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A Study of Construction and Material management during Construction of Integrated Structure at Chandani Chowk Junction on NH-4, Pune

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Abstract—*Chandani Chowk is one of the busiest and most important road junctions in Pune city. Despite several attempts by the civic and police authorities to resolve the traffic issues, the spot is constantly beset by traffic snarls and accidents, owing to the lack of planning and management. This constant flow of traffic at the Chowk is because it is the intersection where many important roads meet, including the heavy and high-speed traffic of the Pune-Bengaluru Bypass. Also, at the location NDA Road, Bavdhan, Paud/ Mulashi, Kothrud, VedBhavan service road and the bypass from Mumbai and Katraj intersects. The Detailed Project Report (DPR) for construction of integrated structure is prepared by NHAI recently to resolve the traffic issue at the location. The improvement proposal includes construction of road networks and flyovers/underpasses etc. The present study includes the construction planning and management for completing the work within estimated budget and Specified time and Material management to improve the productivity and cost efficiency of a project and help to ensure its timely completion.*

Key words—Contruction Management, Material Management, and Construction Methodology.

1 INTRODUCTION

Chandani Chowk is one of the busiest and most important road junctions in Pune city. There is constant flow of traffic at the junction It is the western entry gate of Pune city. Chandani Chow junction interconnects four local roads with NH-4. Due to lack of planning and proper traffic management, the junction location is constantly beset by traffic snarls and accidents. At this junction, road coming from NDA side, Bavdhan side, Paud side, Kothrud side, VedBhavan service road and the bypass road (NH-4) from Mumbai -Katraj intersects.

On an average, about 1,50,000 vehicles, converge daily at the junction from six different directions. The traffic consists of two-wheelers, cars, buses and trucks. The stretch also comprises a narrow bridge, and a narrow service road (LHS). The never-ending traffic flow, the flagrant flouting of traffic rules and poor infrastructure are the prime reasons for the ensuing chaos at the spot.

Efficient planning and management of traffic are the burning needs to resolve the issues at Chandani Chowk. Adequate and capable policing is sorely needed, along with the curbing of lawlessness by road-users.

2 IMPROVEMENT PROPOSAL BY NHAI

2.1 Background

The main objective of the study by NHAI is to establish the technical, economical and financial viability of the project and prepare a report for "Road Improvement network of NH-4 at Chandani Chowk at Pune, Maharashtra with development of Service Roads, as per the best practices for Urban roads, meeting the City requirements for the roads.

2.2 ProposedStructures and Road works by NHAI Roads work

i. NH-4: Widening of Main Carriageway (3 Lanes each) and development of Service Roads on LHS and RHS as well as Outer Service roads on LHS and RHS within PMC D P land.

ii. NDA- Mulashi Road section of SH 60.

a)NDA Junction to Mulashi Toll Plaza Location

b)Mulashiroad old Toll Plaza to Mulashi Road

c)Ramp-1: Mulashi towards Satara.

d)Ramp-2: Mulashi towards Mumbai.

e)Ramp-3: Mulashi towards Pashan.

f)Ramp-4: From Outer Service road towardsMulashi.

g)Ramp-5: Pashan/NDA towards Mumbai.

h)Ramp-6: Pashan towards Satara.

i)Ramp-7: Satara/Kothrud towards Pashan.

j)Ramp-8: NH-4 Exit towards Outer Service roads.

iii. NDA to Pashan Road.

iv. Pashan Connector Road (24m DP road).

v. Ved-Vihar towards NDA Junction Road.

vi. Pashan towards PMC Water supply Road.

vii. Existing VUP towards Kothrud Road.

viii. VUP-1 towards Kothrud Road.

ix. Rotary at Pashan.

x. Rotary at NDA

List of Structures to be constructed across NH-4:

i. VUP-1: New Vehicular underpass.

ii.NDA-Pashan VOP: Replacement of Existing NDA-Pashan VOP.

iii. Ramp-1: Flyover from Mulashi towards Satara.

iv. Ramp-3 & Ramp-7: Vehicular Underpass on Mulashi to Pashan and Satara/Kothrud to Pashan road.

v. Ramp-5: Vehicular Underpass on Pashan towards Mumbairoad.

vi. Ramp-6: Flyover from Pashan towards Satara.

2.3 Objectives of the Study

The objectives of the study are as follows-

- Effective Construction Planning and Construction Management for completing the work within estimated budget and Specified time.

- Material management during construction to improve the productivity and cost efficiency of project and to help for ensuring its timely completion.

3 CONSTRUCTION MANAGEMENT

3.1 Construction Sequence of Project

The project location is within Municipal limits of PMC. There is rapid development taking place on both sides of the road. Due to site constraints at the project location and being located within municipal corporation area of Pune, it felt necessary to decide the project construction sequence. The main objective of preparing construction sequence is to observe minimum disturbance for the traffic movement on NH -4. To achieve this, project activities are divided into nine stages. Each stage is having four to five activities planned. Also, traffic movement is shown in black arrow during construction.The detailed description of these stages is as follows-

Stage- I: In this stage construction of road works proposed are as below. These road works are not affecting the main carriageway traffic of NH-4. In this stage following road works are proposed:

1) Construction of LHS and RHS Service roads from Km. 841.400 to Km. 842.160.

2) Construction of LHS and RHS outer service roads from Km. 841.400 to Km. 842.160.

3) Construction of LHS and RHS Service roads from Km. 842.640 to Km. 843.600.

4) Construction of LHS and RHS outer service roads from Km. 842.640 to Km. 843.600.

5) Construction of Pashan Connector DP Road &Pashan Rotary.

6) Construction of new NDA - Mulshi Road.

7) Construction of Kothrud to Vehicular Underpass (VUP-1) Road.

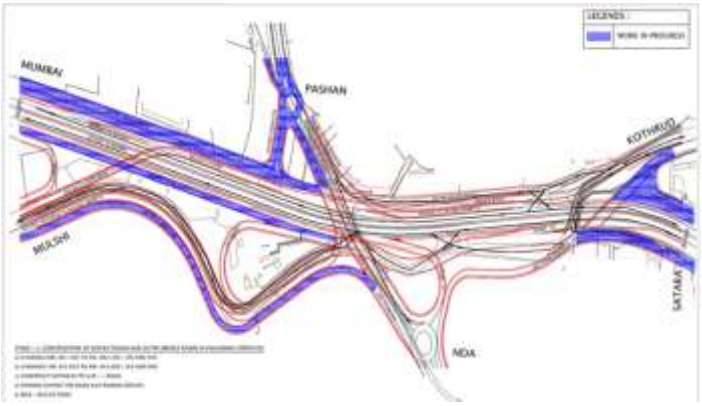


Fig. 1: Stage-I

Stage- II: After Completion of Stage – I, Construction of Stage – II can be started. Stage – II includes construction of following road works and Structures.

8) Construction of Ramp - 1: Mulshi to Satara road.

9) Construction of Mulshi Flyover.

10) Construction of Ramp - 2: Mulshi to Mumbai Road.

11) Construction of Ramp - 3: Mulshi to Pashan Road.

12) Construction of Ramp - 4: Satara/Kothrud to Mulshi Road.

13) Construction of VUP on Ramp – 3 and Ramp – 7.

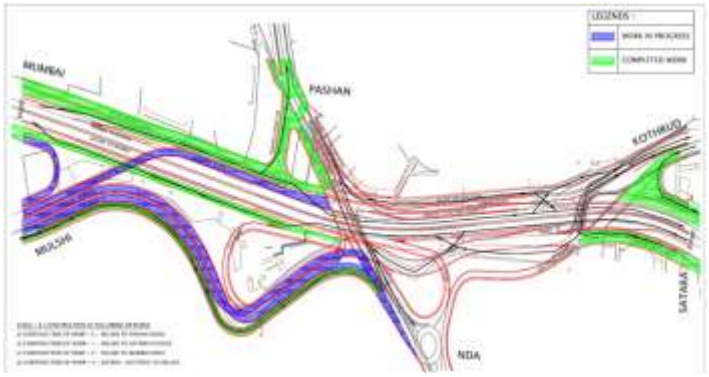


Fig. 2: Stage-II

Stage-III: After completion of Stage – II, Construction of Stage – III can be started. For construction of Stage – III, it is necessary to reduce the traffic volume at Pashan VOP. In stage - I and stage – II, traffic volumes have been reduced. Stage – III includes construction of following structure-

14) Construction of NDA - Pashan Vehicular overpass VOP (Part -1).

Fig. 3: Stage-III

Stage-IV: After Completion of Stage – III, Construction of Stage – IV can be started. Stage – IV includes construction of following road works and Structures-

15) Construction of RHS Service roads from Km. 842.250 to Km. 842.640.

16) Construction of RHS outer service roads from Km. 842.250 to Km. 842.640.

17) Construction of Ved-Vihar to NDA Road.

18) Construction of NDA Rotary.

19) PashanSatara VOP – Foundation work.

Fig. 4: Stage-IV

Stage-V: After Completion of Stage – IV, Construction of Stage – V can be started. Stage – V includes construction of following road works and Structures-

20) Construction of LHS Service roads from Km. 842.160 to Km. 842.640

21) Construction of RHS outer service roads from Km. 842.160 to Km. 842.640

22) Construction of Kothrud/Satara to Pashan Road (Ramp – 7).

23) VUP on Ramp – 5 – Foundation and abutment work.

Fig. 5: Stage-V

Stage-VI: After Completion of Stage – V, Construction of Stage – VI can be started. Stage – VI includes construction of following road works and Structures.

24) Construction of VUP-1.

Fig. 6: Stage-VI

Stage-VII: After Completion of Stage – VI, Construction of Stage – VII can be started. Stage – VII includes construction of following road works and Structures.

25) Widening of Existing VUP.

26) Widening of NH-MCW from Km.841.400 to 842.160.

27) Construction of RHS Inner service road from Km. 842.250 to Km. 842.160.

28) Construction of Ramp – 8.

Fig. 7: Stage-VII

Stage-VIII: After Completion of Stage – VII, Construction of Stage – VIII can be started. Stage – VIII includes construction of following road works.

29) Construction of RHS - Outer service road from Km. 842.160 to Km. 842.640 up to final profile.

Fig. 8: Stage-VIII

Stage-IX: After Completion of Stage – VIII, Construction of Stage – IX can be started. Stage – IX includes construction of following road works.

30) Road NDA -Pashan VOP (Part - II).

31) Pashan - Mumbai Ramp (Ramp - 5) – Superstructure and approaches.

32) Pashan - Satara Ramp (Ramp - 6) – Substructure, Superstructure and approaches.

33) Pashan to Panipuravatha Road.

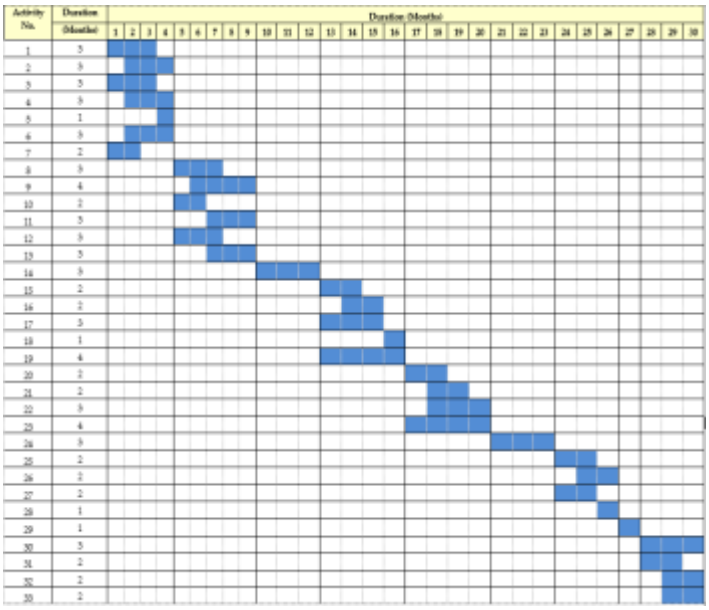
Fig. 9: Stage-IX

3.2 Project Completion Period

Stages	Activity No.	Duration (Months)
Stage - I	1	3
	2	3
	3	3
	4	3
	5	1

Stages	Activity No.	Duration (Months)
	6	3
	7	2
Stage - II	8	3
	9	4
	10	2
	11	3
	12	3
	13	3
Stage - III	14	3
Stage - IV	15	2
	16	2
	17	3
	18	1
	19	4
Stage - V	20	2
Stages	Activity No.	Duration (Months)
	19	4
Stage - V	20	2
	21	2
	22	3
	23	4
Stage -VI	24	3
Stage - VII	25	2
	26	2
	27	2
	28	1
Stage - VIII	29	1
Stage - IX	30	3
	31	2
	32	2
	33	2

3.3 Analysis by Critical Path Method



Grant Chart for Critical Path Method

It is seen that; the critical path of the project is activity **1-5-10-11-14-19-23-24-25-28-29-30**. Therefore, duration for critical path is 3+1+2+3+3+4+4+3+2+1+1+3 = 30 Months. The project duration of 30 months is sufficient for the construction of the project.

3.4 Analysis by PERT Method

So far, we have talked about projects, where there is high certainty about the outcomes of activities. In other words, the cause-effect logic is well known. This is particularly the case in engineering projects. However, in Research & Development projects, or in Social Projects which are defined as "Process Projects", where learning is an important outcome, the cause-effect relationship is not so well established.

In such situations, the PERT approach is useful, because it can accommodate the variation in event completion times, based on an expert's or an expert committee's estimates.

For each activity, three-time estimates are considered.

Activity No.	Optimistic time	Most Probable time	Pessimistic time	Mean μ_p	Variance σ_p^2	Critical Path
1	1	3	5	3	0.44	Yes
2	1	3	5	3	0.44	
3	1	3	5	3	0.44	
4	1	3	5	3	0.44	
5	0.5	1	1.5	1	0.03	Yes

Activity No.	Optimistic time	Most Probable time	Pessimistic time	Mean μ_p	Variance σ_p^2	Critical Path
6	1	3	5	3	0.44	
7	1	2	3	2	0.11	
8	1	3	5	3	0.44	
9	2	4	6	4	0.44	
10	1	2	3	2	0.11	Yes
11	1	3	5	3	0.44	Yes
12	1	3	5	3	0.44	
13	1	3	5	3	0.44	
14	1	3	5	3	0.44	Yes
15	1	2	3	2	0.11	
16	1	2	3	2	0.11	
17	1	3	5	3	0.44	
18	0.5	1	1.5	1	0.03	
19	2	4	6	4	0.44	Yes
20	1	2	3	2	0.11	
21	1	2	3	2	0.11	
22	2	3	4	3	0.11	
23	1	4	7	4	1	Yes
24	1	3	5	3	0.44	Yes
25	1	2	3	2	0.11	Yes
26	1	2	3	2	0.11	
27	1	2	3	2	0.11	
28	0.5	1	1.5	1	0.03	Yes
29	0.5	1	1.5	1	0.03	Yes
30	1	3	5	3	0.44	Yes

Activity No.	Optimistic time	Most Probable time	Pessimistic time	Mean μ_p	Variance σ_p^2	Critical Path
31	1	2	3	2	0.11	
32	1	2	3	2	0.11	
33	1	2	3	2	0.11	

The mean critical path is 1-5-10-11-14-19-23-24-25-28-29-30.

Calculation of μp and σp2

Mean Activities on critical Path	Mean μ_p	Variance σ_p^2
1	3	0.44
5	1	0.03
10	2	0.11
11	3	0.44
14	3	0.44
19	4	0.44
23	4	1
25	2	0.11
28	1	0.03
29	1	0.03
30	3	0.44
Project Duration =	**30**	**3.95**

Now we are ready to determine (approximately) the probability of completing project within 30 months.

Approximating the Probability of Meeting the Deadline

Let,

T = Kα = project duration (in weeks), which has (approximately) a normal distribution with mean μp =30 and variance σp2 = 3.95,

d = deadline for the project = 30 Months.

$$K_\alpha = \frac{d - \mu_p}{\sigma_p}$$

= (30-30)/1.99 = 0

Therefore, Probability of completion of project in 30 months is 100%.

4 MATERIAL MANAGEMENT

Materials management is a process for planning, executing and controlling field and office activities in construction. The goal of materials management is to ensure that, construction materials are available at their point of use when needed. The materials management system attempts to ensure that, the right quality and quantity of materials are appropriately selected, purchased, delivered and handled onsite in a timely manner and at a reasonable cost. Materials management is the system for planning and controlling all of the efforts necessary to ensure that, the correct quality and quantity of materials are properly specified in a timely manner are obtained at a reasonable cost and most importantly are available at the point of use when required. Thus, Materials management is an important element in project management.

4.1 Excavation Quantity

In Chandani Chowk project, the proposed excavation quantity is about 2.96 lakhs Cubic metres. This excavated quantity can be reutilized for the construction of roads and structures work.

4.2 Utilization of Excavated Material

Instead of dumping the excavated quantity, it can be utilized in construction of road work such as filling/embankment, use in subgrade and GSB. It is also used as crushed aggregate in construction of structures. It is required to transport excavated hard rock to the quarry for crushing to form aggregate and transport back to the site.

4.3 Comparison between rates taken and reduced rates due to use of excavated material

The following table shows the percentage reduction in the rates by using the available excavated materials in various road work items.

Material Description	Unit	Rates used in the estimate	Reduced Rates	% reduction in rate
Close graded Granular sub-base Material 53 mm to 26.5 mm	Cum	1453.83	737.16	49.30
Aggregates below 5.6 mm to Aggregates 40 mm nominal size	Cum	1468.53	737.16	49.80
Stone Boulder of size 150 mm and below at Crusher Plant	cum	958.93	711.74	25.78
Supply of quarried stone 150 - 200 mm size for Hand Broken at site	cum	958.93	711.74	25.78
Boulder with minimum size of 300 mm For Pitching at Site	cum	958.93	711.74	25.78
Gravel/Quarry spall at Site	Cum	958.93	711.74	25.78
Filter media/Filter Material as per Table 300-3	Cum	1052.03	711.74	32.35

The above result shows that, there is about 25 to 50% reduction in the rates which are taken in the estimate by NHAI.

4.4 Reduced Cost of the Project

Due to use of available excavated material, rates are reduced and cost of project gets revised. The comparison between actual cost of project and revised cost due to use of available material is shown in the table below:

Actual Cost of project	Revised Cost after Re-use of Excavated Material	% Saving
371.98 Cr.	336.64 Cr.	9.5%

The above table shows that, the cost of the project is reduced to 336.64 Cr. There is total saving of 35.34 Cr. by using the available excavated material, which is 9.5% of actual cost of the project.

5 CONCLUSIONS

The improvement proposal of Chandani Chowk by NHAI and difficulties during the implementation of project are thoroughly studied, the construction sequence, material management study is given in this report. The conclusion of the study is as below:

- Construction Planning and Construction Management is done by using CPM and PERT methods. It is observed that, the time specified for completing the work is sufficient.
- After studying the available material during excavation and its management during the construction, it is observed that, there will be total saving by 9.5% of actual cost of the project by using the available excavated material.

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