Slope Management in DOR – Retrospect and Prospects

MG Maleku – DG/DOR and D N Chalise – UC/GEU/DOR

1 Introduction

Objective of this paper is to provide information regarding slope management in Department of Roads [DOR] of His Majesty's Government of Nepal [HMG/N] to participating delegates at the international seminar on Sustainable Slope Management in Roads jointly being organized by the Permanent International Association of Road Congresses [PIARC] and the DOR here at Kathmandu during 25th to 28th March 2003.

Paper is divided into two parts. First part deals with the retrospect of slope management in DOR providing some background information, road network development data, and existing practices of the slope management in DOR during project planning, design, implementation, and operation and maintenance. Second part provides the generic idea about the planned expansion of Strategic Road Network [SRN], strategy shift, challenges and development priorities, and the proposed modality for integrated road slope management in future.

2 Background Information

Hills and Mountain in Nepal cover about 79 % of the 147181 km^2 country's area. It hosts 51.6 % of the country's population [23.2 ml]. It contains 69.7 % [3598 km] of Strategic Road Network

Nepalese mountains are very fragile as they are the part of young Himalaya. The whole zone is geologically very fragile. Main central thrust [MCT] and main boundary thrust [MBT] passes through the Nepalese territory.

Within an average width of ~ 100 km, the topographical disparity is so enormous that it starts from ~ 150 m amsl at Jhapa district in the east and reaches well over 8000 m amsl at the northern boarder with Tibet [China]. This has inherited a wide diversity of climate, physical environment, culture and religions, demography, and topography and geology. The rugged topography is dissected by numerous rivers and streams originating from perennial snow at the northern Himalaya and flowing towards the plain in the south. Gorges, slopes, and the river cuts are often very steep.

Similarly there is a very wide economic disparity between the Terai and Hills, between the urban and rural areas, and between the east and west of the country.

Population is also very sparsely dispersed and service centers providing services to this dispersed population is sparser.

In this condition, anyone can guess that it is very difficult to construct roads in Nepal. It is more difficult to maintain a mountain road in such areas because of numerous slope failures leading to road closures during heavy Monsoon rain that delivers colossal amount

of water in a short time. It is further made difficult to deliver transport service to the people because of:

- Huge cost of construction;
- Questionable economic return and low traffic;
- Many environmental and social hazards and risks requiring huge cost for mitigation;
- Unfavorable topography and meteorology;
- Huge cost of maintenance and disaster management;
- Disturbance to natural slopes by man made activities such as road construction.

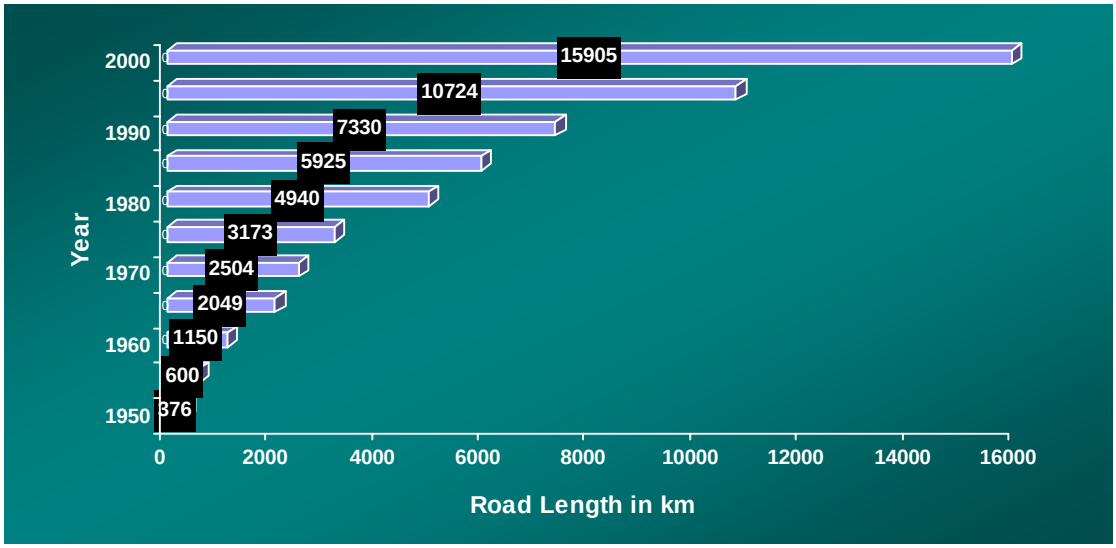
3 Development of Roads in last 50 years

Despite the difficulty great many kilometers of roads have been added to national assets during the last five decades. As the road was rightly considered as the backbone of all other development activities a huge investment has been made in this sector. A lot of foreign support both grant and loan, has been utilized to achieve the current size of the network. The network status is given in table 3.1 and development of total network during last 50 years is represented graphically in figure 3.1 bellow.

Table 3.1

	Black Top	Graveled	Earthen	Total
Total Network (km) [Type of Roads]	4617	3959	7329	15905
Total Network (km) based on Category of Roads				
National Highway	Feeder Roads	District Roads	Others	
2974	1820	9060	2051	15905
These two categories comprise the Strategic Road Network		*District Road Network*	*Urban Road Network*	Source: Nepal Road Statistics 2000 - DOR

Figure 3.1



Problem faced by the DOR at present is related with the difficulty to deliver transport service to people along significantly huge total network. Problem arises because of the need to maintain the road along the total network while its actual mandate is only the SRN. Budget allocation, which is meager in comparison of the need, is another great problem to be addressed to. The expectation of the people in general and the entities in particular is ever rising. When such expectations are not met, though due to valid reasons, negative comments regarding DOR appears in the media, which does not help DOR to carry out its work effectively and efficiently in any way. Further reasons for the difficult slope management are as follows.

- Slope failures and road closures during heavy monsoon rain in a short time;
- Huge cost of maintenance and disaster management;
- Questionable economic return and low traffic;
- Environmental and social hazards and risks;
- Unfavorable topography and meteorology.

With this as background it can be said that the road construction and especially its maintenance poses a real challenge to Nepal. There are minor to huge slope failures which cause road closures and make the delivery of services redundant for few days to many months depending on the nature, magnitude and type of the slope failure. Many examples of such road closures can be taken from existing roads such as Prithvi Raj Marga, Arnico Raj Marga, Lamosangu Jiri Rajmarga, Tribhuvan Raj Path, and many others.

4 Existing Practices of Slope Management in DOR

Usually, new construction project is not associated with problems of bigger magnitude as the slopes are studied already from the very outset of project feasibility study and all the consequential activities built into the project design and project implementation. The real problem is faced during the operation and maintenance of already completed roads, which are very often closed by number of slope related problems. This leads to the no transport service to public, though for a short period. But people who are already used to certain service level do not receive the service; it is but natural to have certain amount of dissatisfaction leading to all the hassles in the media.

Existing practice of slope management during various stages of project cycle in DOR is described bellow. Three major stages are considered as follows.

1. During Road Project Planning

- Geotechnical and geological study are conducted together with the project feasibility and detailed design;
- Geologically hazardous area is identified already during the feasibility study of a proposed road project;
- Such area avoided to the possible extent if they invite hazards, which can cause very serious problems later or which are prohibitively expensive to carry out any mitigation measures;
- Mitigation measures are designed where the hazards cannot be avoided but can be mitigated with reasonable investment.

2. During Road Project Implementation:

- Mitigation measures that are designed into the project in order to address to the slope protection and long term slope stabl9ization are also implemented concurrently together with other road construction activities.

3. During Road Project Operation and Maintenance:

This is by and large the stage of road project cycle where the DOR finds itself in a difficult scenario as far as the sustainable slope management is concerned. This is because of the following reasons.

- Although the Planned Maintenance Management System [PMMS] in the form of Strengthened Maintenance Division [SMD] has been established in the DOR, it still has to do a lot towards integrating slope management into its process;
- Present practice provides inadequate attention to planned roadside support maintenance or sustainable slope management;
- Many road closures due to multiple slope failures during the intensive monsoon rain are considered in an *ad hoc* basis;
- The activities are limited to responsive that is addressing to the problem only when it occurs;
- There usually is very little money under maintenance budget [BH 48-4-555] allocated for slope management problem;
- This budget is not adequate for the mobilization, demobilization, and operation of heavy equipment in emergency plan, according to which number of predetermined heavy equipments are mobilized and stationed at specific critical sections of the SRN throughout the country during four months of monsoon season;
- Recently a Performance Based Maintenance Contract is being experimented, in which:

    - Outputs are measured in terms of Performance;
    - Problem of road closures due to minor slope failures are indirectly addressed to in the contract package itself;
    - Road closures due to reasonably small slope failures are taken as non-performance of the contractor;
    - Non performance is reflected in the contractor's mode of payment.

Apart from those three stages the activities undertaken by the DOR during disasters are basically:

- Responsive
- Curative
- Prescriptive
- Ad Hoc
- With Little Budget

A Roads Board has been constituted recently in order to initiate the implementation of *pay as you go* modality for the road maintenance. But it might take a few more years until it can be effective in order to generate the funds for on-road maintenance, let alone for the

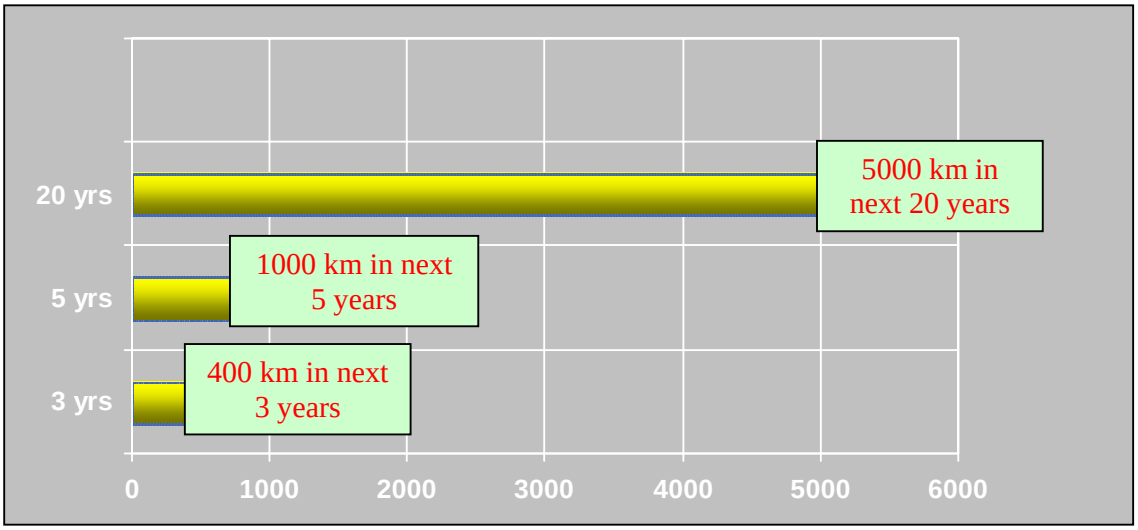
off-road maintenance. For the time being the budget has to be managed from various sources such as foreign support – both grants and loans, and the HMG source.

Due to all these, there are many examples of road disasters leading to road closures at such places as the notorious Krishna Bhir along PRP, Agor along TRP, Mulkhark along Trishuli - Dhunchhe Road, and many others.

5 DOR Future Plans

Department of Roads has recently prepared a long term plan – a 20 Year Road Sector Plan according to which the Strategic Network Expansion is around 5000 km within next 20 years. Similarly within the current 10th five year plan there is a provision for SRN extension by about 1000 km. Only within the forthcoming three years the MTEF of the road sector in DOR has plan for addition of 400 km of SRN in its network. This is represented in figure 5.1 bellow graphically.

Figure 5.1



The experience world wide and in particular in mountain roads in countries similar to ours has shown that the addition of length in network also invites additional slope failures. This poses as a great challenge for Nepalese road builder to keep the road service available to the public by keeping the open to traffic throughout the year.

6 Challenges and Priorities

Challenges in keeping roads open throughout the year are basically:

- Lot of works at many fronts at the same time
- Resource Constraints
- Difficult type of work, and difficult period/season for such work
- Lack of additional facilities to the operation level staff at field working extra time and in difficult situation etc.

At the same time the development priorities of the department are:

- Preservation of Road Assets
- Facilitate an effective and efficient flow of goods and passenger throughout the year
- Sustainable Road Slope Management

In order to accept the challenges and to work towards the achievement of development priorities, the call of the day is to transform this challenge into an opportunity – an opportunity for the Sustainable Slope Management. It has to grow from responsive to planned, from curative to preventive and from prescriptive to diagnostic endeavor. Various types, technologies, and modalities adopted elsewhere are being studied. As the Nepalese economy is small and can not afford to do every things that are demanded by the situation; a system to prioritize the needs has to be worked out based on the cost and benefit, environmental and social benefits and negative impacts, size of the service delivered to the population and its size, and cost effectiveness. After the prioritization the cost required for them has to manage from appropriate resource mobilization.

7 DOR STRATEGY SHIFT in Sustainable Slope Management

A lot of work has been done in this direction and the current strategy shift is described bellow.

Responsive	→	Integrated and Planned
Curative	→	Preventive
Prescriptive	→	Diagnostic
Ad Hoc	→	Well planned
Little Budget	→	Need based budget for prioritized sites

8 Way Forward

Above strategy shift is being materializes by institutionalizing the following activities, tasks, process, and procedures of paramount importance within the department:

- Slope management in road construction and maintenance
- Inventory of roadside support activities including Civil and Bio-engineering
- Inspections and Data collection at DRO level
- Transforming the data into useful information at the DOR
- DATABANK at DOR

The way forward involves the integration of sustainable slope management in the road project cycle – in particular that of planning, preparation, implementation, and follow-up. Together with the feasibility study the slope investigations will have to be carried out. Not only the slope protection but wider measures for the slope stabilization are being incorporated in project design. These measures are to be implemented simultaneously. A proper mechanism to effective supervision, monitoring, evaluation and most important of all – the learning from doing is being established.

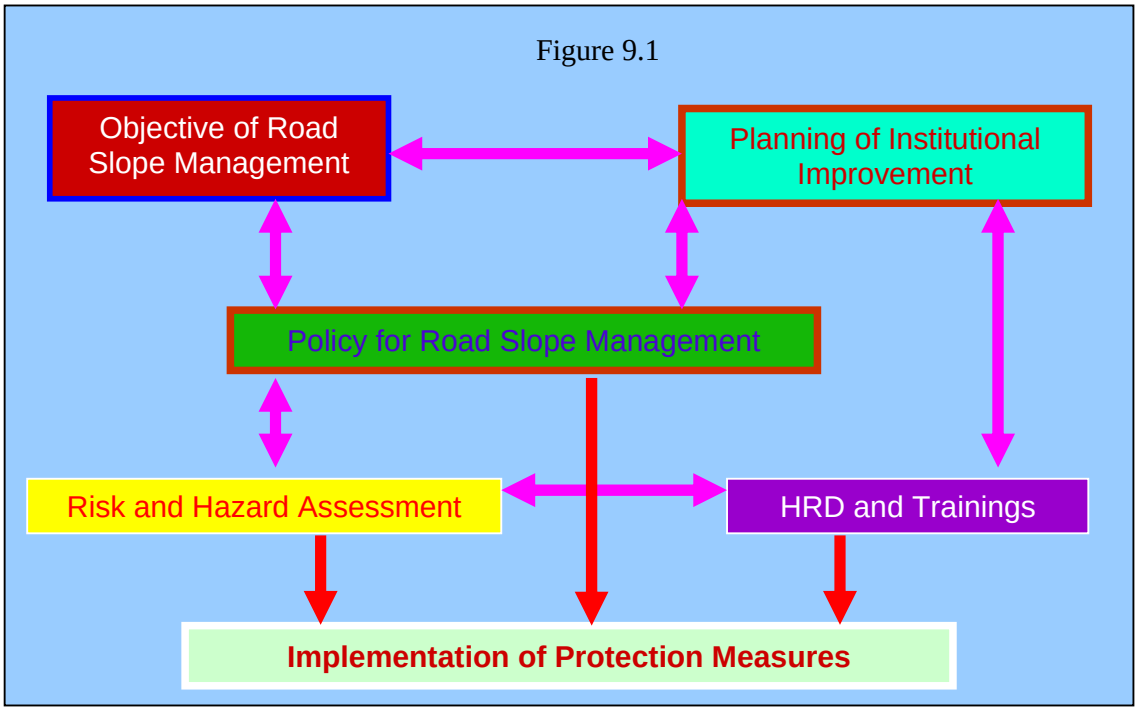
9 Actions Initiated

In this regard, the DOR has already initiated number of actions to work towards the integration of sustainable slope management in the road projects. Major issues that are being integrated in the road project development are as follows:

- Geological/Geotechnical issues – in order to establish a sound hazard and risk assessment of slopes, which are disturbed by road construction and maintenance;
- Environmental issues – in order to establish a sound environmental assessment procedure, to incorporate environmental management action plan [EMAP] in the road project design;
- Social issues – in order to ensure that the project intervention for road development brings about social changes acceptable by all the stakeholders at the local level too, to ensure that the livelihood of the project affected people are better or, at least, remains at the same level after the project, to ensure that the adequate compensation is given to people displaced from the project area according to resettlement and/or rehabilitation action plan [RAP];
- Maintenance issues – in order to ensure a planned maintenance management system not only of on-road, but also of the off-road activities that are directly related with slope management in a self sustaining way;
- Sustainability issues – in order to ensure that the investment made in road project development and service it intends to provide to the people could be sustainable in the national economic, social, and cultural scenarios.

Recently much work has been done in this direction. A modality for sustainable slope management and disaster management of road slopes has been developed with JICA support. The departmental people had put a lot of their effort to make the model such that it can be implemented in departmental context. The model is described in figure 9.1 in forthcoming page.

Figure 9.1



Above mentioned model for road slope management addresses to the following issues.

- Objective of road slope maintenance
- Need of road slope maintenance
- Factors concerned with slope stability:

  - Topography
  - Geological structures
  - Type of rock and soil
  - Magnitude of weathering
  - Surface and ground water condition
  - Effectiveness of protection works
  - Age factor
  - Effects of heavy rain

- Data Collection Based on Inspection, Recording, and Reporting by Division Road Offices [DRO]
- Transformation of Data into information at DOR
- DATABASE regarding slopes at DOR
- Hazard and Risk Assessment
- Comprehensive Planning
- Need identification, prioritization, and budget programming by DOR HQ
- Slope Maintenance and Rehabilitation works implemented by DRO with technical support from the GEU at DOR HQ
- HRD: Various trainings, awareness, and motivation activities
- Institutionalization and integration of the planned slope protection work in regular DOR Planned Maintenance Management System such as SMD

Complete integration of the roadside support maintenance into the planned maintenance management system may it be SMD or the PB Contracts is being planned. Inventory of key roadside supports, bio-engineering sites, and major critical failures will be prepared in next few years.

A system is being worked out to institutionalize the regular inspection of roadside from the concerned Division Road Offices, to acquire the data and convert it into useful information at the HQ [DOR], and to use the information for the planning of slope management and roadside support maintenance in order to better effectively manage the roads and provide intended transport service to the people continuously. For this, again the institutionalization of the budget allocation for the prioritized activities will be established. An effective mechanism will be worked out to carry out these activities. As these activities are a little different from the usual road surface maintenance activity, perhaps such mechanism and procedure might have to be separate to certain extent from the regular DOR tools.

Follow up mechanism will be strictly implemented and ensured by directives and orders from the DOR high level management. However, one specialized unit, preferably the existing GEU with similar Scope of Works and mandates will be endowed with the responsibility to look after these matters. Effective management of this job requires multiple trainings, sharing of experiences, learning from other actors in road development and sustainable slope management the world over.

In order for this to be efficient and effectively initiated, implemented, monitored in the DOR:

- We need to share experience with others around the world;
- We need to learn from others in terms of:
  - New development in sustainable slope management practices;
  - New cost-effective technology in identification, selection, prioritization, design, and implementation of slope protection and slope stabilization activities;
  - Experience from mountain road building in the similar scenario in the region in Hindukush Mountain and from beyond it in Europe, America, and other developed countries that have mountainous terrain within them *etc.*

10 Conclusion and Recommendation

At the end, the department of roads and its staff has considered this forum exactly as one of such activities where we can learn a lot from participating scholars and their presentations in various areas related with the sustainable slope risk management in roads.

DOR and its staff shall consolidate our experience and learning from this forum in order to achieve a sustainable slope risk management established soundly in Nepalese Roads too.

Paper Presented in an International Seminar of Slope Management organized by PIARC in 2003 at Kathmandu, NEPAL