

- (v) Adequate drainage measures and protective structures like intercepting catch water drains, longitudinal drains/culvers, breast walls, retaining and the walls are provided for purposes of establishing the slips Growth vegetative cover is stimulated in the disturbed hill slopes above the road level by planting suitable fast growing shrubs and plants. In certain selected unstable areas terraced afforestation has also been plasticized as a stabilizing measure with good results.
- (vi) Over the past few years the roads wing of the Ministry of Shipping and transport has issued instruction laying down broad guidelines and check list of the preparation of road construction projects which provide an inbuilt mechanism of tackling land slides/erosion control for the guidance and follow up action by engineers of state 'PWD' Border Roads Organization and other engaged in construction of hill roads these should be observed.

प्रमाणित किया जाता है कि योजना आयोग द्वारा गठित टास्क फोर्स की उपरोक्त संस्तुतियाँ याचक विभाग को मान्य हैं।


 ३००२० अभियन्ता
 प्रा०ख०,लो०नि०वि०
 नैनीताल


 सहायक अभियन्ता
 प्रा०ख०,लो०नि०वि०
 नैनीताल


 अधिशासी अभियन्ता
 प्रा०ख०, लो०नि०वि०
 नैनीताल

The generalized stratigraphic succession in the area is as under-

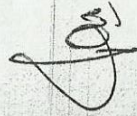
Middle Siwalik Group	Large scale cross bedded salt-pepper coloured medium to Fine grained sandstone, siltstone with subordinate shale
Lower Siwalik Group	Grey coloured micaceous fine grained sandstone with redish brown shales

There are no major streams along the alignment except one seasonal nala. The slopes in general are covered by debris and soil with few outcrops. The proposed reconstruction and renovation work of the existing road needs some cutting and widening at a few places.

STABILITY CONDITIONS :

The southerly dipping slopes of the Nalini ridge in general do not manifest any surface indication of instability. However, as the rocks are not much deformed and the up slopes being steeper 30-50 degrees and covered by soil and debris at places with out crops of sandstones and shales. Any modification of the slope may lead to instability problems. Except at Km 1.05 the slopes do not manifest any surface indication of instability. The following points may be considered for the stabilization so that the link road construction could be undertaken.

- (i) The alignment is located on steeper slopes with ancient debris and soil cover. The outcrops are few in large segment of the road.
- (ii) The steeper part of the alignment just near to Nalini village needs cutting and hair pin bend widened and it is necessary to provide breast and retaining walls with proper design.
- (iii) The seasonal nala, located at about 200 m from the starting point may receive large quantity of water during rains. Therefore proper drainage is necessary as there are huge boulders lying at the channel. The existing bridges abutment and span will need widening /reconstruction with suitable design.



D.A.D

Photocopy attached



D.A.D

SUGGESTIONS :

The aforesaid description of the geology , geomorphology and structure of the area indicates that the slopes are stable at present may become vulnerable to sliding after the slopes are modified. Therefore the following corrective measures may be taken up—

- (i) The slopes should be provided proper drainage as the rocks and slope forming material is fragile.
- (ii) Perforated retaining walls/brest walls be constructed all along the unstable sectors.
- (iii) As the alignment is located mostly on soft lithologies viz. shales ,sandstones and loose debris, no explosives should be used.
- (iv) Bioengineering measures be adopted for the stabilization of slopes. The natural environment /forest cover should be protected as far as possible.
- (v) The rain water from the drains, causeways/scupper should not be allowed freely to move on the slopes. Provision of proper rain water disposal be ensured
- (vi) The road segment at Km 1.05 shows slow creep movement in the down slope area. The shales are fragile and weathered., Therefore, proper brest walls and retaining walls must be designed and constructed.

CONCLUSIONS:

Keeping in view the above conditions the road may be constructed/ renovated along the proposed alignment (total length 2 Km). The site specific recommendations were also discussed with the engineer of the Department.

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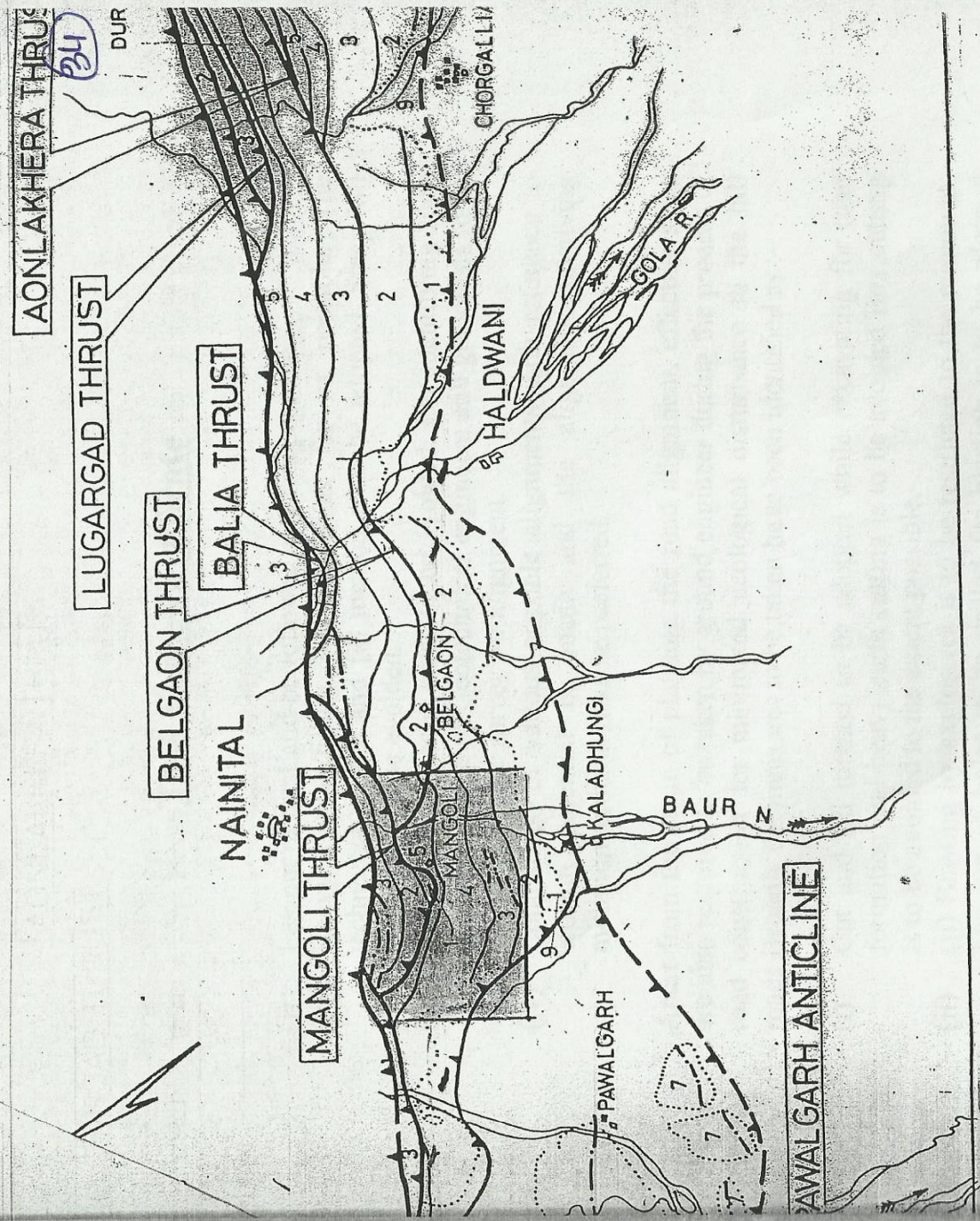
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Professor and Head
Department of Geology
Kuram University
NAINTAL (Mandya)



L E G E N D

Conventional Equivalent

Formation/Group

Enseq

- 9 ☐ SARDA
- 8 ☐ WAHDEVI
- 7 ☐ BATWAN
- 6 ☐ SADHOT
- 5 ☐ KALIDHAR
- 4 ☐ JAWA LAMUKHI
- 3 ☐ MAKRERI
- 2 ☐ KUMARHATTI
- 1 ☐ DHARMPUR
- ☐ PRE-TERTIARY

ALLUVIUM

UPPER SIWALIK

MIDDLE SIWALIK

LOWER SIWALIK

FAULT

THRUST

ANTICLINE

SYNGLE

FAULT

FAULT

Drawn by V.H.

History attached

[Signature]

Task Force Certificate

- (i) Lay out of the Land-be followed as far as possible.
- (ii) Heavy cutting/filling be avoided-as far as possible. The technology of cut and fill method is to be adopted. Steep hill slopes also to be avoided.
- (iii) Unstable/slide-prone areas to be avoided. For identifying such areas the advice of Geotechnical engineers and geologists to be taken during the survey for alignment.
- (iv) Comparison of various possible alignments with reference to erosion potential be made and the alignment involving minimum erosion risks be preferred.

Apart from the stage of planning the road alignment, effective steps are also required to be taken by ground engineer during the process of road construction for minimized ecological disturbance to the hill roads. Broadly the measures to be taken have been identified as :-

- (i) Cut and fill method to be adopted while excavating for road formation and heavy earth cutting is to be avoided. Box cutting is to be avoided to the extent possible.
- (ii) Blasting by explosives is to be restricted to the minimum. Lay out of holes to be drilled for blasting is to be planned keeping in view the line of least resistance and the existence of joints. Controlled blasting should be repeated using low charge and care be taken to avoid activating slide zones or widening fissures and cracks in rock. Use of delay detonators in large scale blasting work is to be made for anaoiline dispersion of chock waves, so that minimum disturbance is caused to the rock stratum as a result of the blasting process.
- (iii) All cut slopes, unusable hill side and slide prone erosion prone areas are to be provided with suitable correction measures by using one or the other of the techniques developed by CRRI. Several techniques have been sponsored by CRRI. like simple vegetative turning, bitumen much treatment and slide treatment by jute netting coir netting of these simple vegetative turning seems to be the most appropriate preventive measure in many situations. This should be established in the denuded slopes immediately after the excavation is made.