

## SLOPE PROTECTION MEASURES - HILL SIDE SLOPE AT BIRAH, UTTARAKHAND

### CHAMOLI DISTRICT, UTTARAKHAND, INDIA

#### Slope Protection

##### Problem

Birahi is situated on the riverbanks of Alaknanda and Birahi Ganga along NH 58 in Chamoli District of Uttarakhand State, India. Apparently, the landslide at Birahi has been activated during the Chamoli earthquake in March 1999. The area lies in highly active seismic zone i.e. zone V and receives heavy rainfall. Slope modification for infrastructure development and improper water channelization are the major causes of the landslide at Birahi. Exposed cut slope is always at risk of eroding due to reasons such as heavy precipitation during the rainy season, gradient, absence of vegetation cover, drainage issues, etc. which eventually leads to landslides that is dangerous and poses harm to the people and infrastructure. Hence, it is pertinent to address the need for protecting the slope in order to control erosion by growing sustainable vegetation.

This case study focuses on the hill side slope protection measure requirements which are part of other overall treatment measures adopted for this location.

##### Solution

After a judicious assessment of the site conditions, a combination of slope protection solutions along with a 100m long 3m high gabion toe wall has been adopted as part of erosion control and surficial slope stability measures for the hillside slope. Nailing using self drilling anchors (SDA) of 25mm dia. along with 3D erosion control mat (a steel reinforced synthetic geomat ie, MacMat R) and bio-engineering measures have been adopted here. As a system, it holds the soil in position on slopes and provides root reinforcement during the early stages of plant growth which is necessary for natural vegetation to resist the extreme effects of wind and water erosion. MacMat R Steel is used in combination with soil bio-engineering techniques to reduce surface runoff and it helps in creating hospitable conditions for plant invasion, establishment and high moisture containment.

The project is completed and very good vegetation has grown on the protected slope. Additional measures such as roadside retention with Maccaferri's Paramesh system, water channelization, drainage measures etc are adopted separately.

**Client:** NATIONAL HIGHWAYS & INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.(NHIDCL)

**Designer / Consultant:** MAGOT ENGINEERING CONSULTANTS PVT. LTD.

**Contractor:** RG BUILDWELL ENGINEERING LTD.

**Products used (Qty.)**

- MacMat R - Steel	1573 Sq.m
- Anchor Bar	SDA-25mm dia- 525 RM

**Date of construction:** 11/2016 - 01/2020



Figure-1 Initial site condition (2016)



Figure-2 During construction above retention structure (May 2018)



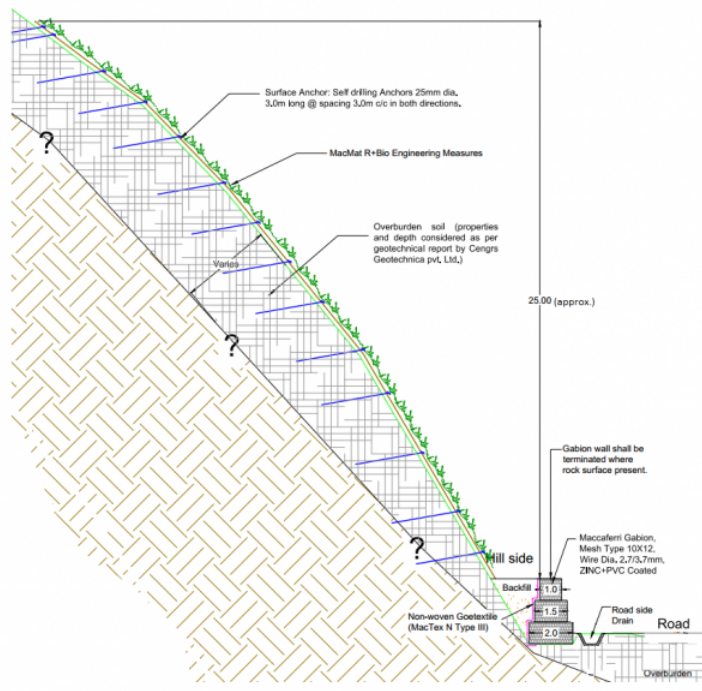
Figure-3 Vegetation establishment within some time (June 2018)



Figure-4 Improved site condition (October 2021)



Figure-5 Improved site condition (October 2021)



## TYPICAL CROSS SECTION

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