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Pre-Project Resource Planning for a Highway Construction Project – A Case Study

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Abstract: ***Highway construction requires lot of raw material which costs 65% of the total project cost. Location of project site layout should be such that it helps reduce overall project cost by optimizing resource transportation. This can be achieved through mapping resource available locally and pre-bid agreement with vendors. This work has been undertaken to map resources required for the upcoming highway project "Guhagar-Chiplun-Karad-Tasgaon-Jath-Bijapur Highway and Manmad-Ahmednagar-Daund-Baramati-Phaltan-Dhaiwadi-Vita-Tasgaon-Miraj-Belagavi Highway" in order to help construction firms to mobilize fast and acquire resources optimally.***

Keywords: Material mapping, Resource Optimization

1. Introduction

The raw materials are the backbone of any construction project. Of the total construction cost that occurs on any project about 65% cost is of raw materials and its allied activities. Thus any further increase in the material cost would directly result in an increase in the project cost.[6]

By optimizing the use of these raw materials available in the vicinity the costs associated with the raw materials can be reduced without affecting the quality of the materials. Time plays an important role in any construction project. The lesser the time required for the completion of the project, lesser will be the increment in the overall cost of the project.

The major problem faced by the road construction industry today is associated with not using the materials available in the vicinity. The raw materials are needed to be excavated from the ground. Thus by improper utilization of raw materials from the vicinity, it results in a need to bring in raw materials from a larger distance. This results in an increase in the transportation cost and transportation time. [1] Project cost can be optimized through proper utilization of favorable resources in the nearby vicinity. Thus pre-project resource mapping will help to optimize the project cost.

2. Resource Mapping

Resource Mapping is the technique of visualizing the level of resource, varieties of resource, and spatial extents of resources in geographical domain in the form of graphical representation of data i.e. maps. Resource mapping helps resource manager to develop and implement a better plan for better management and to do modeling for the future resource availability and management action. The main objective of resource mapping is to locate zones of available resources and find areas of resource land cover.

3. Case Study

As a part of case study the two proposed National Highways passing through Sangli District are considered.

1) The Guhagar-Chiplun-Karad-Tasgaon-Jath-Bijapur highway travels for a total distance of 295km in Maharashtra out of which 153 km is in the Sangli district. It travels in the West to East direction and then enters the state of Karnataka.

2) The Manmad-Ahmednagar-Daund-Baramati-Phaltan-Dhaiwadi-Vita-Tasgaon-Miraj-Belagavi highway travels a total distance of 453km in Maharashtra out of which 98 km is covered in Sangli District. This road travels from the North to South and then enters the state of Karnataka.

4. Methodology

The work is undertaken to provide guidelines for the contractors to obtain resources from the nearby vicinity even before the actual commence of the work on the construction site. This will help to reduce the overall cost of the road construction project. For the convenience purpose the proposed National Highways are divided into patches of 50 Kilometers. These highways are mapped using GPS and GIS. There are total 56 highway structures on the two proposed highways combined. For these highway structures, concrete is required, and that the proposed highways are considered to be built in flexible pavement. The total quantity of materials required has been calculated which came out to be as: Concrete =28,182 cum, Bitumen = 30,453 cum. The location of RMC plants and Hot Mix plants is obtained by calculating the distances between the plants and the work place.

A. Quantity of Concrete for Highway Structures

From the divided patches the material quantity of concrete required in cubic meter is calculated for each section of highway. The concrete is required for the highway structures which are present on the highway sections. The values for design of the highway structures were assumed.

Table 1: Quantity of Concrete for road patches for the highway structures

Road Patch	Quantity of Concrete in cum	Cement in kg	Sand in Kg	Aggregate in Kg
GV_04	5840.71	1839824	3379260	6508245
GV_05	3378.3	1064165	1954583	3764406
GV_06	2848.91	897406.7	1648294	3174512
MB_08	7587.16	2389955	4389703	8454297
MB_09_1	2552.52	804043.8	1476811	2844248
MB_09_2	5974.2	1881873	3456493	6656991

From the calculated concrete quantities, the dry volume is calculated. For the calculations it is assumed that the proportion of 1 cum concrete is 1:2:4. And 50% increment is considered as for wastage during transportation and storage.

Table 2: Quantity of Aggregates & Bitumen required for road

Structure of the Road	Materials	Aggregates in cum	Bitumen in cum
Seal Coat	Bitumen	Nil	6549
Surface Course	Bitumen, Aggregates	15946.5	4257
Binder Course	Bitumen, Aggregates	320901	6549
Base Course	Bitumen, Aggregates	962703	13098
Sub base Course	Murum (Aggregate)	982350	Nil
Compacted Sub base	Soil/Murum	982350	Nil
	Total	**3264250.5**	**30453**

B. Quantity of Material for Highway Pavement

Both the National Highways which are considered for the case study are considered to have flexible pavement on all lanes. An increment of 50% is considered as for wastage during transportation, storage and for maintenance works. Thus the total quantity estimate of aggregate and bitumen is as in the table.

Thus a total of 3277299 cum of aggregate are required for the road project passing through Sangli District. Now if this aggregate is to be obtained from existing quarries, then the transportation cost will be very high.

C. Location of Plants

The location of the RMC and the Hot Mix plants is obtained for each section of the road patches. The location is based on the distance between the place of work and the RMC plant. More the quantity of material required, lesser should be the transportation distance. While as the bituminous mix is evenly required on the road it should be situated at the central distance of the road patch and near to the area of availability of the raw materials.

Table 3: Location of RMC Plant

Sr. No.	Road Patch	Location of RMC from road start in km
01	GV_04	22.3
02	GV_05	26.1
03	GV_06	12.07
04	MB_08	7.17
05	MB_09_1	1.62
06	MB_09_2	2.83

D. Make or Buy Decision

There are total 51 quarries that have an excavation capacity of 30 brass/day. So the total excavation capacity of all the 51 quarries combined becomes 1530 brass/day. Therefore the time required to excavate the total 3277299 cum of aggregate in the available quarries is about 765 days. Therefore more quarries are needed to be setup the road contractor as the present quarries will not be able to provide such huge quantity of aggregates in the specific project time period. If the contractor will setup quarries in such a way that the cost incorporated in the transportation of raw materials from the quarries to the RMC & Hot Mix plants can be reduced, then it can positively reduce the total project costs. Most parts of Maharashtra are occupied by the Deccan trap, and the Deccan trap consists of igneous Basalt rock which is suitable for construction activities. So this stratum is suitable for setting up stone quarries.

E. Transportation Cost

As the quarries are now located at different locations in the district, it is required to transport the aggregates to the RMC and Hot Mix Plants. This results in increase in transportation cost, as the quarries are remotely located. These distances between the quarries and RMC plant are found out, which will be used to determine the cost of transportation.

Table 4: Transportation cost for GV_04 road section

Sr. No.	Quarry Number	Distance in km	Cost in ₹
1	2	13.5951	576.52
2	1	10.3789	440.13
3	8	5.5937	237.21
4	4	4.534	192.27
5	3	4.524	191.85
6	20	4.634	196.51
7	5	4.734	200.75
8	6	4.734	200.75
9	7	5.314	225.35

For the above calculations the average of the hauler is assumed to be 3 km/Ltr. And the present cost of diesel i.e. 63.61 ₹/Ltr. is considered. Thus the cost calculation for one road section is as above.

The Deccan trap is the largest igneous rock region in India stretching to about 5, 00,000 sq. km. It contains most of the parts of Maharashtra Madhya Pradesh, Karnataka, Gujarat, and Andhra Pradesh and also has its presence in southern parts of Uttar Pradesh. This rock is Basalt, and it is good for construction allied activities.

As the raw material is abundantly available in Maharashtra, quarries can be easily setup in the vicinity of the highway construction project. Setting up of new quarries will help in increase in the production levels of the raw materials. The time required will also be reduced and it will help to reduce the total project cost.

If the quarries are setup at places where the RMC Plant and the Hot Mix Plants are setup, then the transportation cost can be reduced.

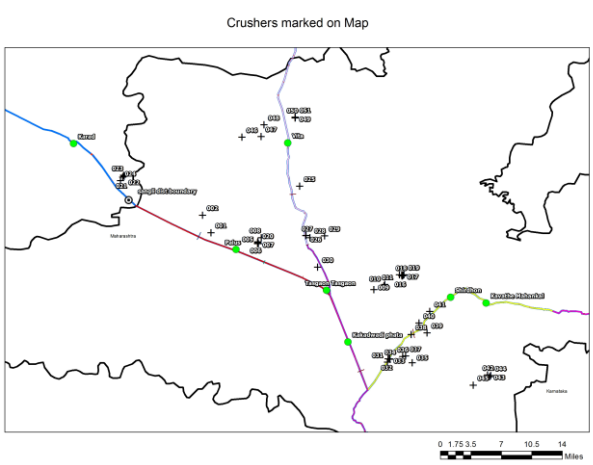

Figure 1: Location of Quarries in Sangli District

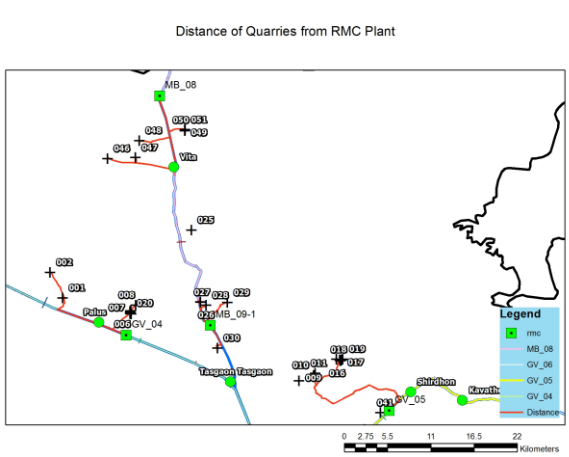

Figure 2: Distance of Quarries from the proposed RMC Plants

5. Conclusion

In general it is concluded that by using the raw materials which are available in the vicinity the cost associated with the transportation of materials, storing and re-handling can be reduced.

As the quantity of raw material in the form of aggregates is not available in the existing set-up new set-up of quarries is required.

As Maharashtra has large amount of Deccan trap, i.e. Basalt rock, quarries can be set-up in the area optimized the cost calculations.

It will also help to reduce the time required for the construction activities. This will result in reduction in the overall cost of the project and also reduce the time required.

As per the permissions granted by the Collector in Maharashtra, it is permissible to excavate up to 25000 brass in one permit. But the required material quantity is 1158060 Brass.

Thus from the total limit of excavation set at 25000 brass per quarry it is required to setup 47 quarries to excavate required quantity of raw materials.

For convenience it is required to setup the HMA near to the quarries, while the RMC plant can be setup at the distances where the concrete is required.

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