Risk Management in Construction of Cross Passage With Live Tunneling

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Abstract- In this paper, construction of cross passage of urban metro is discussed using a case study of CMRL project. Emphasize is given on cross passage works along with live tunneling. The methodology and value engineering has been illustrated to elaborate the benefits of the same. Approach adopted to address the various problems encountered during execution is reported in project.

Keywords- Cross Passage, risk evaluation, Mulazor

I. INTRODUCTION

Transportation plays a vital role in development of a nation. One of current scenario in India transportation is Metro Rails construction through the lengths and breaths of major cities which includes Mumbai, Delhi, Chennai, Bangalore and recently it's been sanctioned in Pune.

Construction of Metro Rail requires huge funds due to requirement of machineries, expert consultants, and number of man power. This may differ according to the type of Metro line which can underground or overhead. So it is need to highlight most efficient technique of construction without affecting its quality.

PROJECT BACKGROUND

The population of Chennai in 1639 was 40000 and today the city is estimated to have a population of 7.5 million, which gives a population density of about 6482 per sq. km. The city, with its present population generates about 11 million trips in a day, with about 6million vehicular trips. The ever growing vehicular and passenger demands coupled with constraints on capacity augmentation of the existing network have resulted in chaotic condition during peak hours of the day.

A number of transportation studies were carried out in the past for Chennai Metropolitan Development Authority (CMDA). These studies discussed travel pattern, network characteristics and the degree of traffic saturation on the existing roads in the Study Area. The proposed high capacity, high frequency metro will not only be a cheaper mode of transport but also provide for a safer, reliable and better customer service. A feasibility study was carried out in 2003 to select and priorities the corridors for Chennai metro. Based on detailed traffic surveys seven corridors were identified.

• Corridors:

The portions of Corridor-1 with a length of 14.3 kms. from Washermanpet to Saidapet, and Corridor-2 with a length of 9.7 kms. from Chennai Central to Anna Nagar 2nd Avenue will be underground and the remainder elevated.

• Corridor-1:

Washermenpet – Manadi – High court – Chennai central – Government estate – LIC – Thousang lights – AG DMS – Teynampet – Nandhanam – Saidapet - Chennai Airport

• Corridor-2:

Chennai central – Egmore – Nehrupark – Kilpauk – Pahiyappa's college – shenoy nagar – Annanagar East – Anna nagar tower – Thirumangalam

Benefits of Metro to commuters

- 1. Time saving for commuters
- 2. Reliable and safe journey
- 3. Reduction in atmospheric pollution
- 4. Reduction in accident
- 5. Reduced fuel consumption
- 6. Reduced vehicle operating costs
- 7. Increase in the average speed of road vehicles
- 8. Improvement in the quality of life
- 9. More attractive city for economic investment and growth

II. OBJECTIVE

• Brief study of Methodology adopted for construction of Cross Passages.

- In depth analysis of Construction of Cross Passages during Live Tunneling.
- To establish pro-active approach in identifying, evaluating and mitigating risks associated with execution of project.

III. REVIEW OF LITERATURE

R.G. Saini, Ishaan Uniyal (2016): -

In this paper, work for the cross-passage for CC27 of Delhi Metro by L&T-SUCG JV commenced after the completion of the twin tunnel on account of ease and efficiency. Method employed for construction of the crosspassage was excavation by heading and benching. The paper also reports a solution adopted for mitigation of a major problem of water-logging encountered during the construction. Approach adopted to address the problem was use of pressure grout and pumping out excess water. Efficacy of the procedure utilized and applicable conditions for same along with possible contributing factors have been also indicated.

Xiangdong Hu (2011): -

This thesis summarizes cross passage construction methods for soft ground conditions in China, in which the most successful and popular one, mining method with ground improved by artificial ground freezing and its risk prevention and safety protection measures, are introduced in detail.

Tsai, Y.Y. (2010): -

In this paper, design and construction of cross passage of urban metro are discussed using a case history from a contract at south end of Qutab Minar Line of the Delhi metro project. In order to start to build permanent structural works in TBM driven shafts as early as possible, construction activities of cross passages should be isolated from TBM shafts. Vertical shafts for cross passages were thus installed between the two main running tunnels from ground surface level to increase workable areas as well as to transport excavated spoil. Details of design and construction of the cross passage will be reported in this paper.

According to all researches mentioned above, in each cases the construction of Cross Passage begins after the completion of the transit tunnels which intern requires separate funds apart from which is required for the main tunnel construction with respect to time, machineries and manpower. Based on above discussion, for our study it is necessary to analyze the practical problems encountered during the construction of Cross Passages and the techniques that were adopted for mitigating those problems.

IV. METHODOLOGY

- Site Visit to CMRL Project; wherein site activities, drawings, project feasibility study was done.
- Site Management assigned to monitor ongoing activities mainly cross passage works.
- In-depth analysis of cross passage with live tunnelling and conventional method was too carried out.
- After analysis Value Engineering conceptualize by preparing extra cost and duration analysis.
- Lastly, Risk Analysis was performed to identify the Risk Factor for the project.

V. METHOD OF CONSTRUCTION (CONVENTIONAL vs INNOVATIVE)

CONVENTIONAL METHOD:

Construction of the cross-passages is taken up only after completion of the tunnels on account of ease of working and efficiency.

Following steps were followed for construction of cross passage.

- (i) Marking up of the survey lines (for excavation purpose) with the help of total station.
- (ii) Temporary structural ring for supporting the tunnel ring to be installed for the tunnel support.
- (iii) Packing of the ring girder with wooden wedges so as to fill the void spaces between the tunnel segment and the ring members thereby increasing the contact area and thus the overall strength of the system.
- (iv) The cut-out portion of the ring with steel lintel beams to be installed in two segment cut-outs using core cutting machine to be done at each cross passage entry sections.
 - a) In the upper section as "Top lintel".
 - b) In the bottom section as "Bottom lintel"
- (v) The opening area segment cut to be removed. Next in the course of excavation, reinforcement steel lattice girder as per the design considerations, is placed inside the cross passage to support the excavated strata, where in the load gets transferred by 'arch effect'.
- (vi) To ensure the stable and safe cross passage construction and minimize ground movements within

the surrounding area due to exposure of unsupported ground, a suitable tunnel support has to be installed as soon as possible. Lattice girders in conjunction with Shotcrete are achieving an excellent level of tunnel support and are therefore commonly used in tunnelling. These lattice girder rings are having following advantages:

- a) Reasonable easy and accurate in dimensions to manufacture.
- b) Due to the reduced weight (compared to full steel rings) easy to transport, store and handle in the tunnel.
- c) Accurate template guide for tunnel profile during excavation.
- d) Accurate guide for required Shotcrete thickness for the Shotcrete application.
- e) Fully embedding of the steel structure in the lining by Shotcrete coating all around the steel structure done.
- f) Fast ring installation during construction process.
- g) Easy adoption to ground condition due to flexibility in ring spacing and ring assembly sequence

INNOVATIVE APPROACH:

Unlike conventional method construction of the cross-passages is taken up parallel to the tunnel mining on account of ease of working and efficiency with "time saving".

In this innovative approach of construction the below mentioned areas are to be modified compared to the conventional method

- a) Track Shifting
- b) Working Platform
- c) Usage of Mini Excavator for faster excavation
- d) Modified Concrete Transport & Pouring method.

a) Track Shifting:

At Cross passage section the alignment of track line changed compared to normal tunnel alignment section. For the location where the rail line is to be side shifted, special size sleepers of 3.24m length with two legged is used to get more width. The two legged sleeper are used to provide more stability to eccentric rail track.

b) Working Platform:

The working platform with both side ramp to accommodate the needed equipment's & construction

materials (pumps, agitators, tanks, grouting, shotcreting, excavated materials & mini excavator etc.) to be installed in the tunnel cross passage section.

c) Usage of Mini excavator:

Mini excavator used for faster excavation and also for utilizing the time gap of mining rolling stock.

It helps in faster muck disposal, thus accommodating between ring building & mining.

JS 30 features: Operating Weight: 2870kg, Net Engine Power: 18.4kW (24.7 hp) Maximum Bucket Capacity0.076 cum TMX 20 features: Operating Weight: 2200kg,

Net Engine Power: 28 hp Maximum Bucket Capacity0.12 cum

d) Modified Concrete Transport & pouring method:

Modification & Implementation of concrete transportation & pouring method during shut down time of mining. During down time of TBM mining the concreting of cross passages done by introducing concrete re-mixer (Mulazor). The dimension of re-mixer selected so that it can be accommodated within the available tunnel rolling stock space & ease in concrete delivery to concrete pump.



Photo 1: Track Shifting



Photo 2: Mini Excavator working over Platform



Photo 3: Mulazor

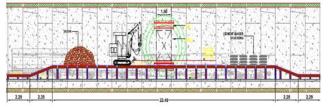


Photo 4: Equipment over Platform with Muck & Material Stacking

VI. RISK MANAGEMENT

- The main purpose of this procedure is to establish a proactive approach in identifying, evaluating and mitigating risks associated with selection of tender up to execution of project.
- The scope of this procedure starts once Proposal Manager handed over the awarded project to Project Manager for execution. This procedure involves systematic quantification and managing all risks and opportunities that can affect successful execution of projects. Mitigation measures as recommended by management during review to be duly implemented for project completion. Any new risk identified during project execution shall be analysed and quantified with mitigation measures.

RISK EVALUATION

- An evaluation of the risk helps in understanding the nature and quantum of risk and its likely impact and possible mitigation measures. The consequences arising from occurrence of risks can be either economic or non-economic and determine the severity of a risk.
- Clear and well defined risk acceptance thresholds are identified in order to determine the level of risk that can be tolerated. Risk acceptance thresholds are based on defined scales for likelihood and consequences, Risks are then assessed and classified against the predefined parameters s under:

Table No. 01: Risk Ranking Matrix

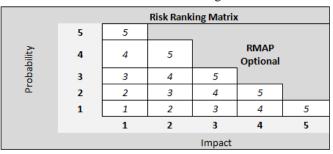


Table No. 02: Impact Assessment

Impact Assessment							
Rank	Qualitative	Impact					
5	Crisis	Catastrophic					
4	Critical	High					
3	Significant	Moderate					
2	Marginal	Low					
1	Negligible	Insignificant					

Table No. 03: Probability Assessment

Probability Assessment							
Rank	%	Qualitative					
5	> 80%	Almost Certain					
4	60 - 80%	Likely					
3	30 - 60%	Possible					
2	10 - 30%	Unlikely					
1	< 10%	Rare					

Table No. 04: Risk Assessment Matrix (5 x 5)

	IMPACT								
		Catastrophic 5	High 4	Moderate 3	Low 2	Insignificant 1			
	Almost Certain 5								
PROBABILITY	Likely 4		>5.1 >5.3 >6.1 >7.2 >10.2	>3.4 >4.1					
	Possible 3		>6.2	>1.1 >1.2 >3.1 >3.2 >5.2 >7.1 >8.3 >9.1 >11.1	>4.2 >8.1 >10.1				
	Unlikely 2		>8.4	>9.2	>1.3 >8.2 >11.2	>6.3			
	Rare 1					>2.1 >3.3 >4.3			

• With above analysis the project risk factor is 2.78 which well below 3 having moderate impact on the project, so there is higher chances of accepting the project is possible.

VII. CONCLUSION

- Construction of cross passages is a tedious and costlier affair. Hence the construction has to be preciously planned and executed. Construction along with Live tunneling is a better option, but due care needs to be taken while executing.
- Live tunneling cross passage excavation helps in transshipment of material and manpower with the help of

locomotive. Thus reducing in construction time as well as lesser cost.

- Also, requisite manpower can be shared during tunneling activities. Otherwise the extended stay is required.
- Generally, all over the India it has been notice the cross passage works delay the site by 03-06 months after tunneling. Hence this technique will be helpful in reducing the extension of time.

R/O	RISK/OPPORTUNIT	RISK/OPPORTUNIT	MITIGATION	RESPONSE	RESPONSIBI	PROBA	IMPACT	RAN	REM
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		Risk: Delay in	JICA, economic	Priced	MIS				
		government approvals.	stability risk is low.						
		Effect: Cash inflow	Still external funding						
			modes to be						
			identified and sorted						
			out.						
1.3	Currency exchange rate	Cause: Market variation	Last 5 years foreign	Retain-	Accounts &	Possible	Insignific	2	
	and banking	Risk: Increase in cost	exchange to be	Priced	MIS		ant		
		Effect: Cash inflow &	studied and						
		profit margin	accordingly rate to be						
			incorporated.						
2	CLIENT RISK								
2.1	Client default	Risk: Project	Cost Provision to be	Avoidance	HO & Project	Rare	Insignific	1	
		Terminaton.	considered.		Manager		ant		
		Effect: Investment							
		return.							
В	TENDERING								
3	CONTRACT								
	CONDITION								
3.1	Liquidated damages	Cause: Maximum LD	Required resources in	Retain-	CPMG	Unlikely	Moderate	2.5	
		limited to 10% of the	the form of	Priced					
		CV	Manpower &						
		Risk: Delay in	Equipments has been						
		achieveing Completion	priced.						
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		Keydates							
		Effect: Cost Overrun							
3.2	Variation clause	Cause: Any Variation	As this is a Design	Retain-	Project	Possible	Moderate	3	
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APPENDIX

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4.3	Taxes and duties	Cause: The price basis	Tax component to be	Retain-	Tender	Rare	Insicnific	1	Estim
		shall include all taxes	discussed, computed	Priced	Manager		ant		ated
		and duties, etc. during	& included in cost in						cost
		contract period. Sales	consultation with						in
		Tax, local taxes and	Taxation Dept.						tender
		other levies. Service							Price
		Tax is exempted and							of Rs.
		excise duty is							0 cr.
		reimbursable							
		Risk: We may							
		underestimate the bid							
		Effect: Cost Overrun							
5	MATERIAL RISK								
5.1	Specifications	Cause: Material	Trial with	Avoidance	Quality	Likely	High	4	
		specifications are	Manufactured sand		Manager				
		normal, crisis in getting	has been made and						
		River sand.	found meeting the						
		Risk: Limited suppliers	specification						
		available who can	requirements.						
		supply river sand.							
		Effect: Delay in							
		Concrete Pouring.							
5.2	Availability	Cause: Crisis in getting	Trial with	Retain-	Quality	Possible	Moderate	3	
		River sand.	Manufactured sand	Priced	Manager				
		Risk: Possibility of	has been made and		-				
		increase in cost of Sand	found meeting the						
		due to cartelisation.	specification						
		Effect: Effect on Cost	requirements.						
		Overrun	requirements.						
5.2	Managaha		Outstiensmitht	A	Tanlar	T. 3 1	II'- L	4	
5.3	Monopoly	Cause: Quarry owner	Quotations received	Avoidance	Tender	Likely	High	4	
		carteling	from all Msand		Manager				
		Risk: Increase in Quarry	suppliers. No other						
		lease rates	development in the						
		Effect: Effect on Cost	area except this						
		Overrun	project.						
6	LABOUR RISK								
6.1	Availability of labour	Cause: Approx 2500	Mix of own & Local	Avoidance	Project	Likely	High	4	
		manpower required	labour contractor to		Manager		, i i i i i i i i i i i i i i i i i i i		
		Risk: Non availablity of	be deployed.						
		skilled manpower may							
		cause cost & time							
		overrun.							
		Effect: Effect on Time							
		& cost overrun				L			
6.2	Union/influence	Cause: No Local labour	Cost Provision for	Avoidance	Project	Possible	High	3.5	
		union existsRisk:	Union Influence		Manager				
		Effect: May cause cost	considered in						
		overun & schedule	Business Expenses						
		slippage							
6.3	Labour laws	Cause: Labour Laws	All provisions as per	Retain-	Project	Unlikely	Insicnific	1.5	
		Risk: No Risk Forseen	local labour law shall	Priced	Manager		ant		
		Effect: No effect on cost	be taken in cost.						
		overrun	se taken in cost.						
	EOUIDMENTE DIGU	ovenum							
7	EQUIPMENT RISK								
7.1	Availability of	Cause: Sophisticated	CAPEX sholud	Retain-	Project	Possible	Moderate	3	
	equipment	equipments &	include specialise	Priced	Manager				
		technology required.	machiniers. Not to						
		Risk: Work delay.	invest on localised						
		Effect: Project delay	equipments.						
		&cost overrun.	Development of						
			strong vendor base						
			strong venuor base			1			

	a								
7.2	Specialized/Monopolize	Cause: Sophisticated	CAPEX sholud	Retain-	Project	Likely	High	4	
	d equipment	equipments &	include specialise	Priced	Manager				
		technology required.	machiniers. Not to						
		Risk: Work delay.	invest on localised						
		Effect: Project delay	equipments.						
		&cost overrun.	Development of						
			strong vendor base						
8	TIME RISK								
8.1	Contract Duration	Cause: Contract	We have deployed	Retain-	Planning	Possible	Low	2.5	
		duration is 63 months.	required equipment &	Priced	Manager				
		Risk: Early	manpower to meet						
		Mobilisation is very	the time line as per						
		important for achieving	clients requirement.						
		the completion	As well as						
		Effect: Will have	development new						
		schedule slippage &	methodolies.						
		Cost overrun							
8.2	Intermediate Milestone	Cause: Not Applicable	NA	Retain-	Planning	Unlikely	Low	2	
		Risk: Early Mobilisation		Priced	Manager				
		is very important			-				
		Effect: Will have							
		schedule slippage &							
		Cost overrun							
8.3	Mobilization time	Cause: Mobilisation	- Based on bore log	Retain-	Planning	Possible	Moderate	3	
		time for cross passage	data, grout pattern to	Priced	Manager			-	
		subcontractor &	be planned for cross	Theeu	in and ger				
		equipments to be speed	passage.						
		up.	- Excavation work to						
		Risk: All the required	be started on priority						
		activity needs to be	with Hired						
		undertaken and finished							
			Equipments.						
		within the mobilistion							
		period.							
		Effect: Will have							
		schedule slippage &							
		Cost overrun							
8.4	Possibility of schedule	Cause:No possibility of	Certain Acitities of	Avoidance	Planning	Unlikely	High	3	
	crashing	further crashing of	the schedule can be		Manager				
		schedule	crashed, however						
		Risk: Not Possible	overall duration						
		Effect: N.A	cannot be crashed						
			due to						
			interdependancy of						
			civil structures.						
С	OPERATION								
9	UNKNOWN SITE								
	CONDITION								
9.1	Topographic and	Cause: Vivid geological	Detailed evaluation	Retain-	Project	Possible	Moderate	3	
	geological conditions	strata	of borelogs, wherein	Priced	Manager				
		Risk: Delay in tunneling	required we go for						
		& cross passage	more bore logs.						
		excavation							
		Effect: Project delay &							
		cost overun							
9.2	Floods, Cyclones, Bad	Cause:	CAR policy to be	Retain-	Contract	Unlikely	Moderate	2.5	
	Weather and Other	Risk: Work stoppage	taken covering all	Priced	Manager &				
	Delays	Effect: Project delay &	incidental losses.		Project				
		cost overun			Manager				
					(Follow-up)				
10	CONSTRUCTION				, <u>r</u> /				
	METHOD								
1		1	1	1	1	1	1		1

10.1	Grouting	Cause: Grout to be	Grout sequence to be	Retain-	Quality	Possible	Low	2.5	
		desing in accordance	finalised with proper	Unpriced	Manager				
		with soil condition.	Mix Desing.						
		Risk: Side collapse							
		Effect: No effect on cost							
		overrun							
10.2	Cross Passage	Cause: Innovation to be	New methodology to	Reduction	Construction	Likely	High	4	
	excavation	anticipated.	be planned to		Manager				
		Risk: Cross passage	construct the cross						
		works	passages alongwith						
		Effect: Cost overrun	the live tunneling.						
		and project delay							
11	DESIGN RISK								
11.1	Client Design	Cause: We have	Proper drawings to be	Transfer	Design Team	Possible	Moderate	3	Hire a
		undertaken	submitted to the						3rd
		Risk: Delay in approval	cclient in accordance						party
		Effect: No effect on cost	to the contractural						desig
		overrun	requirment and IS						ner.
			codes.						
11.2	Our Design	Cause: Design	Both Permanent and	Transfer	Design Team	Unlikely	Low	2	
		responsibility of both	Temporary Designs						
		Permanent and	has been finalised						
		Temporary structures.	during bid stage and						
		Risk: No Risk Forseen	at construction stage						
		Effect: No effect on cost	design and drawings						
		overrun	will be evaluated						
						Average P	roject Risk	2.758	

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REFERENCES

- R.G. Saini, Ishaan Uniyal, Construction of a Cross-Passage for a Twin Tunnel System for Delhi Metro's CC-27 Project, Punjab, January 2016, http://www.masterbuilder.co.in.
- [2] Fang Y.S., Lin C.T., Liu C., Construction of a Cross Passage between Two MRT Tunnels, Proceedings of the 18th International Conference on Soil Mechanics and Geotechnical Engineering, Paris 2013.
- [3] Xiangdong Hu, Wang Guo, Construction Methods for Cross Passage in Soft Ground Tunnels in China. 2011, https://www.researchgate.net
- [4] Hsiung, B.C.B., Tsai, Y.Y., Tsai, C.C., Analysis and Construction of Cross Passage of Delhi Metro, Indian Geotechnical Conference – 2010, GEOtrendz, IGS Mumbai Chapter & IIT Bombay, December 16-18, 2010.
- [5] M. J. Murray, Mott MacDonald, S. D. Eskesen, Design and Construction of Cross
 Passages at the Storebaelt Eastern Railway Tunnel, Tunnelling 97 Conference, Olympia, London, September 1997.