High Embankmnt V/s Viaduct - A Case Study

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Synopsis

N. F. Railway is constructing a new line from Bhairabi to Sairang (Aizawl) to connect the capital of Mizoram. Topography in the region is largely immature with steep slopes, narrow intervening synclinal valleys and series of parallel hummocks. High embankments, particularly at locations of hilly streams, with minor bridges pose risk of land slide and slope failures. In order to ensure safety of track, some minor bridges have been converted into major bridges to avoid high embankments. In this paper two such case studies have been presented. Though the decision was directed purely by technical requirements, it has been found that total cost of construction of the major bridges is somewhat lower than the cost of minor bridges with very long barrel lengths and high embankments along with cost of land, as proposed originally.

Introduction

Execution of new line projects presents unique set of challenges. It is more so when laying a new line through mountainous terrain of North East. A number of National Projects have been taken up to connect capitals of North Eastern states. Construction of new line from Bhairabi to Sairang is one such project to connect Aizawl, capital of Mizoram through a Broad Gauge rail link with rest of the country. The entire alignment passes through hilly terrain. Topography of Mizoram is largely immature except for the eastern part. There are N-S trending mostly anticline strike ridges with steep

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slopes and narrow intervening synclinal valleys and series of parallel hummocks or topographic highs.

Mizoram, being a hilly terrain is prone to landslides. Every year a number of landslides have been usually reported from various localities. This is primarily attributed to high slope, immature geology, neo-tectonic activity and heavy rainfall. Landslide are more prominent during the rainy/monsoon season as the soil structure gets soften by heavy and continuous downpour, especially with high degree of slope.

High embankments, particularly at locations of hilly streams, with minor bridges pose risk of land slide and slope failures. In order to ensure safety of track formation, a few minor bridges have been converted into major bridges to avoid high embankments. Though the decision is directed purely by technical requirements, it has been found in a number of cases, that total cost of providing a major bridge is somewhat lower than the cost of acquiring land to construct minor bridges with very long barrel lengths and high embankments as proposed originally.

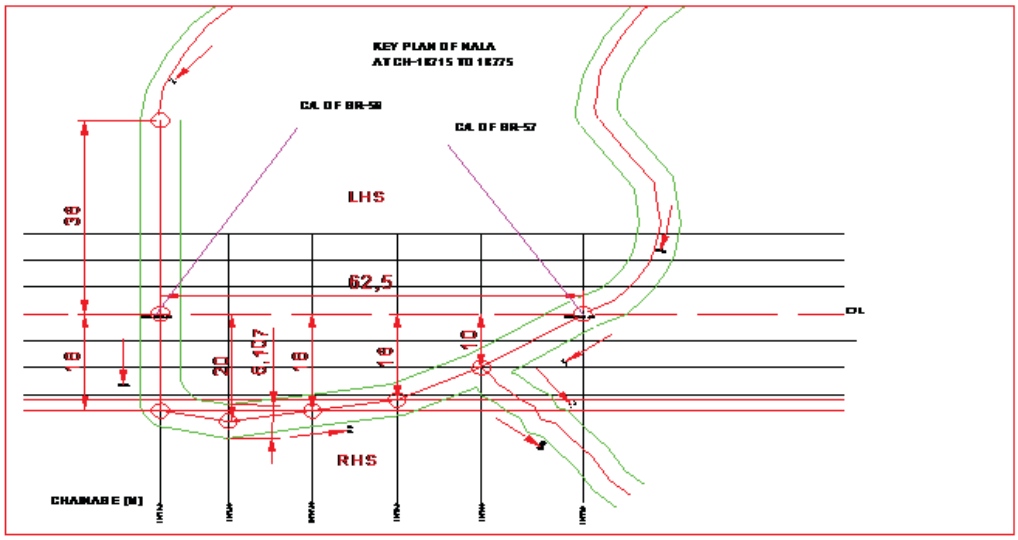
Case Studies

In the final location survey of Bairabi-Sairang new line, at number of locations of hilly streams, minor bridges with high embankment having filling of more than 15m was proposed. However, due to steep transverse slopes and narrow gorges, construction of minor bridge and very high embankment on either side involved very long barrel lengths. Further, slopes of these embankments, many a times obstruct the water channel itself requiring massive protection and retaining works. In such places major bridges have now been planned. It is seen that provision of viaduct in place of embankment is working out economical apart from improved safety against landslides. Two such cases are presented in following paras.

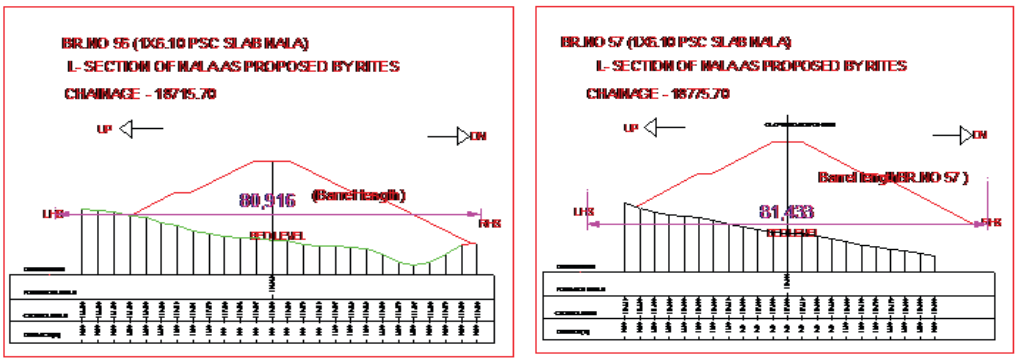
Case -I

Two minor bridges no. 56 and 57 were originally proposed at chainage 18.715 & 18.775. The embankment filling at this location

is 18m and the proposed barrel length to accommodate this height comes to 80m. There is steep slope on upstream side of both the bridges which runs very close to centre line of alignment. Both the bridges are located at a distance of 62.5m.



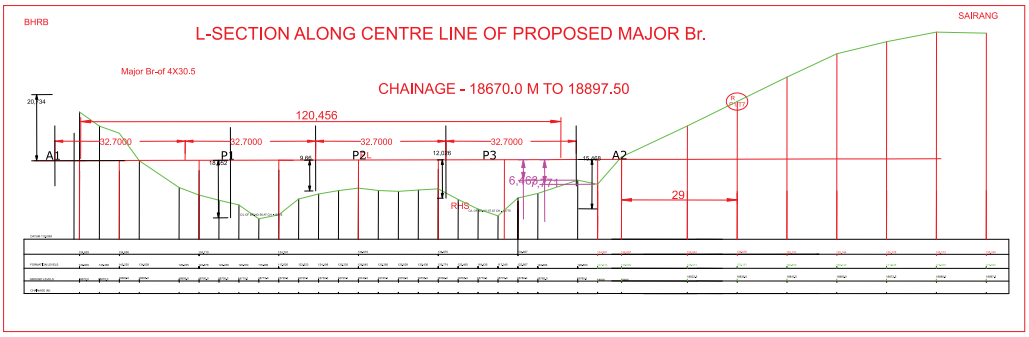
Plan showing proposed two Minor bridges in close proximity



Proposed Minor Bridge No. 56 and Bridge No. 57

In order to construct the minor bridge at this location, the hill slope was required to be cut on upstream side so as to accommodate full barrel length. Construction by cutting huge hill was difficult task apart from issues regarding stability of hill slope,

A detailed study of the topography was again carried out. It is now proposed to construct a viaduct with span of 4x30.5m and having composite girder. Schematic diagram showing the proposed major bridge in place of two minor bridges proposed earlier is shown in the figure below.



Proposed Major Bridge in place of two Minor Bridges

Cost Comparison

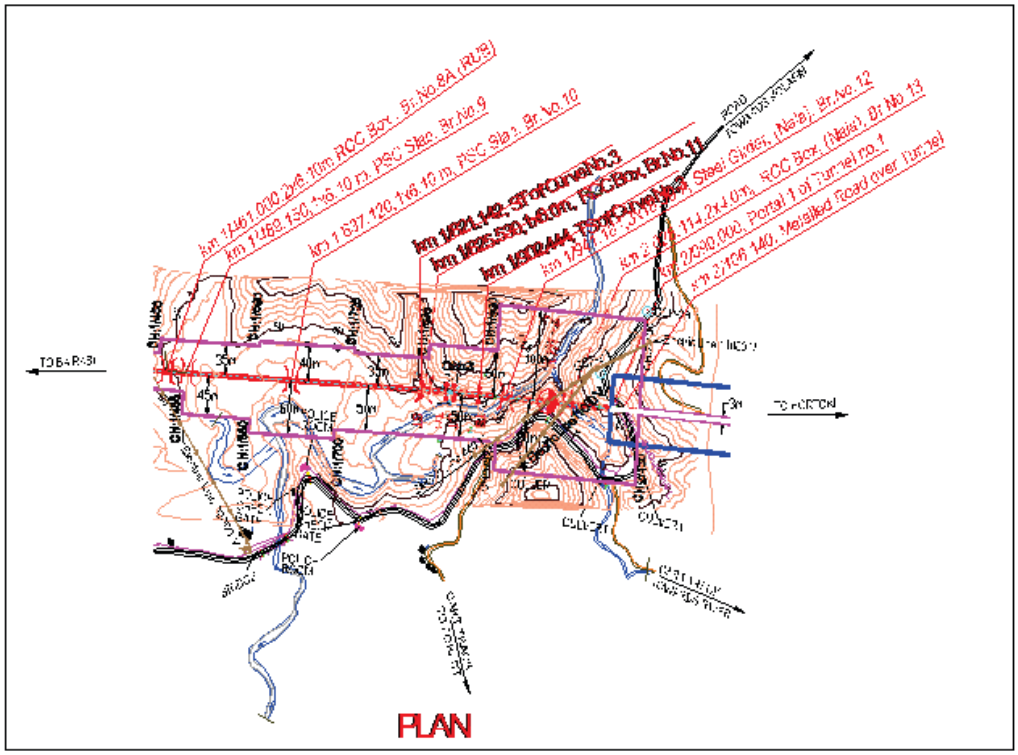
A cost comparison of both the proposals, based on prevalent rate in the project, is presented in following table.

Embankment with two minor bridge No. 56 & 57 of 1x6.1m	**Construction of viaduct 4x30.5 (composite girder)**
Cost of land Rs. 84,41,349.12 (120x120m^2)	Cost of land Rs. 38,36,976.87 (80x120m^2)
Cost of earthwork in cutting, excavation Rs. 1,98,56,500.00	Cost of earthwork in excavation Rs. 18,19,793.08
Cost of minor bridge Rs. 6,90,71,796.90	Cost of major bridge Rs. 13,31,63,712.00
Cost of earthwork in filling Rs. 2,79,57,586.80	Cost of major bridge superstructure Rs. 4,26,26000.00
Cost of ancillary work like R/Wall Rs. 7,50,00,000.00	Cost of Misc work Rs. 20,00,000.00
Total - Rs. 20,03,27,232.82	Total - Rs. 18,34,46,481.87

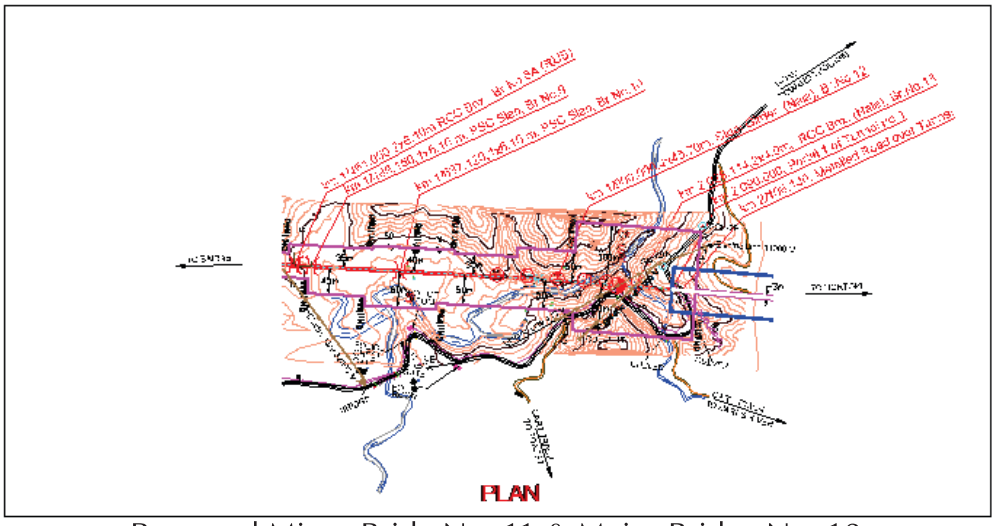
From the above, it can be seen that providing viaduct in place of minor bridge is financially economical. Moreover it is technically better suited to site conditions having minimum interference with natural hill slopes which have attained equilibrium over a very long period.

CASE-II:

At chainage 1.825 - 2.028, originally, it was proposed to construct a major bridge No.12 with one span of 45.7m and two Minor Bridges No. 11 & 13. These bridges are located within a distance of 200m. Height of filling at the location is 9.00.m. It is seen, from topography of the area, that the nallah in downstream of Br No. 12 takes turn and flows parallel to the embankment. Construction of minor bridges No. 11 & 13 required cutting of hill slopes on the upstream side so as to provide the required barrel length of 40 m and filling in approach of single span bridge required construction of retaining wall to protect toe of embankment and also diversion of nallah away from embankment toe.



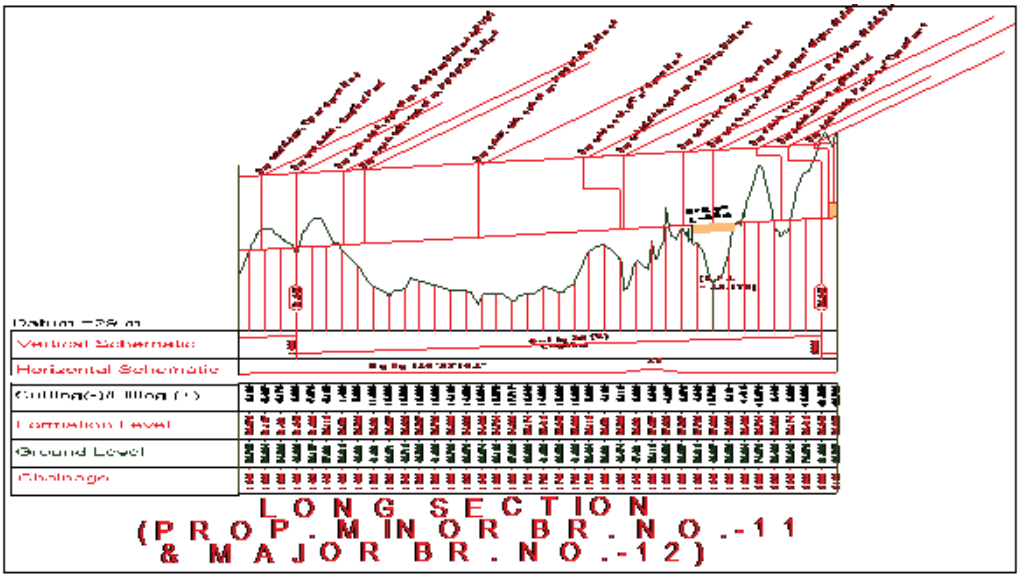
Location Plan

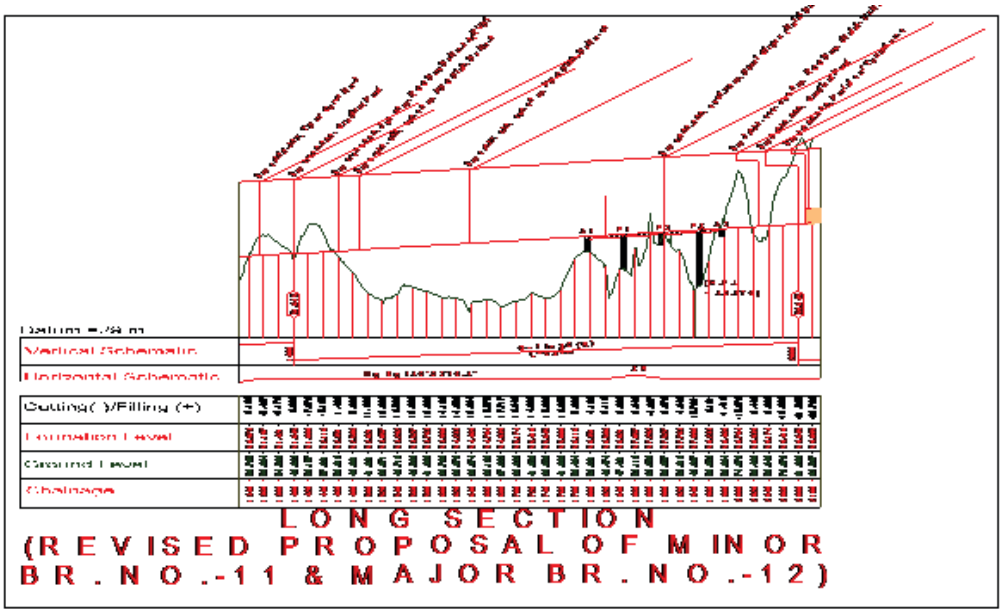


Proposed Minor Bride No. 11 & Major Bridge No. 12

The proposal to make minor bridges, retaining wall at this location was technically difficult to execute and lead to unnecessary interference with already stabilized hill slope.

After detailed site study, it was decided to provide a viaduct at this location having span of 4x45.7m steel girders in place of Br No. 12 (1x45.7m) & minor bridge No. 11 & 13 and construction of R/Wall to protect the embankment





Cost Comparison

A cost comparison of both the proposals, based on prevalent rate in the project, is presented in following table.

Cost of minor bridge No. 11 & 13 + R/Wall and construction of major bridge No. 12 (1x45.7)	**Construction of viaduct 4x45.7m**
Cost of land Rs. 1,40,68,915.20 (200X120m^2)	Cost of land Rs. 58,62,048.00 (50x200m^2)
Cost of earthwork in cutting, excavation Rs. 3,75,00,000.00	Cost of earthwork in excavation Rs. 12,35,310.00
Cost of minor bridge Rs. 10,99,82,769.10	Cost of major bridge substructure Rs. 17,00,55,313.00
Cost of major bridge substructure Rs. 4,25,13,828.25	Cost of major bridge superstructure Rs. 7,91,99,185.60
Cost of major bridge superstructure Rs. 2,07,31,273.10	Cost of approach filling Rs. 1,00,00,000.00
Cost of R/Wall Rs. 7,50,00,000.00	
Cost of R/Wall in filling Rs. 15,00,000.00	
Total – Rs.30,12,96,785.65	Total - Rs.25,63,51,856.60

Conclusion

High embankments, particularly at locations of hilly streams, with minor bridges pose risk of land slide and slope failures. In order to ensure safety of track, some minor bridges have been converted into major bridges to avoid high embankments. Though the decision was directed purely by technical requirements, it has been found that total cost of construction of the major bridges is somewhat lower than the cost of minor bridges with very long barrel lengths and high embankments along with cost of land, as proposed originally. It also helps in maintaining natural hill slope and minimum interference to the drainage pattern developed over a very long period.