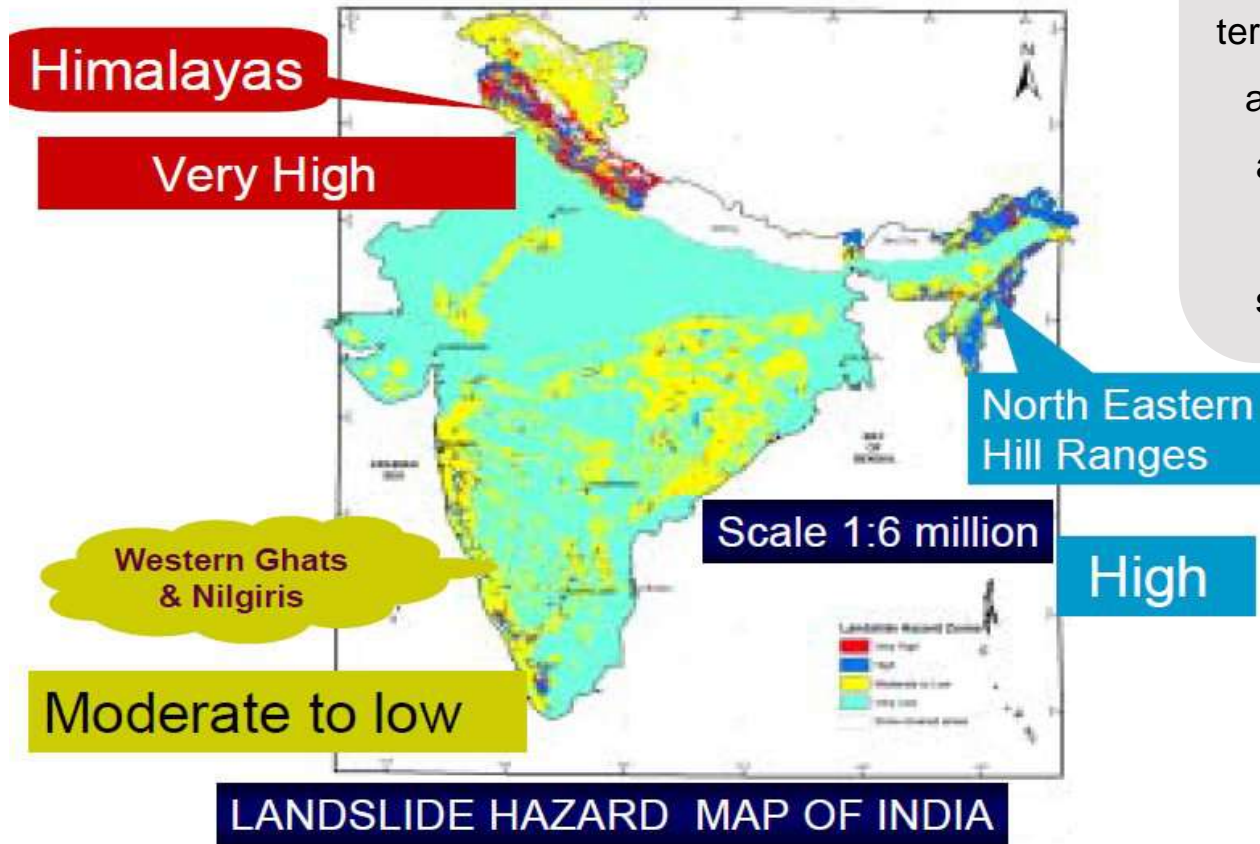


# **SAFER ROADS-A WAY TOWARDS ECONOMIC GROWTH: A CASE STUDY ON LANDSLIDE MITIGATION MEASURES ALONG NATIONAL HIGHWAY 58 AT UTTARAKHAND, INDIA**



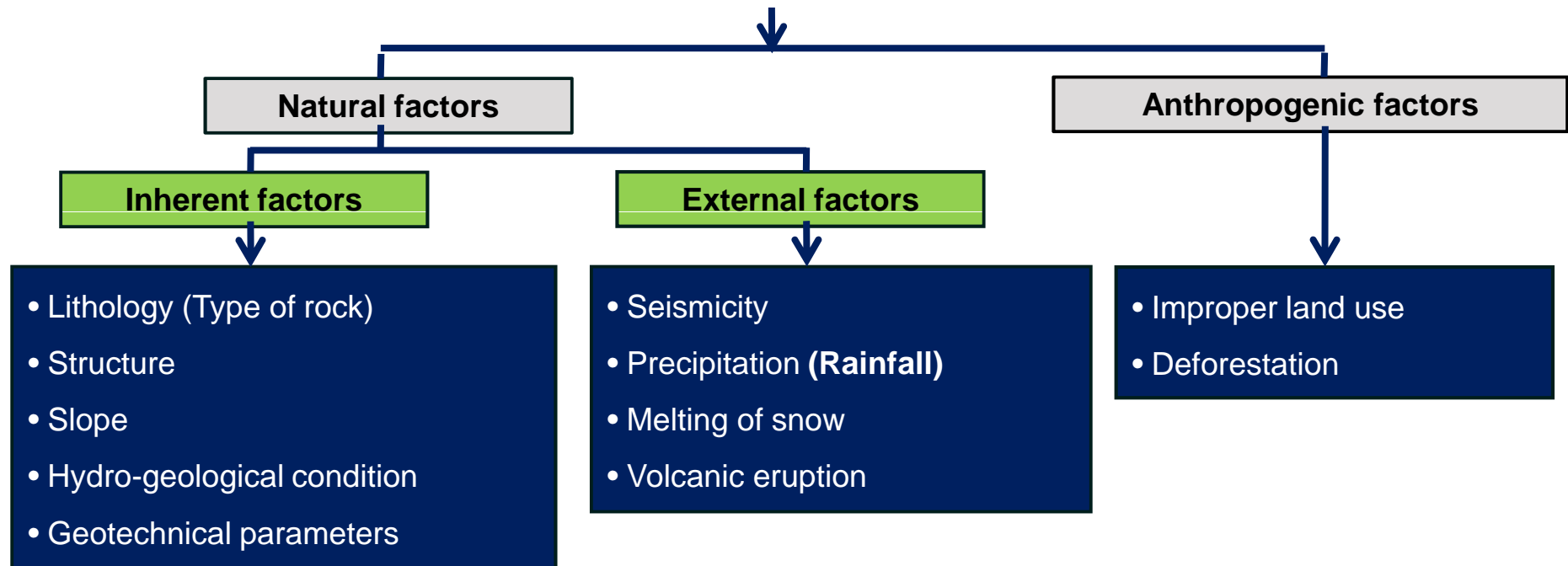
## LANDSLIDE SCENARIO IN THE COUNTRY



22 states and 2 union territory of the country are affected by landslides, although they differ from the scale of severity of disaster.

## INVESTIGATION-FACTORS TRIGERRRING THE LANDSLIDE

**Mitigation cannot begin without investigating the various factors that triggers the slope instability**

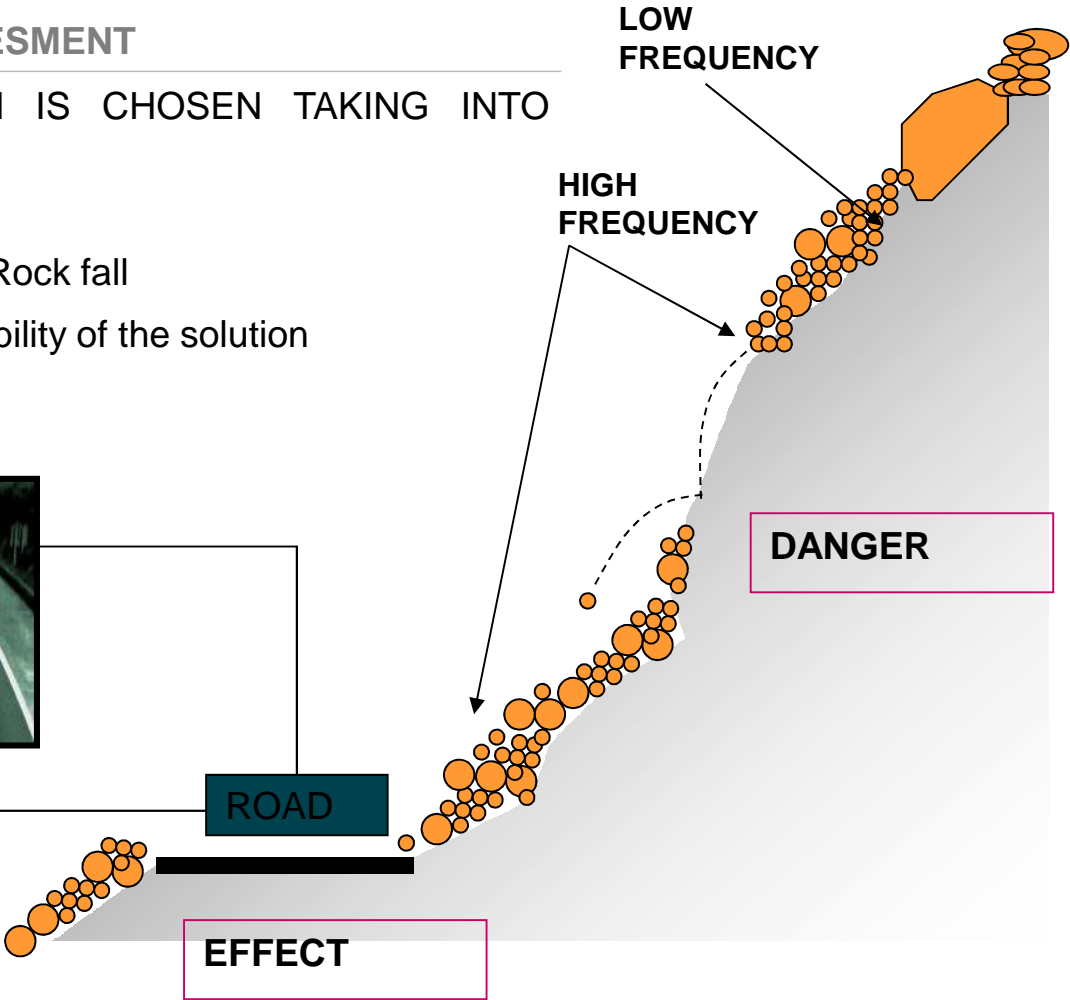


# RISK ASSESMENT

THE SIZE OF THE INTERVENTION IS CHOSEN TAKING INTO ACCOUNT

- Type of Infrastructure to be Protected
- Extent of the most probable Landslide/ Rock fall
- Correct evaluation of the technical feasibility of the solution
- Extent of Risk involved

A RISK ANALYSIS IS REQUIRED



## RISK ASSESSMENT

# HAZARD RISK ASSESSMENT MATRIX

| Frequency of Occurrence | Hazard Categories |               |              |            |
|-------------------------|-------------------|---------------|--------------|------------|
|                         | 1<br>Catastrophic | 2<br>Critical | 3<br>Serious | 4<br>Minor |
| (A) Frequent            | 1A                | 2A            | 3A           | 4A         |
| (B) Probable            | 1B                | 2B            | 3B           | 4B         |
| (C) Occasional          | 1C                | 2C            | 3C           | 4C         |
| (D) Remote              | 1D                | 2D            | 3D           | 4D         |
| (E) Improbable          | 1E                | 2E            | 3E           | 4E         |



Unacceptable



High



Medium



Low

## LANDSLIDE - CASE STUDY

In June 2013, a cloud burst hit the state Uttarakhand and damaged its beauty,



## CASE STUDY OF UTTARAKHAND PCKG I &II LANDSLIDE – PROJECT INFORMATION

The Ministry of Road Transport & Highway

Rehabilitation/Treatment of landslide locations with slope protection and drainage improvement

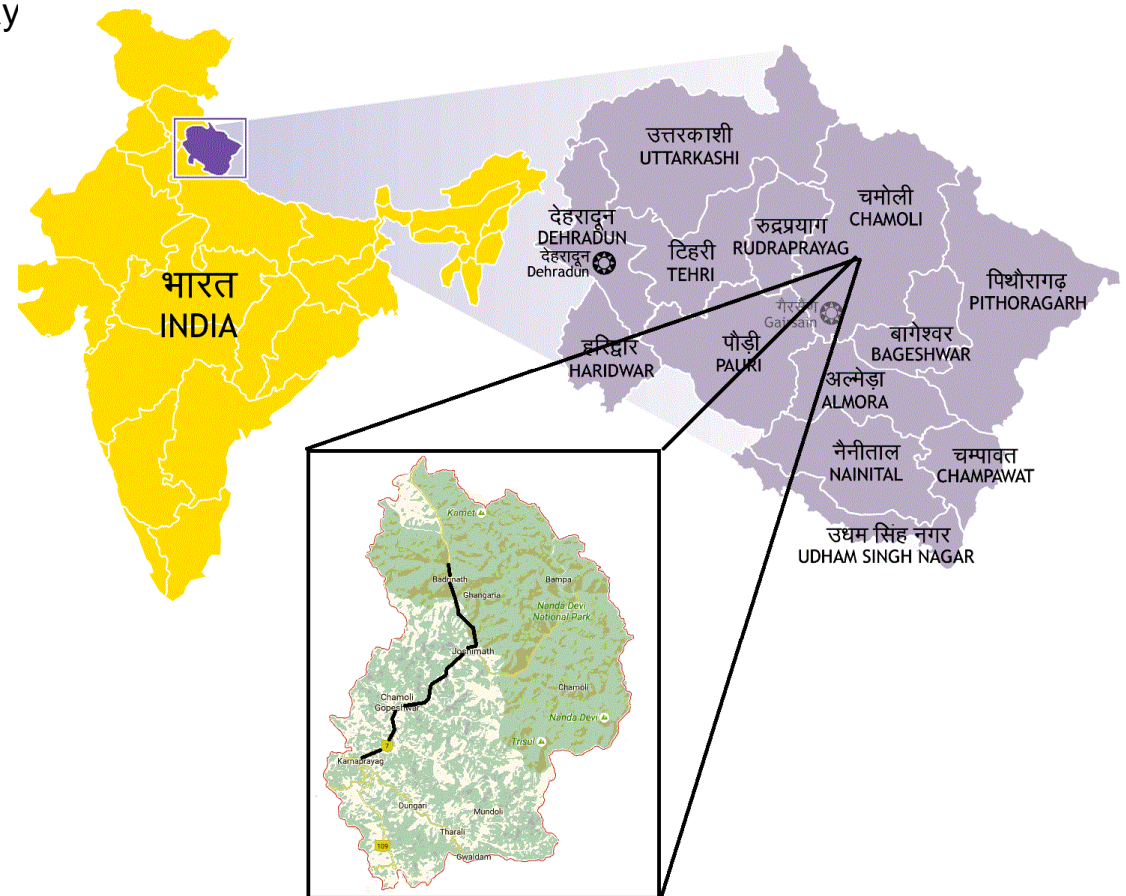
Package-I include following locations:-

1. Nandprayag (200m)
2. Maithana (350m)
3. Birahi (100m)
4. Gulabkothi (125m)

Package-II include following locations:-

1. Helang (275m)
2. Govindghat-II (150m)
3. Govindghat-III (150m)

7



## STAKEHOLDERS INVOLVED

**CLIENT**



**CONSULTANT**



**PROOF CHECKING  
CONSULTANT**



**SAFETY CONSULTANT**

**M/S KHANNA GOYAL  
DESIGNERS LLP**



**TECHNOLOGY  
PARTNER**

**MACCAFERRI**  
Engineering a better solution

**CONTRACTOR**

**RG BUILDWELL ENGG. LTD.**

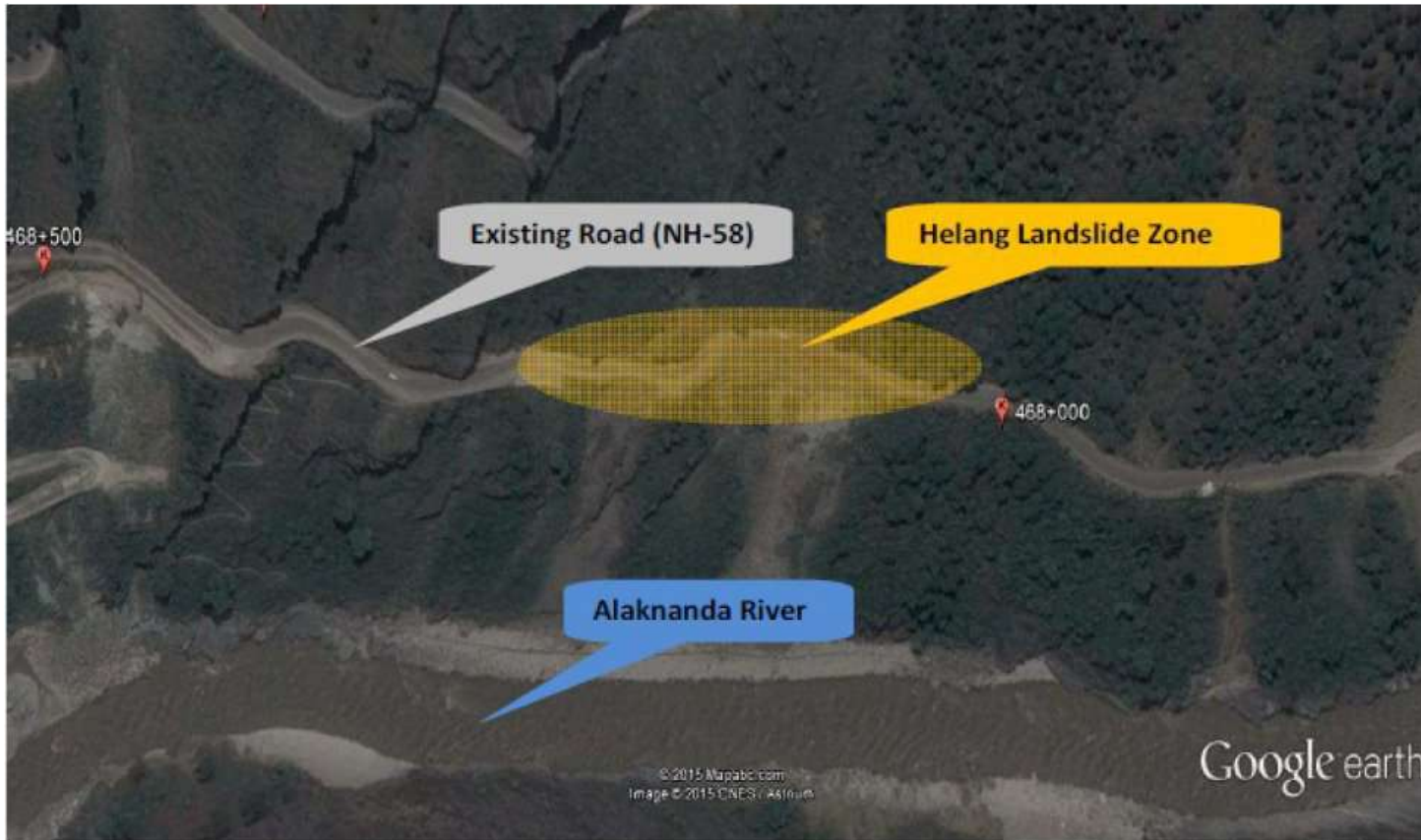


## COMMON PROBLEMS IN THE AREA

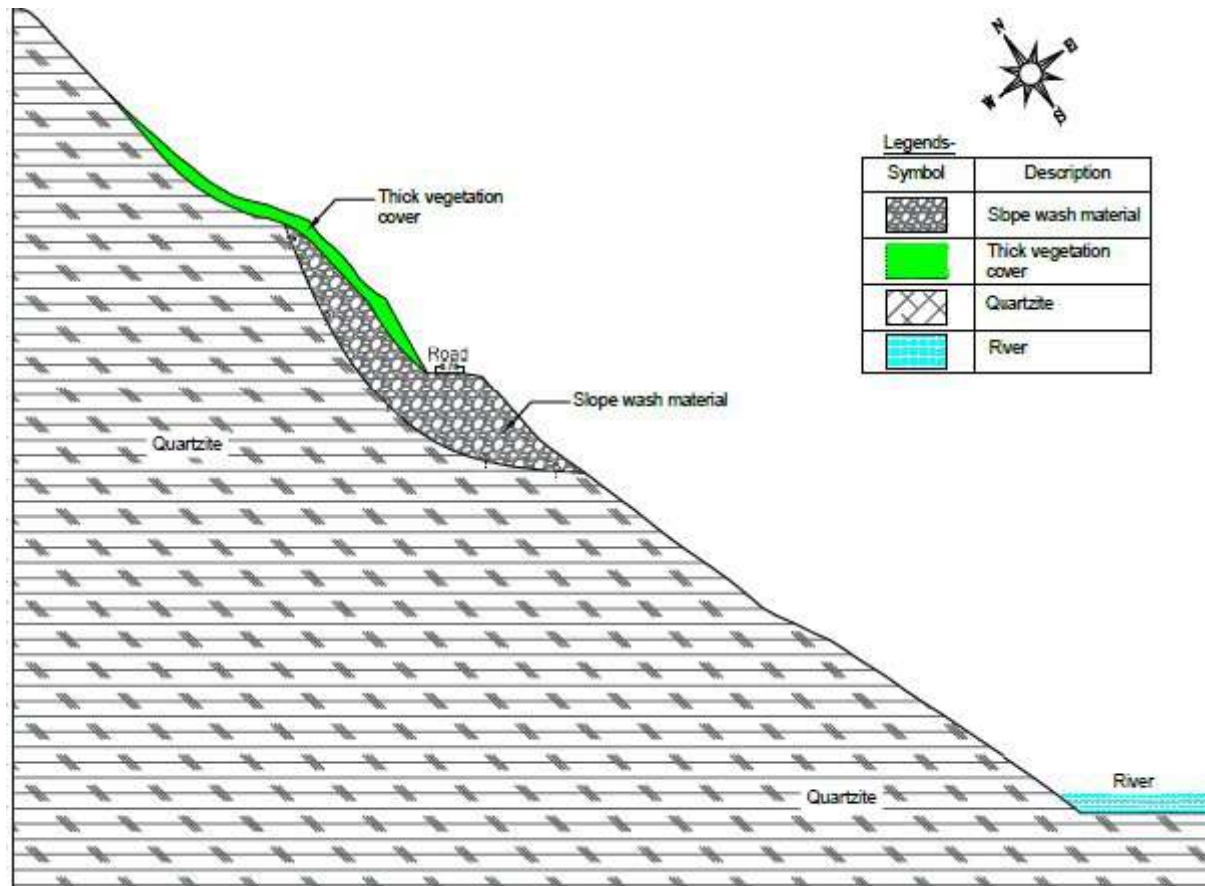
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- The problem at most of the landslide locations:
  - Flow of overburden material from the uphill slope on to the valley side.
  - Surface runoff and formation of natural channels on the slope surface.
  - The climatic changes over the past few years (frequent floods and cloud bursts)
  - The erosion of the toe of the slope due to the flow of river.
  - Unfavorable discontinuity orientation.

## PROJECT LOCATION - HELANG



# GEOLOGICAL SECTION- HELANG

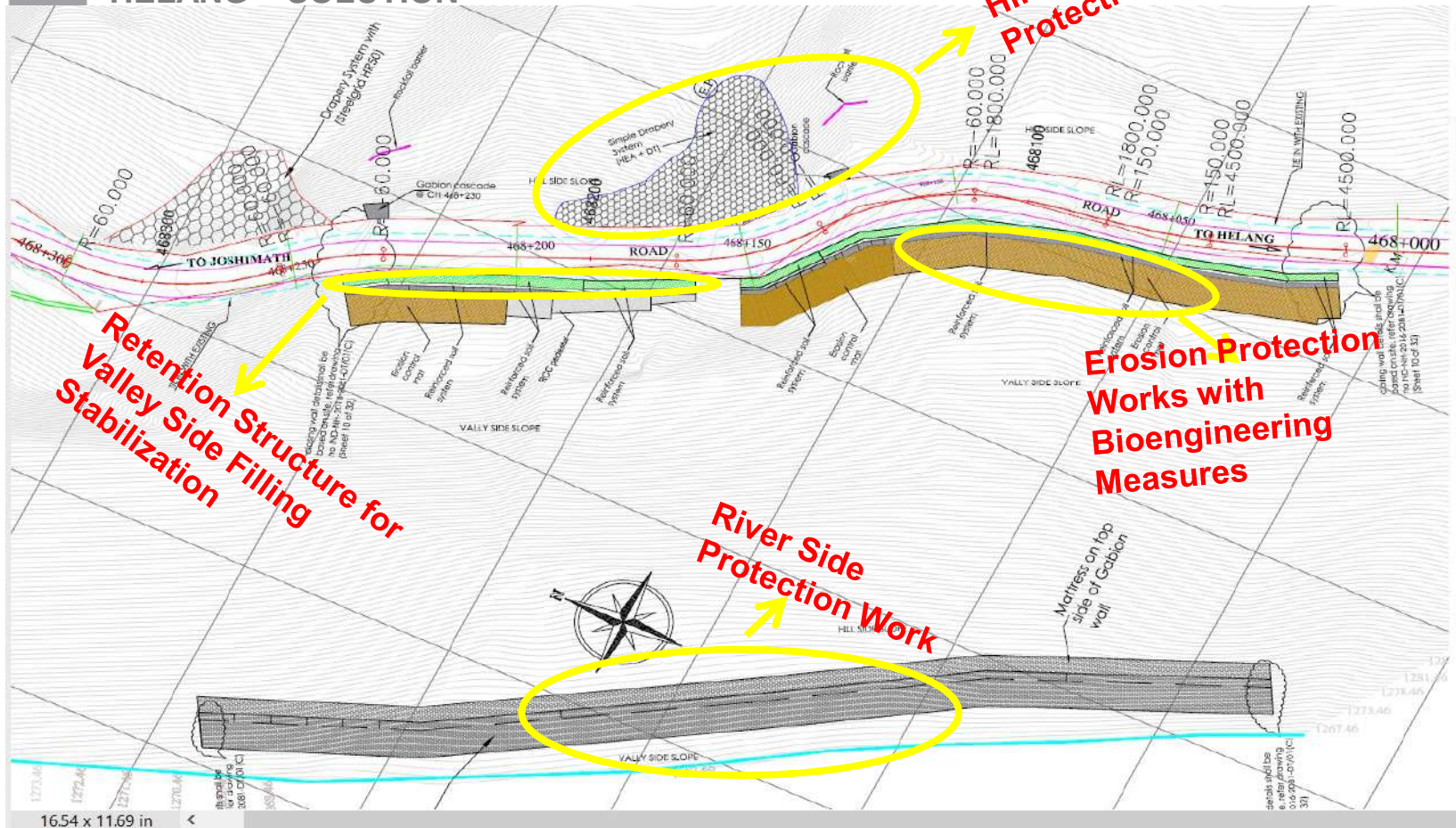


## HELANG – CAUSATIVE FORCES

- Heavy
- Impro
- Existi
- Rock r



# HELANG - SOLUTION

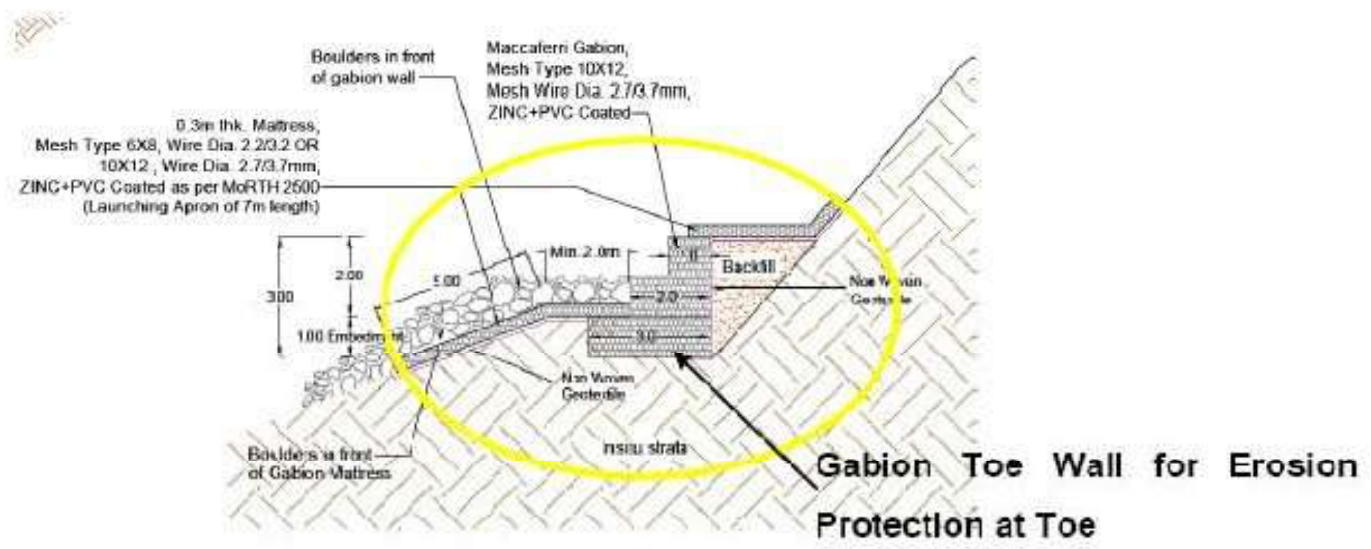


**Retention Structure for Valley Side Filling Stabilization**

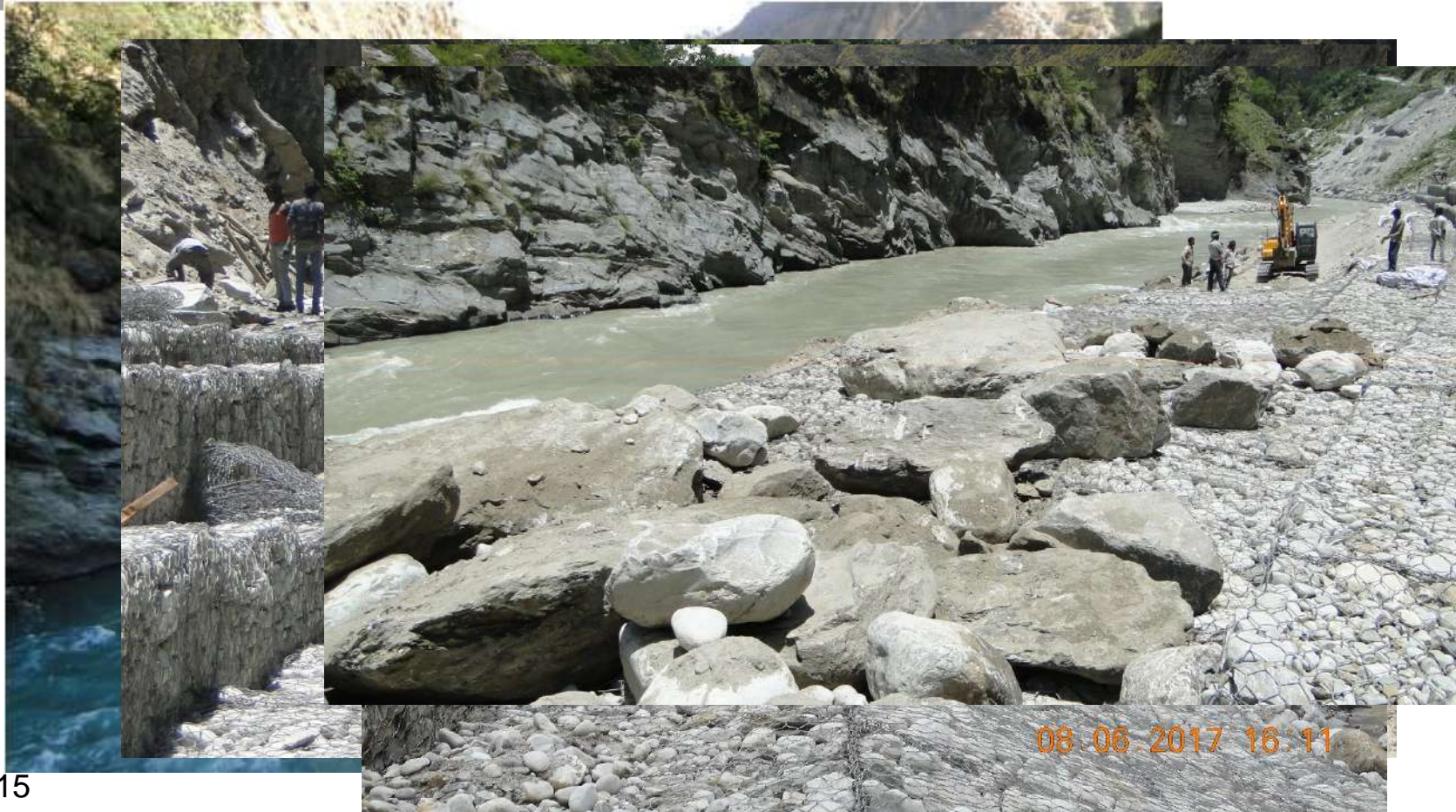
**Hill Side Protection Work**

**Erosion Protection Works with Bioengineering Measures**

**River Side Protection Work**



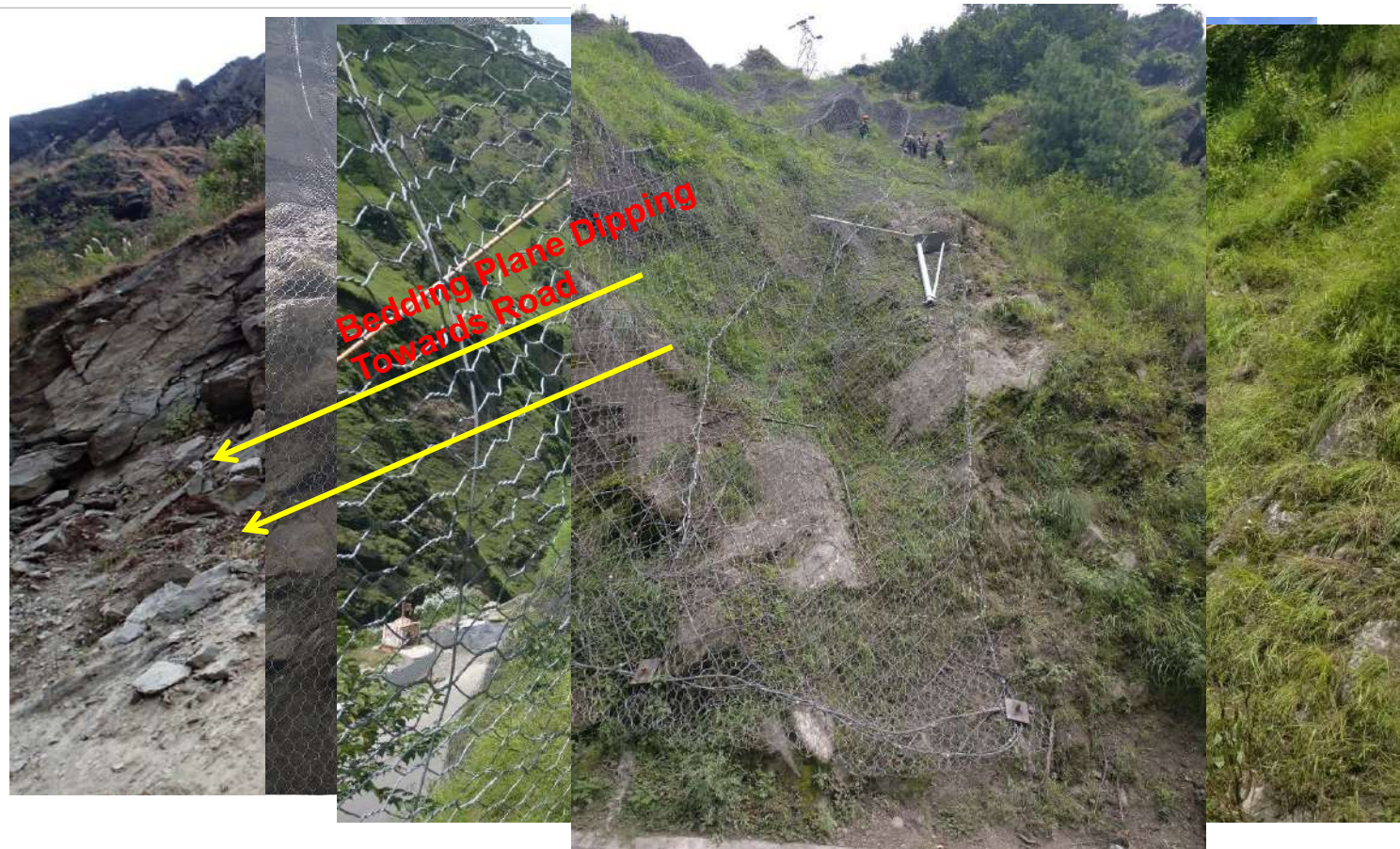
## HELANG – PHOTOS OF ONGOING WORK – RIVER SIDE



## HELANG – PHOTOS OF ONGOING WORK – VALLEY SIDE

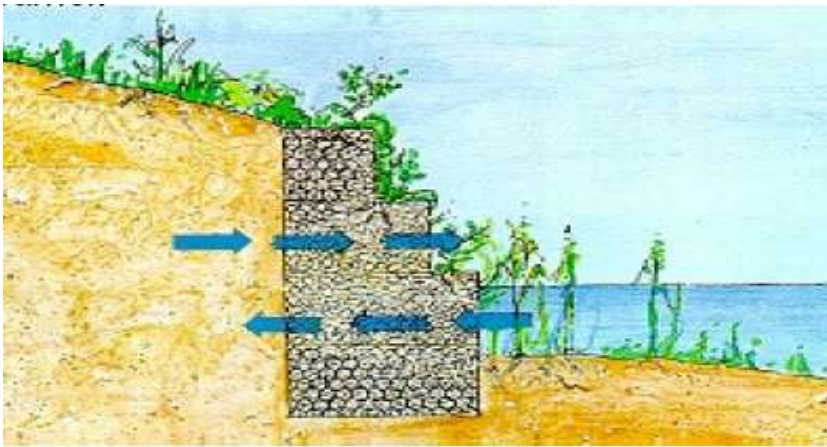


## HELANG – PHOTOS OF ONGOING WORK – HILL SIDE

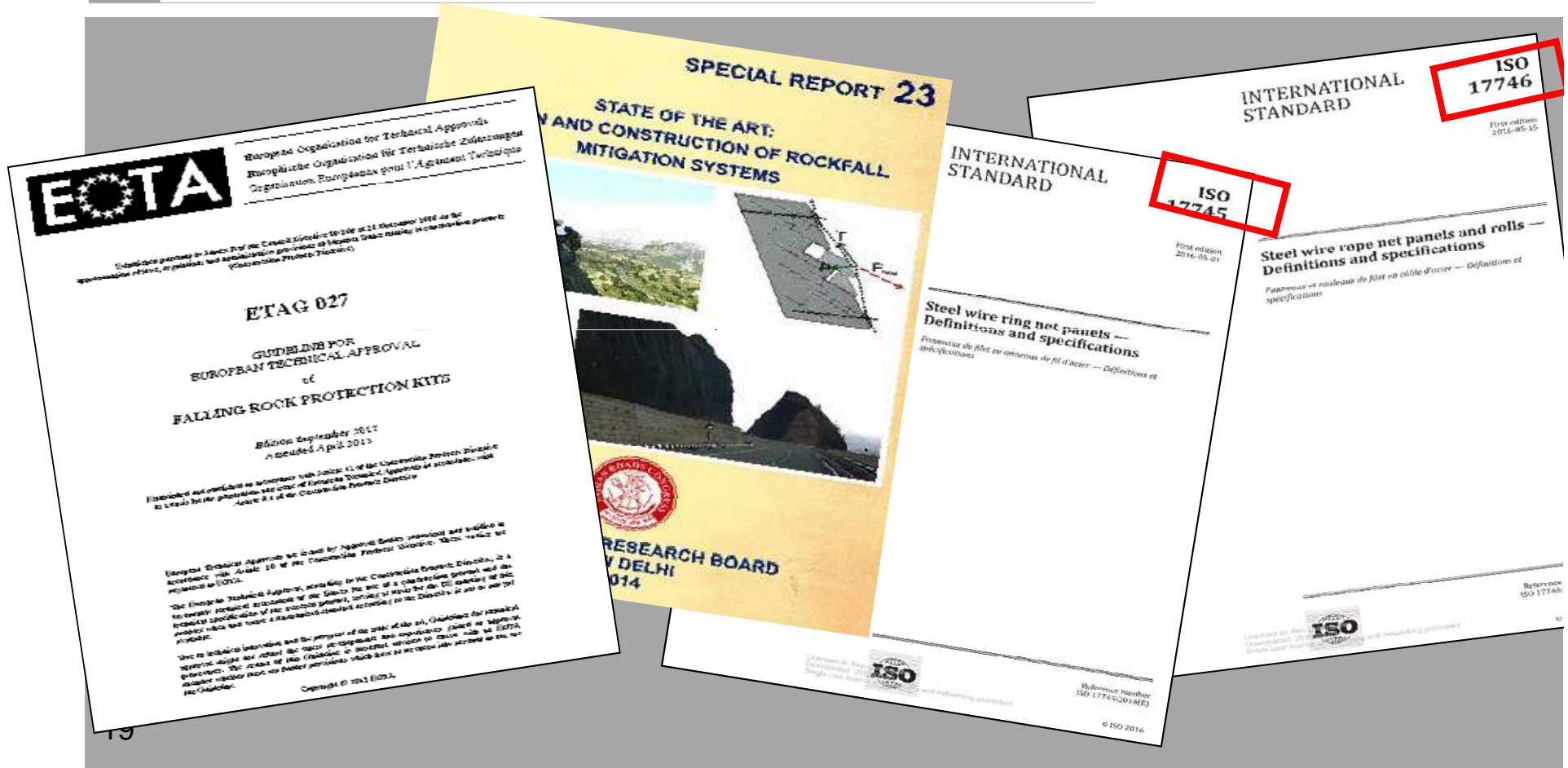


## MERITS OF THE SYSTEMS PROVIDED

- The whole system is designed to make the system sustainable, **green** and **flexible**
- Self draining nature help to dissipate the pore water pressure
- Carbon Foot Print Reduction
- Durability



# CODAL STANDARDS AND REFERENCES



# INSTALLATION GUIDELINES

## A) GABION FACES WITH SECONDARY REINFORCEMENT AND HIGH STRENGTH GEOGRID AS PRIMARY REINFORCEMENT

High strength Geogrid: High strength Geogrid is supplied in rolled form in construction site.



Step 1: Geogrid is cut the first layer of primary soil High strength geogrid reinforcement at desired foundation.



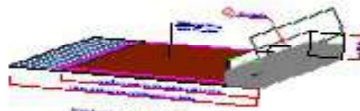
Step 2: High strength Geogrid roll (4-6m wide) should cut to design length.



Step 3: Facs units are supported in collapsible form, fabric roll installed and 1st layer of soil test shall be placed above primary geogrid layer. The units shall be refilled and positioned properly around the steel bars.



Step 4: The units shall be tied or bolted to adjacent units along all existing edges in order to form a continuous composite, monolithic structural unit. The unit shall be filled with the stone.



Step 5: Second layer geogrid shall be provided above the primary reinforcement.



Step 6: Geotextile filter shall be placed in the facing section and backfill material. After placing the appropriate filter, soil fill shall be placed with the approved procedure and compaction shall be carried out. The maximum size of stone to be filled on backfill shall not go beyond 50mm.



Step 7: After completion of first layer, installation of second shall be started by placing the second layer of soil unit.



Step 8: Second layer shall be positioned properly with the help of steel bars.

## I. INSTALLATION PROCEDURE FOR DOUBLE TWISTED MESH, RHOMBOIDAL WIRE ROPE PANELS

### 1. Preparation of the surface

First, manually or by the use of machines, the entire protruding rocks on the slope have to be chipped down.



### II. Installation Procedure

#### Option 1: Providing anchors at the top

In installing the double twisted mesh there are two methods.

#### Method 1

The rolls of the double twisted mesh are transported to the top of the slope (crane may be used) and the rolls are aligned on the upper edge.



## CONCLUSION

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- **Strategy has to be fixed towards the approach of landslide mitigation solutions**
- **Site specific approach** for design, analysis and selection of systems for slope stabilization measures is required. Hence detailed investigation and monitoring is must.
- **A multidisciplinary approach is required to finalise the best feasible solution- from toe to hill which required different solutions.**
- **Risk assessment is required in order to select the appropriate solution**
- **Maintenance part should be taken into consideration while finalising the solutions.**
- **System selection should be in line with the codal guidelines and as per the specifications given in IRC / international standards.**
- **Construction feasibility should be a major consideration , while finalising the dimensions of drain**
- **Drainage-an inevitable part of landslide mitigation**

**THANKS FOR YOUR KIND  
ATTENTION**

