrishaig Community Council
- Tarbert and Skipness Community Council
- Mid-Argyll Chamber of Commerce
- Highlands and Islands Enterprise
- Friends of The Rest

The correspondence received included the following reports commissioned by others in response to the Jacobs and TRL reports -

[1] Winter, M G and Corby, A (2012). A83 Rest and be Thankful: Ecological and Related Landslide Mitigation Options. Published Project Report PPR 2300. Transport Research Laboratory, Wokingham.

- Phillips, J (9 January 2013). A83(T) Glen Croe, Argyll. Report on possible causes of erosion
- Addison, J (22 January 2013). Argyll A83: Rest and Be Thankful. Some observations on the problems of road closures.

1.3 Purpose of this Paper

The purpose of this paper is to provide a response from the A83 project team to the issues raised through the consultation process. The comments received have been summarised to identify the principal issues of concern, to which a response has then been prepared. This allows comments of a similar nature to be grouped together and allows the full context of the comments to be presented openly and fairly without identifying individual respondents.

1.4 Format of the Paper

Comments have been grouped together to reflect the part of the Study Report to which they relate. Comments relevant to Part A of the Report have been grouped as follows –

- Analysis of Problems and Opportunities
- Option Generation and Sifting
- Engineering and Environmental Assessment
- Traffic and Economic Assessment
- Conclusions

Comments relevant to Part B of the report have been grouped as follows:

- Analysis of Problems and Opportunities
- Engineering and Environmental Assessment

The text highlighted in grey text boxes is a summary of the consultation feedback received from correspondents. The comments made in the grey text boxes do not represent the opinion of the project team.

The report text following the grey text boxes provides the response from the project team.

2 Part A Report Consultation Feedback

2.1 Analysis of Problems and Opportunities

A.1 Why does the report not include the debris flow event of 19 November 2012?

The report was submitted to Transport Scotland on 31 October 2012 and landslide closures between 1 January 2007 and 31 October 2012 have been considered. The event of 19 November 2012 was of shorter duration than previous events and if it were to be included it would only alter the average annual duration of closures very slightly. The study included a range of sensitivity tests in section 9 which included a test for larger disruption based on annual road closures due to landslides totalling 13 days.

A.2 Why does the report not include details of the road closures due to landslides prior to 1 January 2007?

While dates of earlier landslide events are known, it has not been possible to gather reliable records of the date/time of the start and end of the resulting road closures.

A.3 Detailed observations by those who have the benefit of local knowledge suggest that there are only three gullies which are the main sources of recent debris flows and road closures.

Based on the recent failure data (from 2007 to 2012) there would appear to be five locations on the existing A83 where debris has reached the road; this includes three well defined channels or gullies which extend well up the hillside and two shallow slip failure areas immediately above the road. The observation that there are only three gullies which are the main sources of the debris flows is therefore essentially correct for the recent history of events. Records prior to 2007 are more limited; however there are at least two further known failure locations above the road, including a large slip on the hillside close to the bridge over the River Croe adjacent to a plantation area and a layby at the south end of the section of concern (now infilled with rockfill), and a channelised debris flow at the uphill end where a new cascade and culvert was constructed around 2003 to address the hazard potential.

As discussed in the Route Study report, the drainage pattern on the hillside is dynamic, changing over time in response to the active geological processes of erosion and deposition together with localised landslips which can block channels forcing water elsewhere. The locations of future failures cannot therefore be predicted with any certainty, and to take the approach of only protecting locations which have previously experienced failures presents a reasonably high risk and may prove to be ineffective in the longer term. It is worth noting that all of the five recent failure locations referred to above have, or are in the process of, being protected with debris barriers/fences or other measures such as a catch pit (Phase 3 for August 2012 failure), totalling over 250m of debris flow barrier.

In relation to the suggestion that there are a limited number of channels causing the majority of the road closures, the idea of a 'mini brown' route option has been proposed during the consultation process. This would comprise short lengths of debris shelters at these discrete channel locations. There are a number of potential issues/constraints to consider in relation to this proposal.

The discrete debris shelter option would be best suited to well defined channels where debris flows could occur rather than the broader areas identified where there is the potential for shallow translational slips. For the protection of channels, structures typically of the order of 30 – 40m in length are likely to be required. These are likely to be visually intrusive, perhaps more so than the full length shelter (Brown Option), due to the requirement to channel the debris across the road over the structure, with high sidewalls profiled to encourage flow, otherwise the debris will merely spread around the structure onto the road. With the full length debris shelter, the ends of the structure can be located a sufficient distance away from the nearest potential failure area such that high sidewalls to divert the debris would not be required and an essentially planar roofed structure could be adopted. This would be less of an issue at the uphill end, as gravity would be working against the debris flow.

The debris shelter concept design outlined in the Report requires that the road alignment is altered to allow traffic management during construction. If a number of discrete debris shelters were proposed reasonably close together then there would be issues providing a flowing road alignment as the alignment switched from the line of current road to the new alignment.

While the project team agree in principal about the merit of protecting the specific sections at higher risk of landslides, this is not considered sufficient as a long term solution and there is a potential risk of landslides occurring elsewhere along this section of the road due to the changing drainage patterns developing on the hillside above the road. The project team has concluded that sufficient protection can be provided by a combination of additional debris flow barriers, improved drainage measures and slope vegetation rather than an engineering structure such as the debris flow shelter.

A.4 The project team received a number of detailed comments in relation to the Emergency Diversion Route which is being brought into use in early 2013 along the Old Military Road.

The decision to proceed with the Emergency Diversion Route was taken prior to the start of Jacobs' commission for the A83 Trunk Road Route Study. Comments on the proposed operation of the Emergency Diversion Route are not addressed in this study.

A.5 The report does not take into account the number of days when there is a "High Landslide Risk" warning, indicated by the flashing warning signs.

The flashing warning signs (or Wig-Wags) are subject of a separate pilot study being undertaken by Transport Scotland and will be subject to separate evaluation and reporting. When these flashing warning signs are activated, the message that they convey is "exercise caution", and the road remains open.

A.6 The report does not describe the landslide risks at other locations on the rest of the A83 trunk road.

The Engineering Assessment chapter of the report does include a discussion on the landslide hazard at other locations on the A83 trunk road at section 6.4. The report recommends actions to address the ground related hazards at other locations on the A83, in particular at Glen Kinglas, Cairndow and Loch Shira to give a comparable level of landslide protection to that proposed at the Rest and Be Thankful.

A.7	The extent of study area chosen for this study and defined in chapter 2 has been queried.

The project team acknowledge the wider region served by the A83. However for the purpose of the economic impact assessment, the area was defined as Cowal, Mid Argyll, Kintyre, Islay, Jura and Colonsay. It is accepted that Colonsay is served by ferry from Oban rather than Kennacraig. The project team considered that since other areas such as Oban with its Inner Hebrides and Western Isles links had an alternative route via the A82 and A85 these areas were not included in the economic impact assessment contained in Appendix F to the report and summarised in section 2.8.

A.8	The socio-economic context presented in chapter 2 of Appendix F and summarised in section 2.4 presents a reasonable overview based on national statistics, but there are some important key omissions in the key industries section. The energy and food & drink sectors have important roles in the economy of the study area, and also a strong reliance on transport. Whilst some analysis of tourism is included, this does not give a full picture of the nature and significance of this in the economy.

Additional information has been added to these sections to highlight the role of these sectors in the local economy.

A.9	The economic impact assessment presented in chapter 4 of Appendix F, and summarised in section 2.8 of the main report is a very narrow assessment based on measurable direct impacts of road closures. In itself this is fine, but we would like to see much greater recognition given to wider impacts, even if these can only be described qualitatively or anecdotally, with more open acknowledgement that these calculations represent only measurable, direct impacts.

Section 2.8 of the main report has been revised in order to note anecdotal evidence of wider impacts.

2.2 Option Generation and Sifting

A.10	Creating options to abandon the current route entirely has to be viewed as a poor engineering approach. The character of the current problem suggests a serious need for “how to think” rather than “what to think” about them. The inherited asset and the obvious advantages of the current road must be focussed on as a priority.

It was necessary to examine a wide range of potential options as part of this study including options to abandon the current route entirely, in order to assess these along with options to improve and protect the current A83 trunk road. The project team agrees that on balance, it is better to provide landslide mitigation and protection measures to the existing road rather than develop an entirely new road corridor.

A.11 The report has not considered the option of providing a new road along the green corridor to be used in addition to the existing road. Inveraray-bound (uphill) traffic could use the new route in the green corridor and Tarbet-bound (downhill) traffic could use the existing A83. If one carriageway was closed for any reason (e.g. landslide or road traffic accident), traffic could operate in two-way contra-flow on the other carriageway.

This option was proposed to the project team at the Stakeholder workshop and was considered during the study and is described in the report at section 4.5.6.1.

The green option was evaluated as a replacement single carriageway route to current alignment and cross section standards for a single carriageway rather than as additional to the existing road. It was felt that should there be a significant investment in a new route alignment, it would not be reasonable to still retain the maintenance burden of the existing route. The report also comments that the existing A83 alignment is not currently of a sufficient standard to operate as a two-lane carriageway for downhill/Tarbet-bound traffic.

2.3 Engineering and Environmental Assessment

A.12 The engineering measures proposed as the Red Option in the form of debris flow barriers are not considered to provide sufficiently effective protection from future landslides, in particular the typical "soil slurry" that is a feature of many landslides at this location.

The Red Option includes substantial drainage measures in combination with the installation of further debris flow barriers. These drainage measures are recommended in order to improve the pathway for water and landslide debris in the form of a slurry and to channel them under the A83 during normal conditions and during debris flow events.

The use of debris flow barriers is well established in the containment of failed material from debris flows or landslides in mountainous terrain, with many examples of their installation and performance. Manufacturers' details relating to the design of the barriers, together with case histories provided by two potential barrier suppliers are included in Appendix A.

The results of research and testing carried out on debris flow barriers, supported by the case history examples, demonstrates their effectiveness in containing failed materials provided the barriers are properly designed and installed. There will inevitably be some uncertainty as to the volume of materials potentially involved in a possible failure and realistic and conservative assumptions must be made in this respect.

With regard to debris flows, where the failed material is essentially supported by a fluid medium, it is likely that some debris in the form of a slurry may pass through the barrier, at least initially until the debris has built up sufficiently behind the barrier. This material however is unlikely to cause any major disruption to the road due to the relatively small volumes involved which could be accommodated by the open ditch drainage system with under road culverts, provided these are upgraded adequately as part of the debris barrier solution.

Of the debris barriers that have already been installed along the A83 at the Rest and Be Thankful, none have been 'tested' during an actual landslide event and local opinion regarding their performance and effectiveness remains sceptical. The technical information provided by potential barrier suppliers addresses this issue and should hopefully allay any fears that the barriers will not be effective.

A.13 The Red Option is the cheapest option and this has been favoured instead of the Yellow Option which is considered to be more effective in reducing closures.

Although the Red Option has the lowest estimated cost it still represents a significant investment in landslide mitigation on the A83, and is not a "cheap" solution. In addition to recommending the Red Option at Rest and Be Thankful, the report also recommends actions to address the ground related hazards at other locations on the A83, in particular at Glen Kinglas, Cairndow and Loch Shira. This recognises the importance of providing a comparable level of landslide protection along the length of the A83 Trunk Road.

The report presents the Red Option as the one which meets the study objectives and is the most cost-effective in addressing the landslide hazard at the Rest and Be Thankful.

A.14 Since you are saying that with the Red Option the beneficial effects of planting will take 15-35 years, does this mean that the emergency diversion route will be in use for 35 years?

The report states that the Emergency Diversion Route would be required until the proposed Red Option measures had provided sufficient protection to the A83. Sufficient protection would be provided once the additional debris flow barriers and additional drainage measures were constructed. While the overall programme for this work depends on a number of factors, it should be possible to complete this work in no more than 2-3 years.

A.15 One consultation response proposed the construction of interceptor catch drains integral with a terraced access track benched inward to bedrock. The purpose of these catch drains is to intercept surface and sub-surface run-off and convey it down the hillside.

It is recognised that there are two main failure mechanisms affecting the hillslopes above the A83, namely shallow translational slips (landslips) within the superficial deposits, and channelised debris flows, the latter being more common in recent time. The suggestion has been made that interceptor land drains could be installed on the hillslope above the A83 to prevent failures occurring. It is accepted that effective management of surface water is the critical element in preventing such failures on the hillside, however the practicality and feasibility of providing this is a significant issue. In order to be effective, extensive drainage measures would be required given the large catchment area and the extent of the hillside area where failures could be initiated. This approach would involve major civil engineering works to provide access roads and relatively deep cut off ditches to intercept the water where it can reach rockhead. Controlled discharge of the water downslope towards the road would also require to be engineered, potentially comprising buried pipework, or lining of the existing major watercourses.

All of these works would lead to a significant visual impact on the hillside. There would also be a significant concern that in forming these drainage channels and access roads that the works themselves may lead to instability, at least in the temporary construction phase.

The suggestion that a couple of drains would suffice is considered inadequate to address shallow slip failures. Such drainage proposals would not address the other main failure mechanism, i.e. concentrated channelised debris flows.

2.4 Traffic and Economic Assessment

A.16 The BCR values for each option are impenetrable and unevidenced.

The calculation of the BCRs has been conducted using standard economic welfare techniques used by Transport Scotland (and by the Department of Transport), as set out in the Scottish Transport Appraisal Guidance (STAG). This methodology is used by Transport Scotland for all transport assessments and is based on evidence and practice developed over decades.

The values presented in the report are –

- *Present Value of Benefits (PVB)*
- *Present Value of Costs (PVC)*
- *Net Present Value (NPV) = PVB – PVC*
- *Benefit/Cost Ratio (BCR) = PVB / PVC*

The Present Value of Benefits (PVB) is the estimated cost savings (through. the avoidance of adverse economic impacts) that may result from implementation of each of the options. This is approximated using the change in travel time and vehicle operating costs, based on alternative travel by the Emergency Diversion Route rather than the A83. The key data include actual traffic flows (i.e. the number of people affected); journey time disbenefits based on people's valuation of changes to journey time, built up using survey evidence; and the average number of days on which the road is closed.

The Present Value of Costs (PVC) for each option includes the capital costs (based on the mid-point of the estimated cost range) and maintenance costs.

All figures are in standard 2010 discounted market prices.

A.17 The economic assessment figures used to evaluate the options appear only to take into account the additional cost of travelling the alternative routes in the event of closure. They do not take any account of the other (and far greater costs) suffered by local business e.g. lost accommodation bed nights, lost income from visitors deciding to go elsewhere, goods being late to market, goods deliveries being delayed and therefore not sold, lost long term business development opportunities resulting from the poor quality and unreliability of the A83.

The economic assessment was conducted using standard economic welfare techniques used by Transport Scotland (and by the Department for Transport). The transport costs and benefits captured under this approach are intended to represent an acceptable approximation of the full impacts of a project, expressed in terms of economic welfare.

Details of the standard economic welfare techniques are available at Transport Scotland's website:
http://www.transportscotland.gov.uk/strategy-and-research/scottish-transport-analysis-guide/stag/td

The parallel socio-economic impact study, undertaken by Optimal Economics, has attempted to quantify the other impacts on local businesses, with the annual loss of GVA estimated at £286,300 (in 2010 prices). Please note that these estimated impacts are complementary and should not be added together.

It is important to note that finding higher impact figures would make no difference to the ranking of options in terms of their relative cost-effectiveness.

2.5 Conclusions

There were a number of consultation responses which expressed a different conclusion in terms of the preferred solution to that of the project team. These comments have been received by Transport Scotland and have been noted.

A.18 Any option that fails to offer the prevention of road closures should be considered as non-compliant and should not be considered at all.

A.19 The low-cost option carries too much risk of landslips occurring. Investment in debris flow shelters, as in the Brown Corridor Option, or viaducts as in the Yellow Corridor Option, would seem to put the risk of landslips at a much lower level.

A.20 The construction of the Green Corridor Option, as an alternative diversionary route, is my preferred option. The Green Corridor Option provides an equivalent alternative “trunk” road route to the existing A83 and it is considered that its construction would reduce the risk of route closure through landslide to be an acceptable level, i.e. the likelihood of landslide events occurring simultaneously on both the existing route and the alternative route is considered to be minimal.

The objectives for this study were framed in terms of reducing the frequency and duration of road closures due to landslides rather than preventing or eliminating these closures altogether. The project team believe that the Red Option provides a cost effective way to significantly reduce the risk of road closures due to landslides to a comparable level to other rural Trunk Roads in similar terrain.

3 Part B Report Consultation Feedback

3.1 Analysis of Problems and Opportunities

B.1 The project team received information relating to additional problems experienced along the A83 that were not identified in the report. The following issues have been raised in recent correspondence,

- The road immediately north of the Aray Bridge is superelevated with an inland inclination trapping water breaking over the sea wall and leading to flooding. This requires effective drainage.
- The north junction of the A83 and B8024 has a poor sight line for northbound traffic due to overgrown trees and vegetation. There is also a problem with surface water flooding at this junction that requires effective drainage.

The problems above were not identified in previous studies and were not identified during the stakeholder workshop or by the Operating Company. They have therefore not been appraised in the Report. Notwithstanding this, the issued raised are related to routine maintenance and operation of the route and have been passed to Transport Scotland Network Maintenance to be addressed by their Operating Company for the north-west unit.

B.2 The accident statistics used in the report only show 2007-2011. Why show only 5 years when the general road conditions have barely changed in the last 20+ years.

The standard approach to transport appraisal utilises accident statistics for the most recent 5 year period.

While the route overall may be broadly similar to that 20 years ago, several factors influence the accident rates on the route. Firstly, the protection afforded to vehicle occupants by modern vehicle design is significantly greater that that afforded 20 years ago, particularly with the advent of safety systems such as ABS and airbags within modern vehicles. Secondly, Transport Scotland's moving cursor programme continuously highlights areas of the Trunk Road Network where accident clusters have occurred. Identification of these locations leads to the implementation of measures which include improved sign and lining provision, safety features such as barriers and the provision of passively safe signposts and street furniture that are designed to deform or break on impact to reduce the severity of injury of vehicle occupants. These types of measures have been introduced at key locations on the A83.

B.3 The report fails to recognise the increase in abnormal loads in recent years and the further increases forecast in future years.

The text in the Part B report has been altered to reflect the increase in abnormal loads on the route, mainly related to the movement of wind turbine components.

B.4 The accident statistics don't show fatal accident on Erines section in 2012.

As detailed above, the appraisal utilises the available accident statistics for the most recently 5-year period. This accident occurred at the start of the study and therefore, was not reported in the available statistical analysis.

B.5 Paragraph 2.5.20 doesn't mention the comparatively good overtaking on either side of this stretch of seriously substandard road.

The aim of the report was not to provide a comprehensive review of the route but an appraisal of potential options to address identified evidence based problems, therefore areas outwith the identified problem locations have not been discussed.

B.6 Paragraph 2.5.20 does not mention the proposed 50mph speed limit between Tarbert and Ardrishaig.

The Speed Limit Review was published while the A83 Trunk Road Route Study was being drafted. This information has now been added to the report.

B.7 Paragraph 2.5.21 - There is no mention of the fact that there are proposed housing and retail developments at the north end of Barmore Road in Tarbert. These are likely to increase pedestrian usage of the footway and also increase the volume of vehicles turning into the new development. This makes widening of the footway even more important.

Text in the report has been altered to reflect these factors.

B.8 Paragraph 2.5.22 - Crossing to the Co-op in Tarbert. The problem is accurately outlined except to report that we are aware of a number of minor accidents and near misses in recent years.

Guidance for the assessment of pedestrian crossing facilities is detailed in the Department for Transport's Local Transport Note (LTN) 1/95. This guidance is utilised for the assessment of pedestrian crossings throughout Scotland. The assessment utilises an evidence base of recorded personal injury accidents. Minor accidents which are not recorded and near misses are not taken into account in the assessment. There are no recorded personal injury accidents at this location during the assessment period.

B.9 Paragraph 2.5.22 - Crossing to the Co-op in Tarbert. We believe that a refuge island is an inadequate answer to the problem of a road crossing. If it is to be fully inclusive to allow the elderly and disabled to cross then they need to have some control over the traffic, therefore a pedestrian controlled crossing is the minimum acceptable solution.

Guidance for the design of pedestrian crossing facilities is detailed in the department for Transport's Local Transport Note 2/95. This note details the desirable and absolute minimum criteria for the design of crossing facilities including visibility and spacing from junctions. With regard to Barmore Road, the provision of a signal controlled facility would require to be sited 20m from the junction with an absolute minimum visibility distance for oncoming vehicles of 40m. In order to achieve these criteria, a signal controlled crossing would require to be sited some distance to the north of the proposed pedestrian island, away from the main pedestrian routes. It is therefore the view of the design team that a signal controlled crossing would not be suitable as it would not be located on or near to the main pedestrian desire lines. The potential solution involving widening the road and providing a pedestrian island has been assessed as the most effective solution to serve the existing desire line.

B.10 Paragraph 2.6.2 Lengthy or no diversion routes available during closures – surprised that the report hasn't addressed the possibility of using some of the better forestry roads which run alongside the A83.

There are a number of issues with using the forestry roads which run alongside the A83, and this was not covered by the study.

B.11 Paragraph 2.6.3 - Excessive duration of road closures. On average each closure lasts 6-7 hours before traffic can get round it. I am really surprised that Strathclyde Police were not asked to provide potential solutions to the problem.

The investigation of serious and fatal accidents is a statutory requirement, the responsibility of which lies with Strathclyde Police. The consideration of alternative response procedures to accidents is not covered by the scope of the A83 Trunk Road Route Study.

3.2 Engineering and Environmental Assessment

B.12 Paragraph 4.1.8 - Scheme for widening pinch point at Erines. Will this scheme leave a road width which is wide enough to prevent complete closure during maintenance?

The road cross section for the Erines improvement scheme will need to be determined as part of the further design development of the scheme. Maintenance considerations will be carefully considered during the design development phase. The aim will always be to provide sufficient width (ideally a 7.3m wide carriageway) to allow maintenance activities to be carried out using single lane traffic management rather than full closure. However, it is not always possible, due to site specific constraints to achieve the desired 7.3m carriageway width.

B.13 Page 53, paragraphs 27, 28 and 29 – Social inclusion and accessibility. This implies that there is no issue or benefit regarding social inclusion or accessibility. This is patently wrong. The narrow pitted footway is regularly damaged by being used as an additional carriageway by HGVs trying to pass one another here. This makes it unsuitable for wheelchairs, prams, pushchairs, anyone with visual impairment or limited mobility. Therefore, there is a considerable benefit in terms of accessibility and social inclusion when this footway is made safe.

The initial assessment considered that as there was no completely new facilities being provided for pedestrians or vehicles, the social inclusion and accessibility benefits were minimal. As a result of the additional information provided through the consultation process relating to problems currently being experienced by pedestrians, the assessment of social inclusion and accessibility in these examples has been adjusted in the report.

B.14 Barmore Road and Erines solutions. Surprise expressed that these have been classified as long term priorities rather than medium or even short term.

B.15 Barmore Road options. If these are seen as long term options then the short term issue of traffic calming still needs to be addressed. It seems to be a serious omission to have excluded the northern approach to this section from the use of flashing speed signs.

Table 1 in the A83 Trunk Road Route Study Part B Summary Report provides an indication of potential delivery timescales. The delivery timescales are estimated based on the amount of additional design and assessment work that may be required in order to deliver each of the potential options. This does not, in any way, reflect a prioritisation of the potential options detailed in the table. Additionally, the issues highlighted by stakeholders relating to this section of Barmore Road highlighted the pinch point and the inability of vehicles to pass without using the verge or footway, no issues with vehicle speed were highlighted.

B.16 Page 56 – Barmore Road chosen option. Would it not be logical to give traffic travelling uphill the priority in the remaining narrow section this preventing HGVs having to make hill starts?

Any potential solution for Barmore Road that is taken forward will require additional assessment and design work before it is able to be delivered. During the detailed design, the prioritisation of traffic flows would be considered and the optimal solution adopted.

B.17 Include the requirement for the installation of a safe pedestrian crossing in Ardrishaig to be added to the 13 safety improvement measures identified by Jacobs.

Whilst we appreciate the concerns raised regarding this issue, there has been no change to the evidence presented in the Report and the appraisal to this problem therefore remains unchanged

Scotland TranServ carried out a feasibility study for Transport Scotland into the provision of a pedestrian crossing on the A83 Chalmers Street, Ardrishaig utilising the guidance detailed in Local Transport Note (LTN) 1/95 published by the Department for Transport. The draft report was issued in July 2012.

The conclusions of this report are:
"Traffic flows and pedestrian crossing figures do not indicate that any pedestrians are unduly delayed from crossing the carriageway as there are sufficient gaps in the traffic to allow pedestrians to cross safely. Also, the lack of injury accidents does not support improvements to the pedestrian facilties in the study area"

Whilst identified as a problem by Stakeholders, it is considered that this problem has been addressed through the previous study and is therefore not considered further in this report..

4 TRL Published Project Report 2300

TRL.1 The project team received feedback in relation to the issues covered in the Ecology and Related Landslide Mitigations Options report (Winter and Corby, 2012). These relate to land management and are relevant to the proposals put forward as part of the Red Option for the introduction of vegetation and planting on the slope.

The response below has been provided by the authors of the report: M Winter and A Corby.

The comments received follow the theme that a vegetative solution is the best approach to addressing the issue of instability at the Rest and Be Thankful. This is indeed the approach taken in the report which identifies both positives and potential negatives to be accrued from such a scheme in order that the outline might best be determined. The approach that we have taken has been developed in close consultation with Forestry Commission Scotland (FCS) and the Royal Botanic Gardens Edinburgh (RBGE). It differs from those put forward by the correspondents, in that it suggests the use of broadleaved species rather than conifer and evergreen species. Most of the species proposed are exotics which we would not legally be allowed to plant without an exemption licence from SNH. An application for an exemption licence would more than likely be declined.

Further, we (along with FCS and RBGE) are convinced that native broadleaved species are perfectly suited to providing the intended slope stabilisation, the key aspects of which are ground water uptake via the plant roots, the root-binding effect with the underlying bedrock and canopy interception. All of the species suggested in the FCS report have the capacity to achieve excellent root water uptake and root binding over time. In addition, coppicing will have the effect of increasing the 'root-to-shoot' ratio and thus the root stabilisation effect and the proposed species are generally better suited to the development of root anchors into bedrock thus reducing the risk of raft failures.

It is accepted that non-native evergreen/coniferous species would (eventually) add the extra dimension of a year-round canopy to help intercept more falling rain and provide the means for greater moisture transpiration and attenuation, but most of the suggested species are large trees that could lead to potential instability problems in the future as is the case adjacent to parts of the A82 and described in our report.

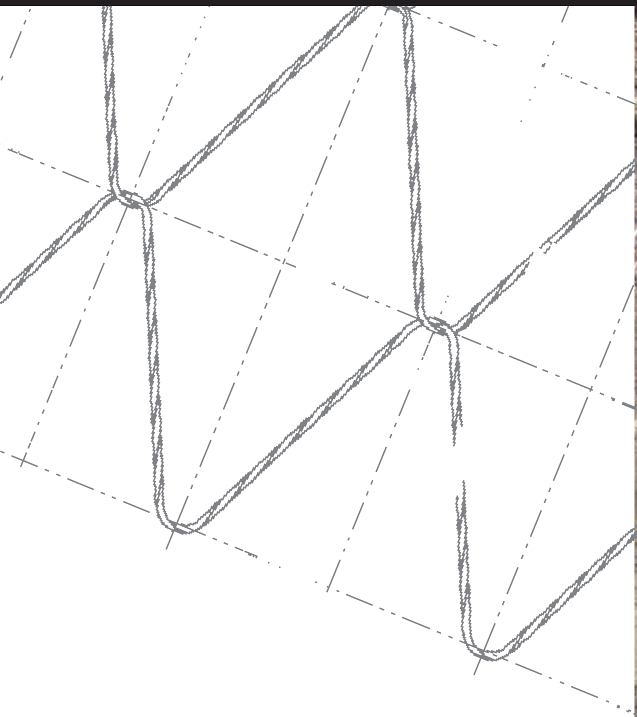
The comments also raise the issue of drainage provision. The planting scheme that is outlined in the report is very much an indicative scheme that will be subject to more detailed design when and if approval is granted. Part of that design will include provision for appropriate access and drainage; both an access track and associated drain(s) are likely to be needed as part of that design and their detail may follow the details set out by the correspondents.

Appendix A Debris Flow Barrier Product Literature

This appendix contains extracts from technical data and product literature provided by two debris barrier manufacturers: Geobrugg and Maccaferri.

These show examples of debris flow barriers including photographs of barriers following successful retention of landslide debris.

Flexible shallow landslide barriers: Cost-effective protection against natural hazards.



On unstable slopes, flexible shallow landslide barriers provide protection against landslips:

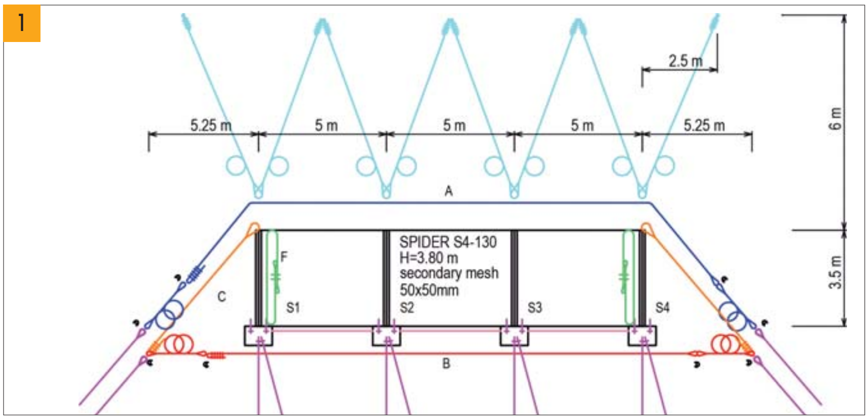
- **lightweight construction cuts costs**
- **easy installation**
- **can also withstand multiple impacts**
- **effectiveness proven in large-scale field tests**
- **dimensionable using FARO simulation software**

Flexible shallow landslide barriers.

1. Shallow landslide barrier SL 130/ 150 for pressure up to 150 kN/m²

A SPIDER® spiral rope net together with a secondary mesh with a mesh width of 50 mm is installed in the danger zone, with posts installed up to eight meters apart. The retaining ropes and the upper and lower support ropes affixed to the ends of the protective structure are fitted with brake rings. This type of protective structure is suitable for use with a span width of up to 30 m without support rope separation and a construction height of up to 4 m. It can withstand pressure of up to 150 kN/m².

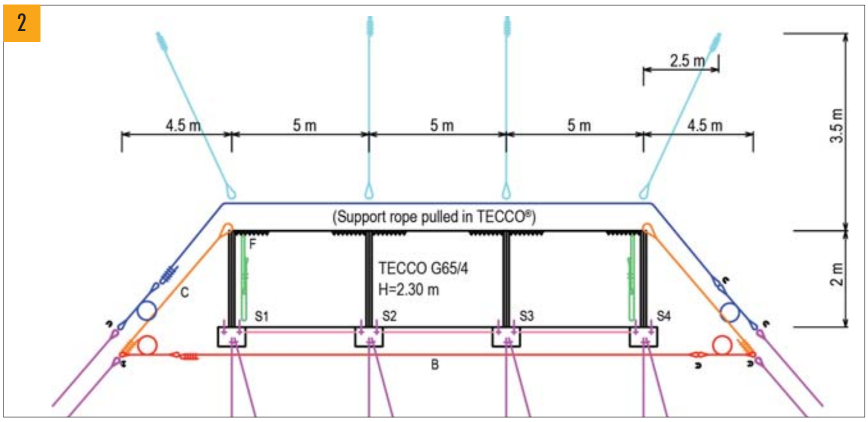
1



2. Shallow landslide barriers SL 100 for pressure up to 100 kN/m²

If the expected pressure is lower (up to 100 kN/m²), an alternative type of protective structure may be used: the installation of a TECCO® mesh G65/4 with posts spaced as far as five meters apart and a barrier height of two meters. This type of protective structure has no secondary mesh.

2



Carefully matched components function as an overall system.

SPIDER® spiral rope net

The SPIDER® spiral rope net – manufactured from a spiral rope made of high-strength 4 mm steel wires has a tensile strength of more than 1770 N/mm². The spiral rope net made with a rhomboid mesh shows a load capacity of 220 kN/m lengthwise.

The brake ring

Brake rings are incorporated in the support and retaining ropes. With major events the brake rings are activated, dissipating energies from the SPIDER® spiral rope net without damaging the ropes. The rope breaking load is not reduced by the activation of the brakes, enabling the force-path characteristic to be fully utilized.

The posts

For shallow landslide barriers we use posts of type RXI, that are mounted on a baseplate via a link. Their function is to guide the ropes to which the SPIDER® spiral rope net is suspended. The associated guides are rounded to protect these support ropes.

The spiral rope anchors

'If it can bend it won't break': The heads of our anchors are flexible and thus unsusceptible to impact. The spiral rope is made from steel wires with a strength of 1770 N/mm². Our spiral rope anchors are superior to traditional anchors – because they are also suitable for diverting forces in the direction of tension that can deviate by up to 30 degrees from the drill axis without loss of supporting capacity.

Self-drilling anchor with Geobrugg FLEX head

The FLEX head absorbs tension and bending forces according to the same principle as the head of the Geobrugg spiral rope anchor. It is unsusceptible to impact and can be mounted to self-drilling anchors available on the market. A concrete foundation is required for the transition from the anchor bar to the FLEX head.

Protective mesh apron

A protective apron is installed across the entire width of the barrier to form an erosion seal between it and the ground below and to prevent erosion and material seepage.

Application possibilities cover a wide range of areas.

Rest and be Thankful, Scotland

Problem

Following heavy rainfall, on September 8, 2009, a shallow landslide - the second in quick succession - struck the A83, a key through road in northwest Scotland, near the "Rest and be thankful" viewpoint. The area is susceptible to shallow landslides that are impossible to prevent. A suitable protective measure was needed to protect road users and ensure that the road could remain open in the event of another landslide.

Geobrugg solution

A shallow landslide barrier 80 m long and 4 m high was installed, complete with a SPIDER® spiral rope net and a secondary mesh with a mesh width of 50 mm. As a combined measure, an additional VX debris flow barrier, 15 m long and 4 m high and fitted with ROCCO ring nets, was installed in an adjacent gully to prevent material seepage from flooding beneath the road.

1

Giampilieri, Sicily, Italy

Problem

On October 1, 2009 in Giampilieri, Messina, heavy rainfall – 223 mm of rain in the space of seven hours - led to multiple shallow landslides. These sparked a debris flow event and dumped large amounts of material on the SP 33 highway, forcing its closure.

Geobrugg solution

To protect the highway, debris flow barriers were installed on the steepest part of the slope. Where the slope was less steep – approx. 60 degrees – two 3.5 meter high flexible shallow landslide barriers were installed, one 25 and one 60 meters long and both fitted with a SPIDER S4/130 spiral rope net and secondary mesh, covering a total length of 85 meters. Heavy rain in January 2010 triggered a further shallow landslide. Around 90 m³ of material was successfully retained by the shorter of the two shallow landslide barriers, preventing the highway from having to be closed once again.

2

Lake Merwin, Washington, USA

Problem

In 2008, a wet snow storm in Amboy, Lake Merwin, Washington State, USA, triggered a shallow landslide, burying the road and damaging houses further down from the road. Loose masses of earth and unconsolidated soil on the steep slope posed a continued threat to the road and houses.

Geobrugg solution

To guard against a further shallow landslide, a 3-meter-high and 15-meter-long flexible shallow landslide barrier was installed, complete with SPIDER® S4/130 spiral rope net and secondary mesh. The barrier was dimensioned using FARO simulation software, which is calibrated using data from large-scale field tests.

3

The challenge: how can each running meter of barrier hold back 10 m³?

It's all a matter of correct dimensioning

Our special retention aprons have to withstand a great deal. Shallow landslides generate huge forces, which we model using complex measurement and simulation methods. Data on the flow behavior and the dynamic impact of the earth masses enable flexible barriers to be constructed according to the load situation. The retention volume here is key: maintaining an optimum distance between the posts increases the amount of usable height available and provides sufficient retention space.

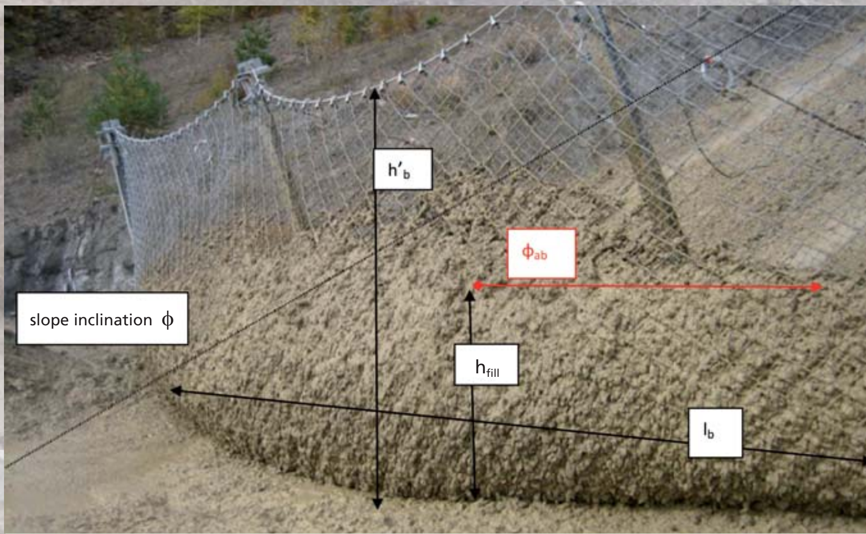
Simulating what the net has to hold back

In the numerical simulation, we calculate the forces acting on the barrier. The result is combined with the pressure on the force measurement plates in the direction of flow, which is calculated from tests. Empirical values from field tests are used to estimate this dynamic pressure. In addition, there is another, significantly smaller force component: the hydrostatic pressure caused by the flow depth. The dimensions that are relevant for dimensioning the dynamic impact are the initial density ρ of the shallow landslide and the speed v at the planned protection net. Using our FARO simulation software, we can use the pressure calculated on the test barrier in a variety of system configurations and carry out a realistic simulation in each case.

Top image: at the field tests in Veltheim, the deviation between simulation and actual measurement is only approx. 10%, thus providing useful information on the dynamic wave impact that the test shallow landslide produces.

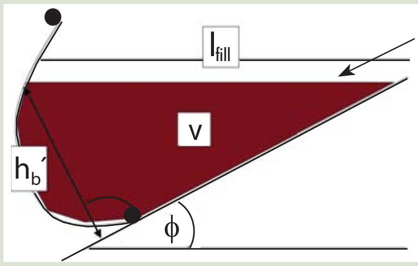
Under static and multiple load

After the first landslide, the net is filled evenly with mud, earth and rubble. Behind the barrier, a hydrostatic pressure distribution (P_{hyd}) initially builds up across the fill depth (h_{fill}). As the water drains away, this pressure is reduced to an active earth pressure (P_{stat}). If another landslide strikes, its dynamic pressure will overlap with the pressure exerted by the material still partially filling the barrier (picture-session below).



Geometric proportions of a filled shallow landslide net

l_b = impact width
ϕ_{ab} = inclination of retained material
$hb_{\prime}$ = reduced net height following impact
h_{fill} = fill depth of the shallow landslide net
l_{fill} = fill length of the shallow landslide net



Technical drawing: calculating the approximate maximum retention volume V of a shallow landslide net.

The simulation shows how the subsequent landslide pushes into the material already deposited. The load level at the barrier increases ($h_{fill}+h_{fl}$).

Calculating the incalculable ...

The retention volume of the protection net must be at least equal to or greater than the expected volume of landslide material, called the "breakout volume." As with snow-slides, the breakout volume is calculated from the area and force of the breakout. This latter can be determined using the hazard map or be identified on site by an engineer.

... and limiting the damage

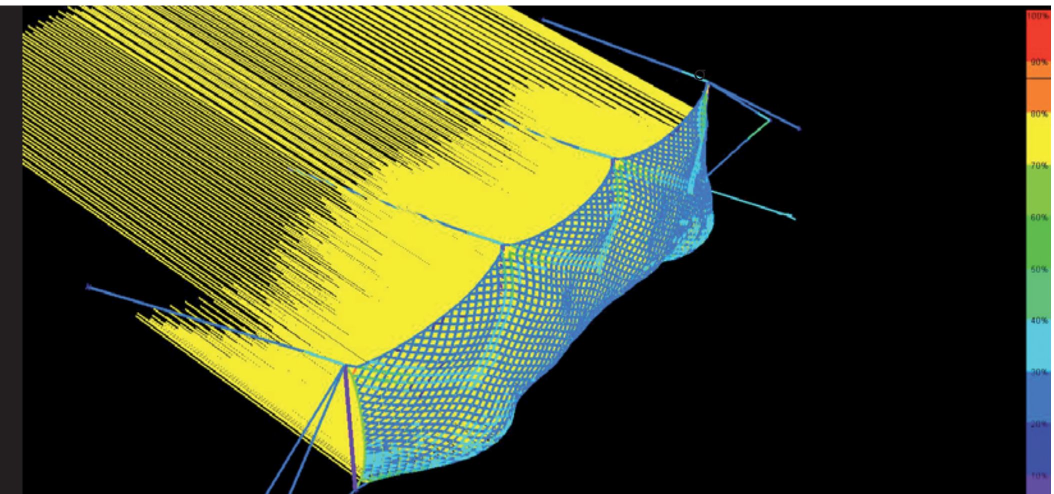
If the protection net is too small in terms of volume, or if the structure is shorter than the impact width, this restricts the potential for protection against shallow landslides. In this case, the difference between the breakout and retention volume is calculated. This difference, together with the speed at which the landslide flows around and over the net, is used to recalculate the damage and optimize the construction of the net accordingly.

Retention volume holds the key

Following the barrier filling process $h_b'=3/4*h$, the calculated height is compared to the installation height h. Assuming that the reduced net height following an impact h_b' is measured vertically to the slope, and ignoring the volume in the deformed bulge of the net, the retention volume V of a shallow landslide net is

$$V = \frac{1}{2} \cdot h_b' \cdot l_{fill} \cdot l_b = \frac{1}{2} \cdot \frac{3}{4} h_b \cdot \frac{3}{4} \frac{h_b}{\sin\varphi} \cdot l_b$$

$$= \frac{9}{32 \cdot \sin\varphi} \cdot h_b^2 \cdot l_b \quad [\mathrm{m}^3]$$



Long service life and ease of maintenance: two decisive aspects.

Durability…

Flexible shallow landslide barriers are built on steep slopes where shallow landslides can form, to hold back large amounts of soil, wet clods of earth and water. Because neither water nor rubble flows over or through the barrier in this "standby phase", they are basically just as durable as rockfall and avalanche protection measures.

…thanks to outstanding protection against corrosion.

With a view to a long life and resistance to local corrosivity, all our steel components are hot-dip galvanized. The ropes and nets are treated with the GEOBRUGG SUPERCOATING® zinc/aluminum coating.

After an event…

Barriers that have retained shallow landslides must be inspected, emptied and maintained (image 1) in order to restore the retention volume (image 2). Here the emphasis must be placed on the evacuation and dumping of the material as this represents the principal outlay in time and cost. Experience shows that any dismantling and reconstruction work on the barrier is of much less significance.

…emptying and maintaining.

The easiest way is emptying the barrier from behind if accessible. More frequently the emptying happens from the front, as the deposit cone, compressed during the impact, is very stable. Nevertheless, the material can be excavated also from the front without dismantling the barrier (image above).

The main replacement parts are the brake rings: After events they must be inspected and changed where necessary. We also recommend that nets and ropes are inspected for serviceability.

1

2

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CASE HISTORY

Ref: SL/CH/SL/RF047 — Rev:01, Feb 12

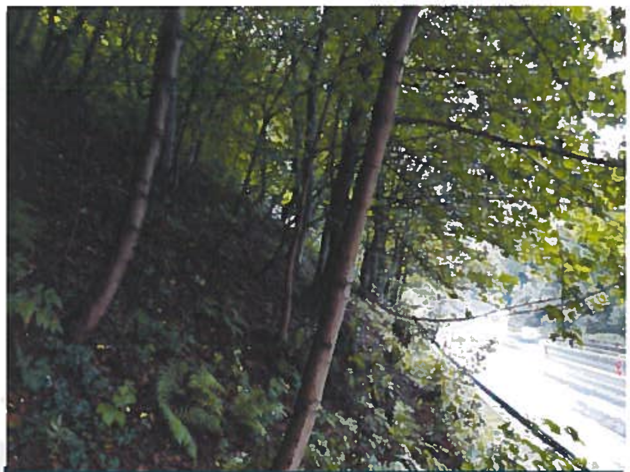
INFRASTRUCTURE PROTECTION

HRAD STREČNO, SLOVAK REPUBLIC

DEBRIS FLOW PROTECTION

Product: DF Series Debris Flow Fence

Highway



Local Slopes

Problem

The I/18 highway is one of the only routes through the Carpathian Mountains in eastern Slovakia.

In the region of Strečno - Dubná Skala near the river Váh and Hrad (castle) Stečno the single carriageway road is precariously positioned between the river and cliffs and steep beech forest slopes. Inevitably the road is regularly affected - and sometimes - closed by rockfalls and debris flows.

Solution

The client required urgent protection for approximately 400m of road following a fatal incident in 2007. The majority of areas required rockfall protection for which they chose CTR 04/07/B dynamic rockfall fences.

In one specific area the road was regularly affected by debris flows that travelled down pre-exisiting drainage channels. To solve this problem Maccaferri supplied a single field DF series debris flow fence. The fence was designed to intercept material within the channel and any material overtopping the channel sides.

Post Installation

Client:

SLOVENSKÁ SPRÁVA CIEST

Main contractor:

DOPRASTAV a.s

Designer:

BASLER & HOFMANN SLOVAKIA s.r.o

Products used:

TYPE 2 DF SERIES FENCE, CTR 05/07/B FENCES

Date of construction

AUTUMN/SUMMER 2008

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CASE HISTORY

Ref: IT/CH/IT/RF048 — Rev:01, Feb 12

INFRASTRUCTURE PROTECTION

BROLO, SICILIA

DEBRIS FLOW PROTECTION

Product: DF Series Debris Flow Fence, Rockall Protection Mesh

Problem

The village of Brolo was one of many severely affected by heavy rains and serious flooding in autumn of 2009 in the Messina District of Sicily.

The flooding caused damage but also resulted many mud flows and debris slides that caused swathes of damage and many fatalities throughout the region.

Solution

Many areas required extensive civil engineering works during the rebuild process. Included amongst those was an important local road near the village of Brolo.

Here a steep hill above the road had brought numerous minor debris flows onto the road so the decision was taken to cover the slope with rockfall mesh to prevent minor failures from become bouncing rock falls. Secondarily, it was decided to use flexible debris flow fences to prevent future flows from reaching and affecting the road (and residential properties below the road).

Maccaferri worked closely with the designer to provide the required Type 3 DF Series fences. During heavy rains in Autumn 2010 the site suffered a catastrophic slope failure manifested as a debris flow.

Despite being far in excess of the design volume and parameters of the predicted flow the DF Series fence held the material with no component failures and prevented any injuries from being sustained below the failure.


Fence - Post Impact


Post Impact Condition

Client:

LOCAL GOVERNMENT

Main contractor:

SPECIALIST SUB CONTRACTOR

Designer:

CONSULTANT DESIGNER

Products used:

TYPE 3 DF SERIES BARRIER, ROCKFALL MESH

Date of construction

SPRING 2010

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CASE HISTORY

Ref: USA056, Issue Date: 10.01.2009

CALIFORNIA HWY 1 - DEBRIS FLOW BARRIERS

BIG SUR, CALIFORNIA, USA

Product: Maccaferri Debris Flow Barrier

Introduction

Maccaferri Debris Flow Barriers were installed at four sites upslope of HWY 1 in Big Sur, CA in order to mitigate potential debris flow activity following extensive wildfires. This project was designed by the client, California Department of Transportation (Caltrans), and was installed by AIS Construction.

Problem

Wildfires in the Summer of 2008 within the Big Sur, CA region resulted in the loss of vegetation and heat damage to the soil. As a result, these hillslopes are more prone to debris flows and mudslides until vegetation is re-established. Many of these hillslopes have steep gradients and can potentially transport significant volumes of soil and debris downslope to CA HWY 1. This may result in flooding from blocked drainage structures, safety issues to travelers, damage to structures, and/or potential road closures.

Solution

Caltrans identified debris flow barriers as a feasible solution to mitigate the potential issues that may result from a debris flow or mudslide incident. Maccaferri debris flow barriers were selected for installation at four separate sites above California HWY 1 in order to mitigate the potential debris flows. These structures were installed at the base of some of the drainage basins susceptible to debris flows approximately 20 to 60 feet upslope of HWY 1. The barriers were designed to be in place for five years or until vegetation is re-established and subsequent debris flow hazards are reduced.

Big Sur Coast

Canyon After Burn

Installed Debris Flow Barrier (drainage culvert in front of barrier)

Client:
California Department of Transportation (Caltrans)

Main contractor:
AIS Construction

Designer:
Caltrans

Products used:
Maccaferri Debris Flow Barriers

Date of construction:
Fall, 2008

MACCAFERRI


Completed Debris Flow Barrier

Description of Debris Flow Barriers

The four barriers ranged in dimension from 120 feet in length and 16 feet in height. The Maccaferri debris flow barrier is similar to the rockfall barrier, but has several differences, such as additional breaking elements and variable geometries. In addition, a combination of one foot and three foot diameter ring nets were used. The larger diameter ring nets were placed along the bottom of the structure in order to allow the small material and water to flow through. The barriers were designed to be in place until vegetation is re-established. They can then be removed leaving the foundation intact. They can be reinstalled if risks from debris flows increase in the future.

Construction

California water quality regulations required that all point sources of sediment must be mitigated by October 15, 2008, the start of the rainfall season. This project was "emergency work" and was successfully supplied by Maccaferri and installed by AIS Construction within the limited timeframe and met the goal of the project.


Debris Flow Barrier


Debris Flow Barrier (looking upstream)

MACCAFERRI

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MD, Williamsport
MO, St. Louis
NJ, Ramsey
NM, Albuquerque
OH, Westerville
PR, Caguas
TN, Chattanooga
TX, Lewisville

MAC.RO. SYSTEM - DEBRIS FLOW BARRIER

BARRIERS AGAINST DETRITAL FLOW

Series DF Barriers are finalized to stop mud-water masses (debris flow) or soil masses (landslide) sliding down from slopes and channels.

Standards:
UNI EN 10025 "Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels";
UNI EN ISO 1461 "Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test";
EN 12385-4 "Steel wire ropes Safety Part 4: Stranded ropes for general lifting applications";
UNI EN 10244-2 "Steel wire and wire products — Non ferrous metallic coatings on steel wire — Zinc or zinc-alloy coatings";
UNI EN 10264-2 "Steel wire and wire products — Steel wire for ropes - Part 2: Cold drawn non alloy steel wire for ropes for general applications".

Technology
The components are made to reduce the damages after impact, minimizing the maintenance operations. The post are free released by the mesh and their main function is holding the upper longitudinal cable. The posts can be left out if the barrier will be install in small size channel. The upslope bracing cables are equipped with brakes to minimizing the effect of the impacts. When a post is damaged, the next one can still afford the barrier functionality. The main mesh is made by steel rings. Special panels can be installed on the barrier sides to close eventually openings whether the structure has been installed into channel. In case of request, the barrier could be send together with another DT net, used to stop the most fine materials.
The barrier meets quality certification standard UNI EN ISO 9001, at each step of design, manufacturing and marketing.

Main barrier features
Series DF Barriers can be installed on each type of land, both on open slopes and depressions with difficult morphology. Their geometry configuration reduces both the impacting forces and consequently the entity of the foundations. The post foundations are made by steel bars or micropile.
Even if shown in the installation manual, the double twist mesh is generally useless and/or dangerous for debris flow barriers. Therefore it will be supplied upon request only. DT mesh function is contain smaller parts of the debris mass, with a global higher loading of the entire structure as consequence, caused by the regular hydraulic flows impediment. DT mesh can be request to stop smaller elements for infrastructures protection when the barrier (with posts) is installed on open slopes. Otherwise, when this type of structures (without posts) are installed into channel, far from sensitive infrastructures, the ring mesh only is suggested (in order to help the passage of water). The barrier could also be used as protection against rockfall (they are not tested in accordance to ETAG 027). The system is easy to install, with difficult conditions as well. The assemblage can be done shortly. Maintenance is necessary after impact.

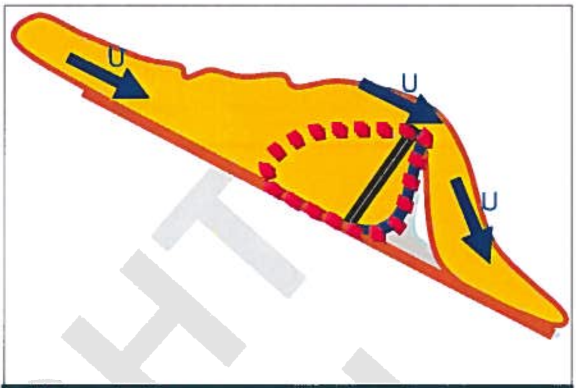

Fig.1: Analysis sketch

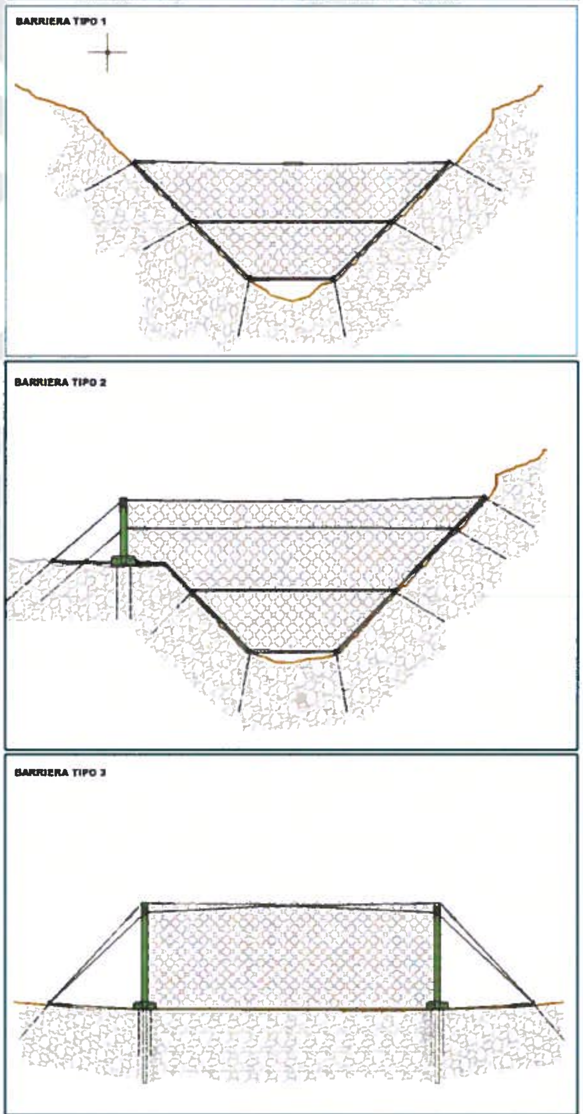

Fig.2: Types of OM CTR DF Barrier

Maccaferri reserves the right to amend product specifications without notice and specifiers are requested to check as to the validity of the specifications they are using.

Barrier Type	Suggested Height	Accessories (upon request)
Barrier OM CTR 20/04/A DF	4 ÷ 5 m	DT net
Barrier OM CTR 30/04/A DF	5 ÷ 6 m	DT net
Barrier OM CTR DF	Geometry dependents by the project	DT net
The optimum barrier length is frequently between 10 and 30m		

Design

DF barriers structure has been designed and verified to stop sliding soil masses and filtering their water contents eventually. All the elements are calculated: panel, posts, cables, foundations and accessories. The analysis carried out with the universities shown that energy and pressures acting on the barrier depend by the site morphology, granulometry and height of the debris flow.

The pressures developed by the deformable impacting mass are decomposed into their static and dynamic components. The panel equally loaded (critical condition) transmits the forces to the longitudinal cables (calculated with the "catenary" approach), posts, bracing cables and foundations.
For the design, the topography profiles, impacting volumes, its section, velocity and granulometry are needed.

The foundation design depends by the soil features end erosion effects eventually.
On site experiences and analysis proved the efficiency of these barriers. The efficiency of these barriers has been verified and validated by University of Parma.

Fig. 3. OM CTR DF Barrier

Fig. 4. OM CTR 20/04/A DF Barrier

Fig. 5: OM CTR 20/04/A DF Barrier impacted by debris flow

Fig. 6. OM CTR 20/04/A DF Barrier imparte by landslide (about 800mc)

WARNING: Install the product in accordance with National Security Requirements! If the job is done with suspension or security ropes, personal protective equipment against fall risk must be connected with anchor points in agreement with EN 795.