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A CASE STUDY OF RETAINING WALLS IN SUNAUN VILLAGE IN THARALI (CHAMOLI) UTTARAKHAND

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Abstract: Increasing developmental activity in mountainous areas has aggravated the landslide hazard in these areas. Sunaun village is one of the examples of these sites. This project is a case study of the retaining walls being built along PINDAR RIVER in the Sunaun village in Chamoli district of Garhwal, Uttarakhand. The region has faced many severe problems due to floods in the past years which affected the normal life of people.The village faced heavy destructions due to floods and landslide disasters in Garhwal region in 2013. There was a huge loss of public and private properties. There was a loss of vegetation affecting the livelihood of the local people.

The two main problems in the region were:

1. **Heavy Floods during rainfall**
2. **The region comes under the Seismic Zone IV**

The Pindar river that flows in the area is a perennial river and water flows throughout the year but during heavy rainfall the water rises and becomes a threat to the livelihood of the local people.The river was a serious threat during floods to the homes and the government school along which the river flows. After the 2013 disaster in the Garhwal region, this initiative was taken under the disaster management work and retaining walls were being proposed as the most convenient, and econolical method to minimize the effects of floods in the future so that [people can normal life of people does not get affected. The design of retaining wall was given by IIT Roorkee. The project comes under the disaster management work and the work is done by the K.G.L Constructions.

Keywords- Landslide, Rainfall, Drainage, Flood

I: INTRODUCTION

India is one of the worst affected countries so far as landslide disasters are concerned. Almost 15% of the land area in India is prone various degrees of landslide hazard. States like J&K, Himachal Pradesh, Uttarakhand, the seven states of North-East, Kerala, Karnataka, Tamilnadu, Andhra Pradesh, Goa, Maharashtra, Madhya Pradesh, Chhattisgarh, Andaman & Nicobar, etc. are all prone to landslides of various intensity and spread. The Himalayan belt is especially prone to disaster due to landslides. It is estimated that landslides cause around 500 human fatalities and costs around INR 300 crores annually .

The hazard impact of landslides and rock falls is dependent on the location, type of human activity, spread, depth (shallow or deep) and frequency of landslide events. In so far as road infrastructure is concerned, DPR preparation for Greenfield roads needs to take extra precautionary studies including collection of historical landslide data, geo-technical investigation and hydro-geological studies to arrive at landslide damage potential of the road alignment even if it is qualitative. The alternative alignments must be explored and an estimate of landslide protection removal and re-construction costs must form one of the decision variables. It is often seen that senior level intervention are missing at the time of reconnaissance and initial decision making process which may lead to sub-optimal choice of alignment. Once the initial surveys are carried out it is both time consuming and costly to reconsider the initial decisions taken for fixing of alignments. In the public work set up fear of administrative action also muddles engineering common sense and work is seldom taken up for a large scale re-thinking and realignment. The possibility of work already executed and paid for being treated as „infructuous expenditure‟ also bogs down the field formations.

The landslide and rock falls hold up traffic in hilly areas apart from causing direct damage by hitting vehicles. In the mountainous region there is usually one road from one point to another and alternative routes are often not available. Blockage of road by landslide not only hampers economic activity at higher elevation, but also prevents relief and reconstruction equipments from reaching the point of obstruction.

II. USE OF GIS FOR ALIGNMENT PLANNING

New road constructions invariably involve earthwork that can trigger slope failures or rock / earth falls if correct and sufficient measures are not incorporated at design and planning stages. It is important to have inputs about the topographical, geological, hydrological and vegetation aspects of the terrain, so as to avoid last minute alterations in alignment and structures; which adversely impacts the cost and time parameters of the project. Use of satellite data and aerial photography enables the identification of vegetation cover, topography, drainage patterns, surficial geology, landslide hazard areas, etc. Though the accuracy of satellite imagery easily accessible for civilian use is low, the Digital Elevation Models derived from it can be strengthened by secondary data from more accurate surveys. One such technique is Light Detection and Ranging (LiDAR) survey, which is especially useful in forested areas.

The use of GIS is extremely effective in establishing the relationship between landslide events and their causative factors. It enables us to capture the characteristics of a large area which is important in planning construction activities in mountainous areas. In CPWD, we have catered for procurement of High Resolution Colored Satellite Imageries, preparation of Digital Terrain Models using the same, proposing alternate alignments and their appraisal and applying corrections to centre line coordinates of best alignment at every 5 km. intervals using high precision Differential GPS with Real Time Kinematic (RTK) accuracy of 8mm ± 1 ppm (horizontal) and 15mm ± 1 ppm (vertical). The DPR consultant is also required to submit complete drainage system and landslide hazard zone mapping along with the alternate alignments.

III. ROCKFALL PROTECTION

In India, considerable road networks are being developed in mountainous terrain, especially in the Northern and North-Eastern parts of the country. The inherently unstable geology of the region, coupled with excessive rainfall, snowfall and hillside cutting for construction, immensely increases the potential for landslide events. Rockfalls constitute a large percentage of such occurrences, and cause avoidable road blockages where access to maintenance teams is also constrained.

Rock fall mitigation measures are broadly classified as prevention measures (nailing, deep anchoring, trimming, benching, etc.), retention measures (mesh netting, chemical stabilization, shotcreting, etc.) and protection measures (drapery, ditches, rock sheds, protection walls, etc.). Practical construction would often encompass all three types of measures and the choice of amelioration technique would depend upon the importance of the road stretch, availability of alternate access / bypass roads, geology of the location, thickness of loose rock mass and volume of debris anticipated, maintenance of the protection system adopted, budgetary constraints, etc.

4.Geo-composite Drainage Systems :

The importance of drainage for stability of hill slopes cannot be over emphasized. Conventional drainage measures like longitudinal drains, filter media behind retaining walls, vertical boreholes or wells, drainage tunnels / galleries, etc. have found usage in various situations. Most commonly used drainage system in hill roads is by providing filter media behind retaining walls, collecting the water through weep holes, carrying the water in roadside drains upto natural channels and passing beneath the road through culverts. The open structures like drains, culverts, bridges, etc. are amenable to easy maintenance. However, the filter media provided behind retaining walls suffers from two main drawbacks
a) Clogging of filter layers by fine particles flowing with the water
b) In situ provision of well graded filter layer made of gravel / crushed stone is difficult to achieve, especially in remote areas

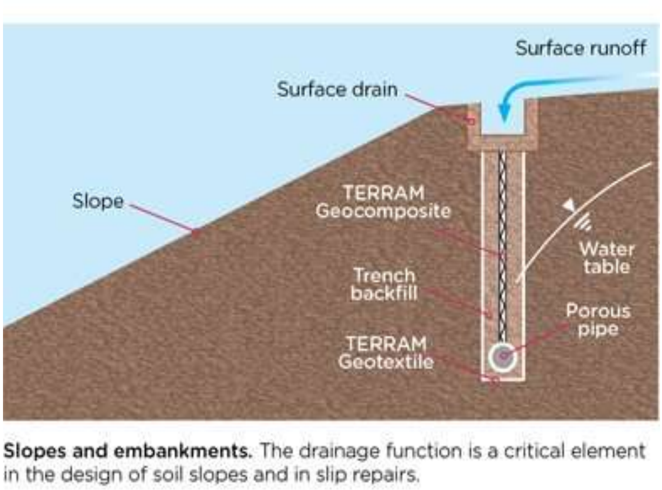


Figure1: Slope and Embankments

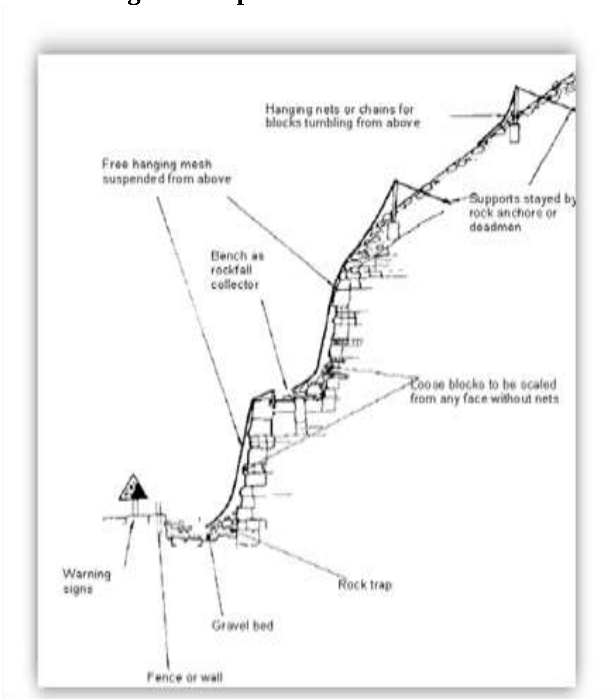
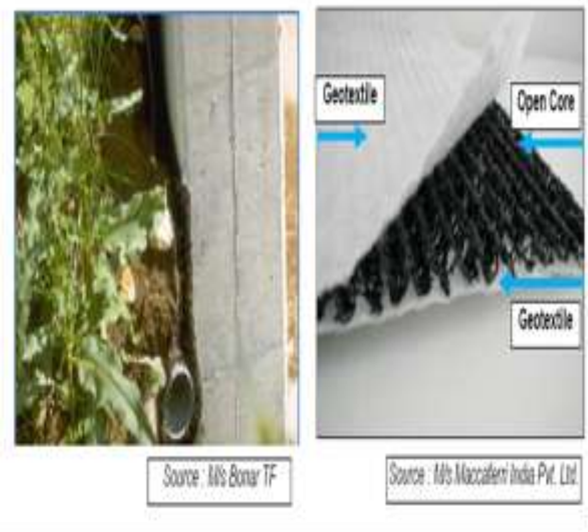


Figure 2: Geo- Composite Drainage system

IV. DRAINAGE BEHIND RETAINING WALLS

Geo composite drains for collecting water behind retaining walls (also called Fin Drains) are now available which have much better drainage capacity over long periods of time. They comprise a polymer drainage mat which is sided by non- woven geotextile on one or both sides. One side geotextile is sufficient for use behind retaining structures (which can be random rubble masonry or any other), with the textile side on the earth fill side to prevent fines from entering the drainage layer.



V. DRAINAGE UNDER PAVEMENTS

In this application, the geo-composite consisting of the drainage mat sandwiched between two layers of non-woven geotextile, is placed below the base course in portions of road which has wet surface conditions, e.g. around water falls, springs, etc. It drains away the water by gravity and prevents it from entering the soil sub-base and creating slushy conditions. Consequently, carriage way surface distress due to loss of shear strength of soil

sub-base is avoided. The textile also serves as separator and prevents mud pumping (mixing of coarse aggregate with soft soil below).

Benefits of Geo-Composites :

The drainage geo-composites are factory manufactured and have much better quality control compared to in-situ systems. These are light weight and fast and easy to install. The material is polymer based and has considerable durability and structural stability. The use of geo-composites reduce the consumption of natural aggregates and thereby reduce the environmental impact of road construction. It is especially important in the ecologically vulnerable mountainous regions.

VI. THE ROAD AHEAD

There is need for taking up landslide control measures as an integral part of road development works. The decision making machinery in State and Central governments need to appreciate the need for such measures. It is also important that half baked initiatives be avoided as these may lead to ineffective measures and consequently wasteful expenditure. There is need to develop capacity for taking up geological and geotechnical investigations which should form an important aspect of the DPR for roads in landslide and rockfall prone areas. GIS based identification and monitoring of slides and falls must be part of the mandate of road maintenance organization.

The use of geo textiles is gaining ground all over the world. These engineered textiles can be customized for different applications and reduce the dependence on crushed stone and rocks, thereby turning out to be environment friendly options. Subsurface drainage behind retaining walls, below road crust and in embankments are areas where more experience needs to be gathered. There is state of the art research in permafrost engineering in places like Alaska, where frost boiling in roads have been addressed by use of specialized geo-composites.

VII. RETAINING DEVICES

A retaining wall, as the name implies, is a wall meant to retain something. Engineering wise, a retaining wall imposes lateral forces against the wall such as wind, earth, fluids, etc. However, in the construction world, everyone understands it as been a wall built to retain soil or earth. In fact, many times the term retaining wall usually infers a concrete retaining wall.

So, in terms of performing a function, a retaining wall is just a retaining wall. The only difference between the types of retaining walls has to do with the way the retaining is done. There are many different types of retaining walls but in this article we'll deal with the most common ones (which happen to be also the most cheap and economical): concrete (cantilever) retaining walls and (modular or segmented) block or stone retaining walls.

A retaining wall is a structure designed and constructed to resist the lateral pressure of soil when there is a desired change in ground elevation that exceeds the angle of repose of the soil basement wall is thus one kind of retaining wall. But the term usually refers to a cantilever wall, which is a free standing structure without lateral support at its toe. These are cantilever from a footing and rise above the grade on one side to retain a higher level grade on the opposite side. The wall must resist the lateral pressures generated by loose soils or, in some cases, water pressures.

Lateral earth pressure are zero at the top of the wall and in a homogenous ground increase proportionally to a maximum value at the lowest depth. Earth pressures will push the wall forward or overturn it if not properly addressed. Also any ground water behind the wall that is not dissipated by a drainage system causes hydrostatic pressure on the wall. The total pressure or thrust may be assumed to act at one –third from the lowest depth for lengthwise stretches of uniform height.

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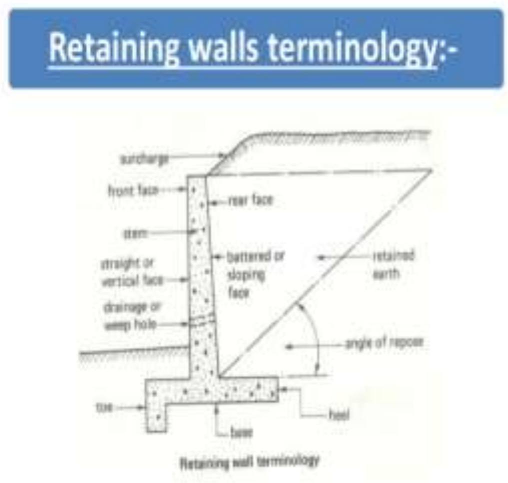
Unless the wall is designed to retain water, it is important to have proper drainage behind the wall in order to limit the pressure to the wall's design value. Drainage materials will reduce or eliminate the hydrostatic pressure and improve the stability of the material behind the wall. Dry stone retaining walls are normally self draining



VIII. SITE STUDY

INFORMATION OF THE AREA AND GENERAL DESCRIPTION

- Site Location- village Sunaun
- Block- Tharali
- District- Chamoli
- State- Uttarakhand
- Structure contructed- Retaining wall
- Junior Engineer- Mr. Vikas Kothari
- Assistant Engineer- Mr. Raj Kumar
- Executive Engineer- Mr. Rakesh Maurya
- Construction company name- K.G.L. Constructions
- total cost- Rs 2,34,00,000
- Project contact person- Mr. A.S.Mehra (9411540579)Functional Goal- To construct permanent flood controlling structure in the area so that the village is not affected by the future floods
- Aesthetic Goal- To choose the best retaining wall in the area that serves its functional goal but also maintain its aesthetic appearance.
- No. of blocks- 38
- No. of retaining walls- 38
- No. of dental blocks- 116

IX. PROBLEMS IN THE AREA

The region has earlier faced many severe problems which affected the normal life of people. The village Sunaun has been hit by heavy floods in the past years.

The two main problems were:

1.Heavy Floods during rainfall
2.The region comes under the Seismic Zone IV
3.Landslide prone area

The Pindar river that flows in the area is a perennial river and water flows throughout the year but during heavy rainfall the water rises and becomes a threat to the livelihood of the local people.

The river was a serious threat during floods to the **homes** and the **government school** along which the river flows. Also the area was very severely affected by the 2013 landslides and heavy floods in the Garhwal region.

Afterwards a survey was being conducted and it was concluded that construction of retaining walls was the most convenient method to prevent the further destructions due to the heavy floods. Building retaining walls will not only prevent the destruction due to the floods but also stabilize the slope thereby preventing the slope failure causing landslides.

X. DESIGN SPECIFICATIONS

The design o the retaining wall was given by IIT Roorkee. The retaining has a slope of 1:3 .

- No. of retaining walls: 38
- No. of blocks: 38
- No. of dented blocks:116
- No. of weep holes: 8 per wall of dia 4 inches.

XI.COST ESTIMATION

(1) 1:3:6 PCC block (38 no.)
a. Earth work in foundation
Length-8m
Width- 3.5m
Height- 2.75m
Quantity cost = 2926*207
Total amount = Rs. 605682.00

b.1:3:6 PCC work in block

Length-8m
Width-3.5m
Height-2m
Quantity cost = 2128*5117
Total amount = Rs.10888976.00

(2) Retaining wall (38 no.)
a.1:5 c/s masonry
Length - 8m
Width – 1.55m
Height – 5.50m
Quantity cost = 2591.60*2537
Total cost = Rs.6574889.20

(3) Dental block (116 no.)
a. Earth work in foundation
Length – 3m
Width – 1,50m
Height – 1.50
Height – 1.50m
Quantity cost = 783*207
Total amount = Rs.162081.00

b.1:3:6 work in dental block
Length – 3m
Width – 1,50m
Height – 1.50m
Quantity cost = 783*5117
Total amount = Rs. 4006611.00

(4)Stone filling on back side of retaining wall (38 no.)
Length – 8m
Width – 2m
Height – 3.5m
Quantity cost = 2128*537
Total amount = Rs.1142736.00

(5)PVC pipes for weep holes (no. at bottom)
Dia – 4 inches
Quantity cost = 38*5*2.50*147
Total amount = Rs.69825.00

TOTAL COST OF PROJECT = Rs 23450800.00

XII. SUMMARY AND CONCLUSION

Disasters are natural and cannot be stopped but we can be prepared to mitigate their ill effects by using traditional techniques of construction suitable for the soil type in a particular region which also means permitting or rather promoting only vernacular construction. It is advisable that shelters may be made out of light construction materials like bamboo, wood (locally available) which have light density. Keeping in mind the mitigation measures and factors that can reduce vulnerability; live loss can be certainly reduced. Most importantly,older buildings should be retrofitted and for new construction whether in developed or rural dwelling NOC should be given for plans which adhere to seismic provisions.

I. The proposed landslide hazard management system may be utilized to drastically reduce the direct losses in term of reduction in: Loss of life, Loss of property and assets, Loss of infrastructure and lifeline facilities, Loss of Resources, Loss of farmland, Loss of places of cultural importance etc.

II. Indirect losses which could be avoided are: Loss in productivity of agricultural or forest lands, Reduced property values, Loss of revenue, Increased cost, Adverse effect on water quality, Secondary physical effects, Loss of human productivity, Reduction in quality of life, Impact on emotional wellbeing etc.

III. If the proposed system properly utilized, the economic losses expected to be reduced to the tune of at least 30 to 40% during the initial years of implementation which can further be increased. Loss of life from the landslides can be reduced significantly because most of the deaths generally happen due to simple ignorance, lack of awareness, lack of timely information, lack of early warning, lack of networking, lack of pre-disaster planning etc,. These issues are foreseen in the proposed system and 70 to 80% causalities can be avoided.

IV. The proposed system will provide the information to educate the public living in disaster prone areas about the landslides and related hazard and risk from these events.

V. .It will forewarn the public about the impending hazard/disaster due to such events in specific risk prone areas so that they can get into alert mode and ready for appropriate action for their safety

VI. It will forewarn and update concerned agencies such as manager of communication, road construction and maintenance units (BRO, PWD's) so that timely action can be taken to save the people and property from the disasters.

XIII. ACKNOWLEDGEMENT

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