POINTS TO BE NOTED WHILE DOING DPR FOR HILLY TERRAIN ROAD PROJECT - CASE STUDY

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ABSTRACT

The preparation of DPR is totally different for hilly terrain project than the plain terrain project. Plain terrain project needs land for the road features like carriage way, junctions, service road, toll plaza, rest area, bus stops, drains etc. Whereas in hilly terrain project needs extra land in addition to the above for slope protection works & approach roads and in view of safety the acquisition of abutting properties like houses besides RoW etc. Further, the engineering needs are also different from plain terrain projects.

Keywords: DPR, Hilly Terrain, Road Project

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1. INTRODUCTION

The author is going to discuss the points to be considered during the preparation of DPR (Detailed Project Report) for a road project going through hilly terrain. As a case study the project named “Four Laning of Addahole (Near Gundya) (Existing Chainage Km 263+000, Design Chainage Km. 255+703) To Bantwal Cross (Exiting km 328+000, Design Chainage Km 318+755) section of NH-75 (old NH-48) under NHDP Phase-IV on EPC mode in the state of Karnataka” is being taken. This project was foreclosed by the NHA1 due to the problems crippled, which were supposed to be addressed during the DPR stage. The author is discussing the problems in general and solutions for the same in road projects running through the hilly terrain.

2. SOME OF THE PROBLEMS WHICH WERE ENCOUNTERED IN THE SAID PROJECT

- Insufficient RoW (30m in forest/rural area and 45M in urban area).
- Additional land has not been proposed to acquire for the steep gradient approach roads.

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- The habitations in high altitude abutting ROW have not been proposed to acquire in safety point of view.
- The requirement of land for slope protection and cost for the same had not been considered in project.
- The wildlife mitigation measures were not envisaged before.
- The major 4 junctions have not been provided with grade separated structures
- In the existing zig-zag alignment, the proposal of rigid pavement is not practical.
- The merger point at one end of the project with another project road is not professionally designed.
- The cross-drainage works were not properly studied for their discharge, type of structure, entry & exit points, orientation, design etc.
- Planning of grade separated structures below ground level with Retaining Wall is not correct.

3. TOPOGRAPHY OF THE PROJECT

- This project is in western Ghats near Mangalore on NH 75 and average annual rainfall of this area is 6500mm and it is going to rain for 5 months from middle of May to middle of October.
- The project alignment contains approximately 30000 trees in both private & forest land.
- The Zig-Zag existing alignment is of flexible pavement running through hilly terrain with sharp and steep curves having 7.0 m width of carriage way with 1.5 m paved shoulder and soft shoulder of 1 m on either side.
- The project is contained with 82 realignments, 2 major bridges, 15 minor bridges, 251 (102 Box Culvert & and 149 Pipe Culvert) Culverts, VUPs, Flyover, EUPs etc.
- The ROW acquired for 4 lane carriage way is 30m and 45m width in forest/rural and urban area, respectively
- The project has got an Average Daily Traffic of 13521 PCUs as per the year 2015 study.
- The project alignment goes through forest land for 20.165Km and private land for 42.887 Km.
- It is proposed for 4 lanes with rigid pavement and with 82 realignments to make the alignment straight.
- The quantity of retaining wall and storm water drains provided in agreement are very less when compared to the site requirement.

4. HISTORY OF THE PROJECT FROM APPOINTED (START) DATE

- After appointed date on 28/03/2017, for 6 to 8 months the trees have been cut by getting the clearance from forest and MESCOM with shut down of electric power for 4 to 6 hours on daily basis.
- The forest has obligated for wildlife mitigation measures to divert the forest land to NHAI.

- The cost of WLM crossed the threshold limit of COS of the project and cannot be administered under this agreement. Therefore, NHAI has descope the forest stretch from this project.
- Meanwhile, the contractor has started cutting the hillocks to the required FRL as per the design. During the rainy season it was found that slopes were not stable and hence contractor has requested for additional land where high cut sections are there.
- The contract is only provided with the given ROW as explained above and hence no additional land is available. But, in view of safety of road users, NHAI has agreed to give additional land wherever slopes are unstable.
- Because the land acquisition (LA) takes reasonable time and hence NHAI has agreed to foreclose the project.

5. PROBLEMS AND SOLUTIONS

5.1. RoW

As per clause 2.3 of IRC SP 84 2019, the minimum RoW for 4 lane road is 60m. But the acquired ROW of 30m in forest land for this project is not at all sufficient even in plain terrain particularly at structure locations. For example, the bare minimum width required for 4 lane carriageways is 24m as per TCS provided in agreement (shown in fig 1) and hence only 3m width of vacant land is available on either side of road. This width of land is not at all sufficient for other works like embankment slope, floor protection works, quadrants, toe drains, storm water drain, rigid & flexible apron after the structure, avenue plantation etc. So, it is much more difficult to accommodate the above features in hilly terrain, where the alignment goes either in cutting or filling. Both the cases, protection works rigid & flexible aprons are very much needed to protect the structure from erosion. For this purpose, at least 6m extra width is needed after the structure. Hence at least acquisition of another 2.5m ROW on either side of the road is a must to overcome the above problem.

Further, (Acquired ROW is 45m in private land) where the service/slip roads to reach ramps/ approaches of grade separated structures are planned, the 45m RoW is not sufficient, whereas the minimum required width for plain terrain is 46.5m with utility corridor of 2m on either side (TCS shown in fig 2). If this alignment is passing in hilly terrain, the acquired 45 m is not at all sufficient.

Based on the above discussion it is to be noted that 35m RoW is a must for road projects, where there are no service / slip roads and 50m RoW is a must for the cross sections with service roads/ slip roads. In addition to the above, if the project is running through hilly terrain, then special care should be taken to acquire additional land at locations to make the slopes stable and safe.

Figure 3 (a & b) Showing the cut approach roads at higher altitude lost their connectivity with the NH.

5.3. The Habitations Abutting to the ROW, which are in Higher Altitude

Due to cutting of hillocks for formation of new road, the habitations located by the side of ROW at higher altitude (outside of RoW) are prone to fall. Such sample locations are shown in Fig 4.a & Fig 4.b. DPR consultant would have identified such locations and would have acquired the same in view of safety. So, it is a mandatory requirement for hilly terrain project to acquire habitations at higher altitude abutting the ROW.

Figure 4 (a & b) Abutting properties after cutting of the road just at RoW

5.4. Land for Slope Protection Including Cost

This project alignment is going through the cutting/filling for about a minimum depth of 4m in general. Therefore, toe wall, breast walls, retaining walls are proposed in the agreement, yet they are suitable up to the height of 4m only. The DPR consultant of this project would have proposed some design for stability of slopes as per the clause 4.4.4.ii.b. of IRC SP 84 2019 (hillocks standing vertically for 4m to 18m after cutting). It is a well-known fact that no soil can stand vertically on its own except moderately hard strata. Therefore, to stabilize these cut slopes additional land requirement is a must to make the slope stable with a required inclination and with some engineering means as shown in Fig 5.a & Fig 5.b. The DPR consultant would

have acquired additional land to protect the slopes with the following formula. At every 100m, edge of the present ROW on both sides of CW, reduced level (RL) of natural ground (NGL) must be taken. Then the land width to be acquired after ROW is $2 * [FRL - NGL] /$. He must propose the slope protection model drawings for different height of slopes in schedule B. Some of the model drawings are attached for ready reference Fig 5.a & Fig 5.b. Further, the cost of slope protection works would have been included in the contract.

1. For depths of cut exceeding 12 mts for PROW widths of 45 mts

2. For depths of cut exceeding 6 mts for PROW widths of 30 mts

Figure 5 (a & b) Typical slope protection works in cutting

5.5. The Wildlife Mitigation Measures (WLM)

Wildlife mitigation measures imposed by forest to divert the forest land to NHAI would have been envisaged by the DPR consultant and hence they could have been included in the project cost. Once the construction contractor came to work, the forest had given the stage I approval along with demand of WLM. The value of COS towards WLM has crossed the threshold limit of CoS of the contract and hence authority could not be able to administer the COS under this contract. Therefore, the authority has descope the WLM stretch from this project, where the wildlife mitigation work had to take place.

5.6. The 30M RoW is not Sufficient in 30M Deep Cutting Area

About 1.2 km length of realignment was planned by the DPR consultant over a hilly terrain to make the new alignment straight. But this new alignment was passing over a 40 m high hillock, which must be cut for a depth of 30m (average) in 30 m RoW. The DPR consultant would have planned for alternative alignment to avoid the cutting of hard rock for 30m deep. Anyway, after the EPC contractor's appointed date, it was planned for realignment along the existing road with speed restriction.

So, upcoming DPR consultant for any hilly terrain project must verify the practicality of activity to be taken up at respective locations.

5.7. The Major 4 Junction have not been Provided with Grade Separated Structures

As per the clause 2.13.2 of IRC SP 84 2019, all the state and important junctions shall be provided with grade separators. But 4 VUPs at important junctions were not proposed in the project. There is a demand from VVIPs and public for these 4 VUPs. All the 4 junctions are leading to important towns and some of them are state highways too. It was good if, these 4 VUPs would have added to the project scope by the DPR consultant.

5.8. The Proposal of Rigid Pavement is Impractical in Zig-Zag Existing Alignment

The existing road alignment is very much zig – zag due to hilly terrain. Sample figure Fig 6.a & Fig 6.b is attached. Hence, the DPR consultant has proposed the new alignment as a straight line as far as possible. But, to make the alignment straight, 82 realignments are proposed in 63 km project. Because of these realignments the new road has crossed the existing road in 164 locations. Because of this crossing with existing road, construction of road in rigid pavement with PQC in rectangular panels is quite impossible with running traffic on existing road. Hence, it would have been better if the road is proposed with flexible pavement in the initial stage and propose for white topping concrete road after 5 years.

Figure 6 (a & b) Proposed alignment along with existing zig-zag alignment.

5.9. The Merger of End Point with another Road would have been Designed Properly

There is a VUP proposed at end point of the project at Ch. 318+745 and was not carefully planned to connect with ROB at just after 70m from VUP, which is a part of another project. The horizontal alignment is not matching with ROB, if the VUP is constructed in the land acquired for the VUP of this project. The service/slip roads' vertical gradient is also a problem to connect with the adjoining service roads' of the adjoining project. Actually, at this location an interchange is very much advisable; since it is a 4 road junction having 3 roads are very much busy leading to Bangalore, Mangalore and Bantwal.

5.10. Design and Orientation of Cross Drainage Structures

The orientation of cross drainage structures may not follow the same orientation of the existing structure when it is widened in hilly terrain as shown in Fig 7a & Fig 7b. Hence, most of the areas the cross-drainage works could not be widened in the same orientation of the existing culvert. Therefore, every cross-drainage work must be finalised during the DPR stage itself for entry & exit points, upstream & downstream, length of each culvert along with total numbers, coordinates of entry & exit points, cross section of the culvert etc. For hilly terrain projects, if these details are not given by the DPR consultant, it is very problematic to make the contractor to work, since every contractor quote in number assuming some standard length based on the ROW.

Figure 7 (a & b) No widening can be possible for the existing culverts in hilly terrain like in plain terrain

5.11. Placement of Grade Separated Structures

This project location is in Western Ghats near to Kerala receives average annual rain fall of 6500mm in a period of 5 months in a year. Two VOPs are planned in this project by putting the NH traffic below ground level through cutting by allowing the crossroad traffic on ground level. This system is not at all advisable in this rain prone area. Therefore, all the grade separators must be planned above ground level in filling (in between RE walls) by putting NH traffic above ground level to avoid inundation by any means. The same system shall be followed for any rain prone areas.

6. CONCLUSION

- Reconstruction of the approach (existing) road connecting the existing properties/ habitation on hill/ valley side should be planned by the DPR Consultant and cost involved for construction including drawings and items for such connection should be included in DPR.
- Likely damage to the adjoining each existing property abutting the planned road, during cutting/ filling of slopes for construction of roads, along with structurally sound restoration measures shall be assessed by the DPR consultant and shall be included in the DPR.
- No portion of the hill road involving cutting and filling shall be left unprotected. Slope stability measures shall be designed for each location involving cutting and filling in hill roads. Wherever cutting and filling is planned, the slope stability measures should be designed for each individual location/ section by the DPR Consultant, and the cost involved including drawings for such slope stability measures and items should be included in the DPR.
- Geo-technical investigation, hydro-logical data & Structural drawing for each drainage structures i.e Culvert as well as bridge and the cost of construction of such drainage structures should be part of the DPR to be prepared by the Consultant.
- To avoid erosion of slopes, spill free arrangement for channelizing of water on slopes discharged from series of culverts in roads constructed one above the other on same face of a hill should be planned by the DPR Consultant and the drawings & cost for each such structures should be included in the DPR.

- In unavoidable circumstances, the RoW to be acquired is minimum of 35m where there are no service / slip roads and 50m for the cross sections with service roads/ slip roads even though the IRC SP 84 is specifying minimum of 60m. In addition to the above, if the project is running through hilly terrain, then special care must be taken to acquire additional land at locations to make the slopes stable and safe.
- The value of wildlife mitigation works and must be added to the project cost along with features of wildlife mitigation works, wherever diversion of forest land is there. Further, the authority also must include the stage I approval of the forest in the scope of DPR contract.
- For any hilly terrain project, the DPR consultant must verify for the practicality and safety while making a proposal in excavation to make the vertical alignment of the road at crucial points in respective locations.
- The rigid pavement option shall be discouraged for projects, where the existing alignment is zig –zag.
- Every cross-drainage work must be finalised during the DPR stage itself for entry & exit points, upstream & downstream, length of each culvert including total number, coordinates of entry & exit points, cross section of the culvert etc for hilly terrain projects due to the difficulties explained above.
- In rain prone areas all the grade separators must be planned above ground level in filling (in between RE walls) than in cutting by putting NH traffic above ground level to avoid inundation. Based on the discussion in points 5A, 5B, 5C & 5D above, any DPR consultant should plan for land acquisition not only for general road construction including project facilities but also should plan for land to protect the slopes, land for approach roads, land of habitations on hillocks prone to fall for projects going through hilly terrain. Further, the cost of slope protection works like toe walls, retaining walls, Breast walls, soil nailing, short creating, pitching etc must be added to the project cost.

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