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# ROLE OF BIOENGINEERING IN MOUNTAIN ROAD MAINTENANCE: OBSERVATIONS FROM NEPAL


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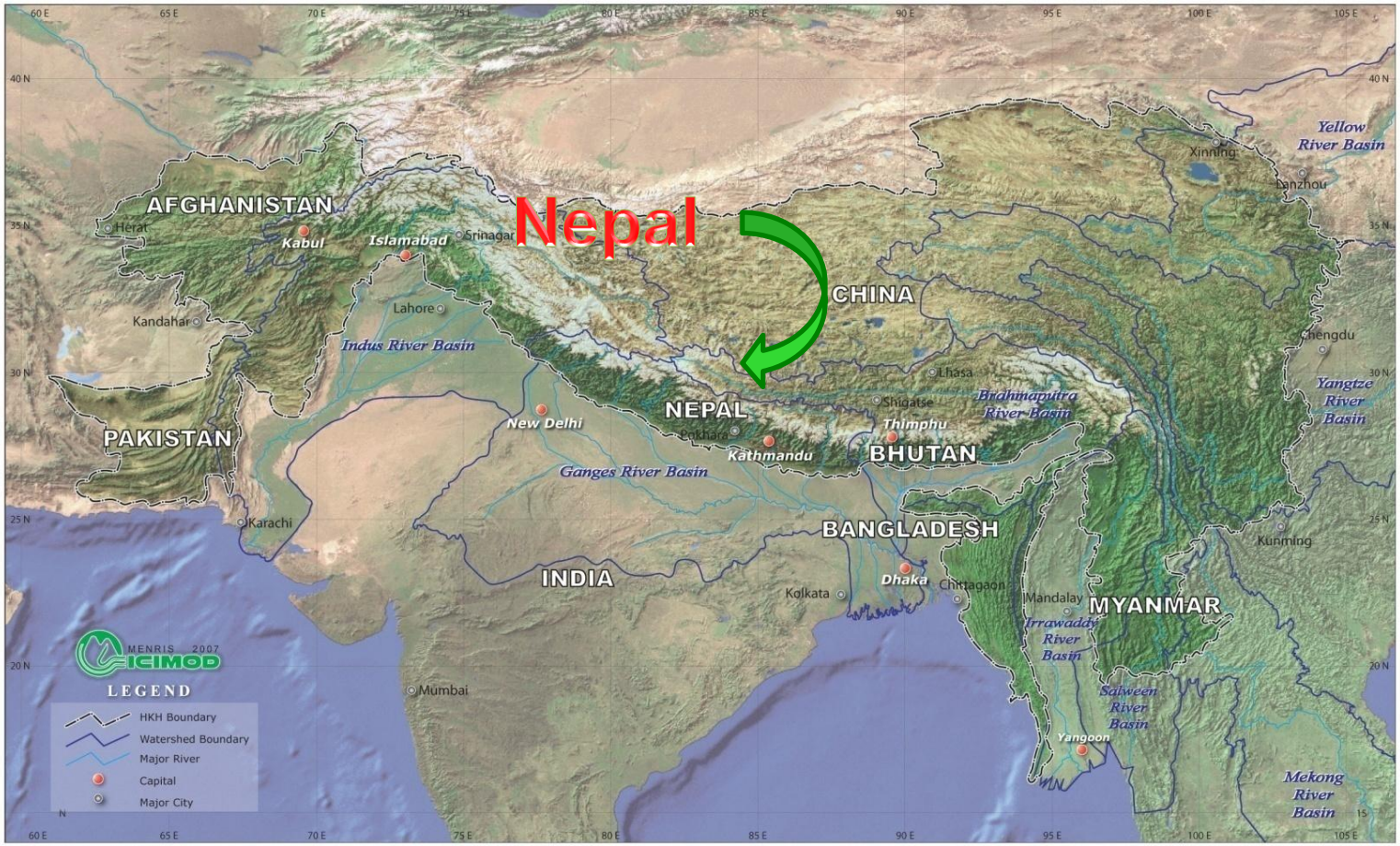
# BACKGROUND

- Road construction started in Nepal since 1956
- Now the Strategic Road Network (SRN) has reached a length of more than 10,000 km
- The SRN is a fundamental contributor to the improvement of accessibility in the remote areas
- Considerable expansion of rural roads has occurred over the past 10 years with local participation

# NEPAL


Hindu Kush - Himalayan Region
Nepal
AFGHANISTAN
Herat
Kabul
Islamabad
Srinagar
Kandahar
Lahore
Indus River Basin
PAKISTAN
Karachi
New Delhi
NEPAL
Kathmandu
Ganges River Basin
CHINA
Lhasa
Shigatse
Thimphu
BHUTAN
BANGLADESH
Dhaka
Kolkata
Chittagaon
INDIA
Mumbai
MYANMAR
Mandalay
Irrawaddy River Basin
Salween River Basin
Yangoon
Mekong River Basin
Kunming
Chengdu
Yangtze River Basin
Brahmaputra River Basin
Yellow River Basin
Xining
Lanzhou
MENRIS 2007
ICIMOD
LEGEND
HKH Boundary
Watershed Boundary
Major River
Capital
Major City
Map prepared by Gauri S. Dangol
Background image source: ESRI

# TOPOGRAPHY

Mount Everest

River System

# STRATEGIC ROAD NETWORK

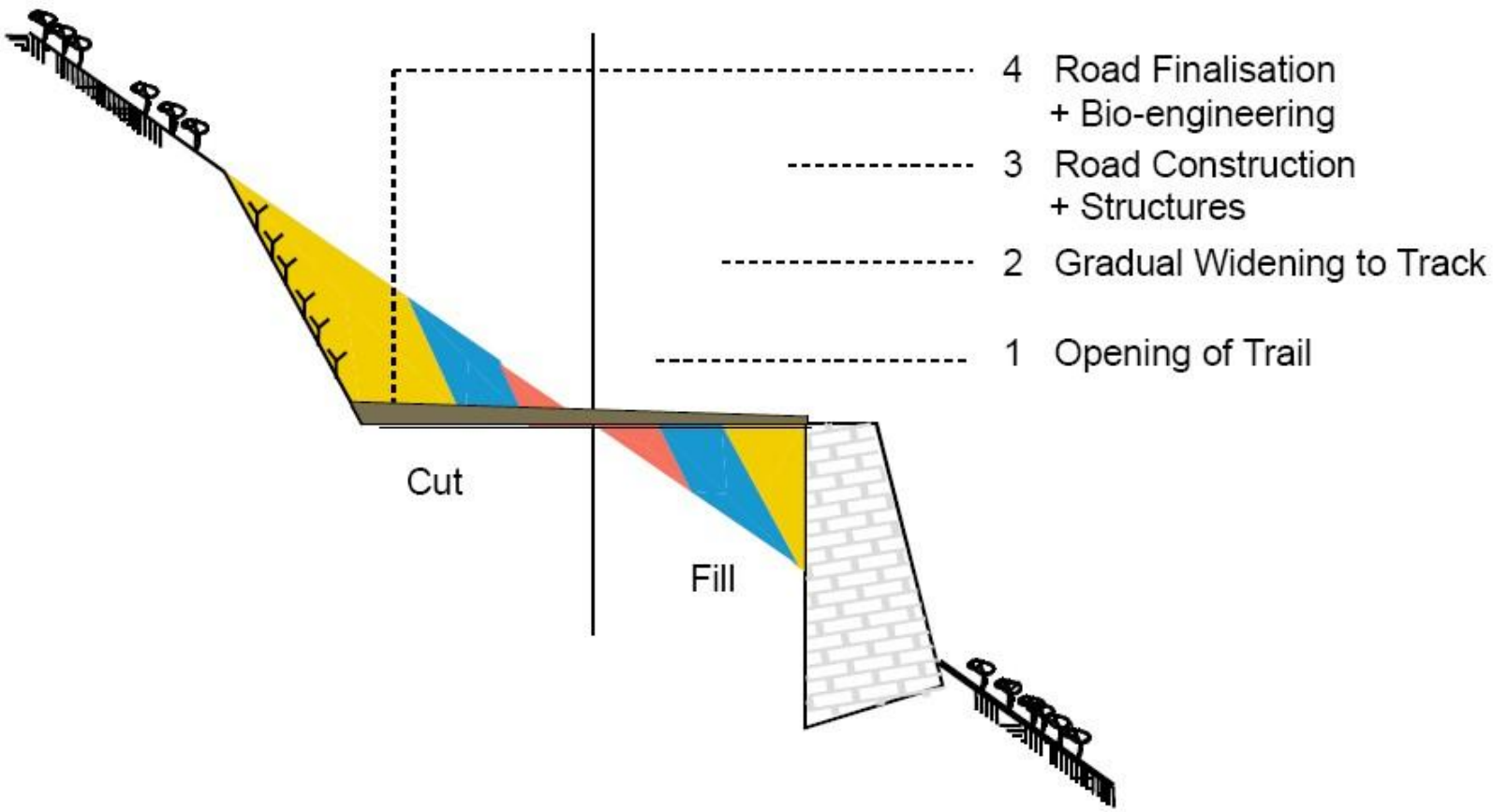
# GEOTECHNICAL ENVIRONMENT

- Mixed geology with several major active faults
- Geographical zone with very high risk of earthquakes
- Steep topography
- Active downcutting of rivers and steepening of slopes
- Geologically volatile and weathered slopes
- Intense rainfall, saturated soil and high surface runoff
- Landslides and erosion during Monsoon

# ALIGNMENT AND MASS BALANCE

- Good alignment selection in mountain terrain
- Road alignment in high landscape
- Avoid the crossing of major slope instability areas
- Green road concept
- Management of earthwork masses
- Sequential construction of roads
- Careful thought approach

# PHASED CONSTRUCTION



# DRAINAGE MANAGEMENT ISSUES

- Marginal stability of existing steep slopes
- Road construction causing mass movements
- Drainage of slopes adjacent to roads
- Disposal of runoff during rain
- Side drains and subsurface drains
- Ground water seepage
- Retaining structures

# ON ROAD MAINTENANCE

- Routine Maintenance
- Recurrent Maintenance
- Periodic Maintenence
- Emergency Maintenance

# ROADSIDE SUPPORT MAINTENANCE

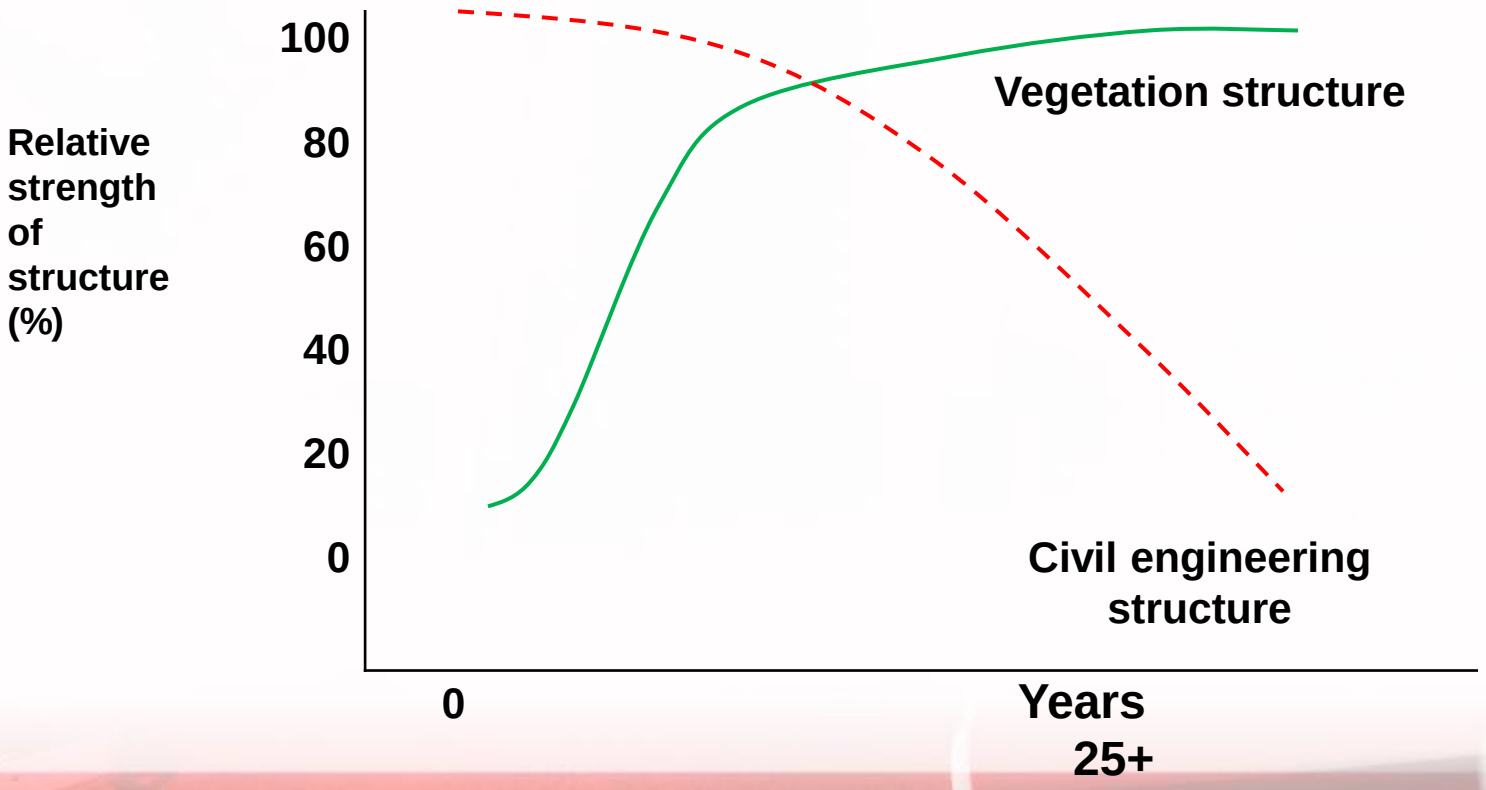
- Remedial and Preventative Works
- Water Management
- Bio-engineering
- Routine Maintenance
- Recurrent Maintenance
- Periodic Maintenence
- Emergency Maintenance

# BIO-ENGINEERING

***Use of living plants for engineering purposes***

- Cost effective way to protect slopes
- Used in combination with civil engineering structures
- Used to protect the slopes against erosion.
- Reduces shallow planar sliding.
- Used to improve surface drainage and reduce slumping.
- Most effective and economic for shallow seated problems

# LIFE SPAN OF CIVIL ENGG & VEGETATION STRUCTURE



# SELECTION OF BIO-ENGINEERING TECHNIQUES

- Selection of appropriate bio-engineering techniques
- Versatality of treatment according to the mechanism of failure and engineering requirements on site
- Careful consideration and attention to details

# BIO-ENGINEERING TECHNIQUES

- Grass planting

  a) Horizontal line  b) Vertical / down slope line

  c) Diagonal line, and  d) Random planting
- Grass seeding
- Shrub / tree planting
- Shrub / tree seeding
- Large bamboo planting

# BIO-ENGINEERING TECHNIQUES *Contd....*

- Brush layering
    - a) Horizontal line
    - b) Diagonal line to facilitate drainage
- Palisades
- Live checkdams
- Fascines
- Vegitated stone pitching

# SELECTION OF SPECIES

- The species that will address the specific problems
- Types of appropriate propagation techniques
- Suitable species for the environmental conditions on site
- Performance of the required functions on site and also useful to local farmers
- Availability of species at the right place, at the right time and in the right quantities

# SELECTION OF SPECIES *Contd….*

- Use of fast-growing species for rapid establishment
- Establishment of a stable, easily maintained plant community
- Development of a vegetation cover that will reduce erosion
- Development of a canopy, shades the soil and improves rooting conditions

# COMBINATION OF JUTE NETTING, BRUSH LAYERING AND GRASS SEEDING

Site before commencement (Left) and after bio-engineering (Right), Hile-Bhojpur Road, Nepal

# LANDSLIDE STABILISATION

Site at the initial stage of works (Left) and after bio-engineering (Right) where bio-engineering techniques are being used, Balefi – Jalbire Road, Nepal

# LIVE CHECK-DAMS

Site just after commencement of works (Left) and with storm water (Top Right) and growth of branches (Bottom Right) on Dharan-Dhankuta Road, Nepal

# BIO-ENGINEERING IN MAINTENANCE

Site where bioengineering was applied (Left) and keeping the road clean (Right) on Malekhu – Mugling Road, Nepal

# BIO-ENGINEERING IN MAINTENANCE

Line of Palisades keeping side drain clean, Naubise – Thankot Road, Nepal

# BIO-ENGINEERING IN MAINTENANCE

Keeping road and side drain clean on Malekhu – Mugling Road, Nepal

# SLOPE PROTECTION AGAINST EROSION

Road neighbors benefit from fodder grass and keeping clean side drain at Banepa-Bardibas Road, Nepal

# LESSIONS

- Bio-engineering techniques should be strong enough for the purpose for which they are designed
- Plants must become stronger over time or to remain strong over a significant period
- Plants should be able to recover from damage
- Bio-engineering techniques must be simple and robust enough to users in remote areas

# LESSIONS *Contd….*

- Good planning makes a road environmentally sound
- Carefully aligned roads require less maintenance in the longer term
- Absence of surface protection leads to maintenance burden
- Special care is required to ensure the stability of slopes and landslide management.

# CONCLUSIONS

The use of bio-engineering has improved the roadside environment reducing maintenance costs and has also shown to be reliable and cost effective for slope protection and landslide management in the road sector of Nepal.

# THANK YOU