



Tunnelling Asia' 2023

International Conference on
Climate Change Resilience and Sustainability
in Tunnelling and Underground Space



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RISK ANALYSIS AND RISK SHARING IN TUNNELLING WORKS FOR METRO RAIL PROJECTS

by

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Present Situation in Tunneling

- Urban Tunnelling is mainly by TBM.
- Generally TBM is owned by contractor.
- Mixed strata needs rock machines.



Rock Machine



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Challenges While Tunneling

- Excavation needs to be stopped (Intervention) for cutter disc replacement/any other maintenance.
- Cost towards loss of productivity and replacement of damaged discs is substantial.
- Actual consumption of cutter discs and number of interventions cannot be assessed accurately.
- Tenderer will consider most critical condition while quoting.
- Quoted rate may go unreasonable.



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NEW CUTTER DISC



DAMAGED CUTTER DISC





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COST OF CUTTER DISC AND REPLACEMENT

- Consumption of cutter disc is based on geological conditions.
- Location & size of boulders cannot be predicted accurately.
- Presence of boulders cause damage to cutter discs.
- Damaged discs to be replaced in hyperbaric conditions.
- Interventions in hyperbaric conditions need additional man power & machinery.
- Cost of replacing each disc is much more than cost of disc itself.



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Resources Required for Intervention

- Dedicated Doctor and Team
- Man Power : 3 to 6 number for 4 hours of Intervention
- Dedicated Safety Team
- Medical Chamber (Suitable for Hyperbaric condition)
- Medical Oxygen and arrangements
- Dedicated Crane for Intervention
- Rescue Cage (Man Basket)
- Standby Compressor
- Dedicated Communication system
- Specialised Pressure Gauges
- Specialised Welding Equipment
- Exhaust System from Hyperbaric condition



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TENDERING

- Work of tunnel using TBMs is generally awarded on design build lumpsum basis.
- All risks are with the Contractor.
- Payment is on running meter basis.
- Awarded cost is independent of discs consumed and number of interventions carried out.
- Some interventions will be as long as 2 weeks.



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COMPARISON OF TOUGHEST & EASIEST DRIVES

Sl.no	DESCRIPTION	TOUGHIEST DRIVE	EASIEST DRIVE
1	TYPE OF MACHINE	SLURRY	SLURRY
2	DIA OF MACHINE	6.72 m	6.65 m
3	LENGTH OF TUNNEL	1086 m	718 m
4	GEOLOGICAL STRATA	Mixed Face with Boulders	Full Face Soil – 618 m Partially Rock – 100m
5	DURATION OF DRIVE	450 Days	105 days
6	NUMBER OF INTERENTIONS	193 nos	13 nos
7	AVERAGE PROGRESS/DAY	2.41 m	6.83 m
8	NUMBER OF DISCS REPLACED	325 nos	94 nos
9	RMT/DISC	3.34 m	7.63 m
10	TUNNEL LENGTH / INTERVENTION	5.62 m	55.23 m

- Huge difference can be seen in progress, interventions and disc consumption.



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RISK SHARING IN PHASE-2 OF BANGALORE METRO

- Geological data is made available in tender document.
- Contractor shall arrive at anticipated/theoretical consumption of cutter disc as per the data made available. - Say X
- The method is based on Rock Mass Rating (RMR) system and Rock Mass Excavability (RME).
- During execution, cutter disc consumption shall be recalculated utilizing the recorded geological data of the encountered soil/rock profile adopting the same method. – Say Y.
- Actual consumption of cutter discs – Say Z.

Con....



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RISK SHARING IN PHASE-2 OF BANGALORE METRO

- Lower of the X or Y will be used for calculating compensation.
- Cost of theoretical consumption of cutter discs calculated (x or y) added with 25% is deemed to be included in the amount quoted in the tender.
- If the actual consumption of cutter disc (Z) exceeds 125% of theoretical consumption, cost of such excess cutter discs will be paid by the employer.
- Such payment should not exceed 3% of the tunneling work.



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REQUIREMENTS OF ASSESSING COST TOWARDS RISK

- Detail soil investigation along actual alignment of tunnel.
- Freezing the tunnel alignment.
- Proper preparation of geological investigation report.
- Owning of accuracy of soil investigation report by employer.



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ADDING ALL RISKS ON CONTRACTOR



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ADVANTAGES

1. Contractor is responsible for handing over completed tunnel within the agreed cost.
2. Minimum variation.
3. Cost of cutter discs, cutter head interventions and all other costs are borne by the contractor.

DISADVANTAGES

1. Contractor will consider cost towards all the risks assessed based on available soil investigation report.
2. Actual condition may not be as assessed during tendering.
3. If geological condition is favorable, contractor may get additional profit.
4. If geological conditions are worse than that assessed, the contractor may fail financially and completion schedule may get affected.
5. In both the above cases, employer needs to incur additional cost.



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SHARING THE RISK AMONG CONTRACTOR AND EMPLOYER

ADVANTAGES

1. Tenderer will need to quote towards known scope only.
2. Cost due to adverse/unknown geology will be reimbursed.
3. Completion cost will be reasonable.
4. Failure of contract due to adverse geological conditions can be avoided.

DISADVANTAGES

1. Guidelines for arriving at risk cost should not be vague.
2. Requires accurate recording of geological conditions met while tunnelling. May need engineers of employer to regularly enter cutting chamber.
3. Contractor may try to depict normal condition as abnormal condition.



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CONCLUSION

- Expecting contractor to cater for all risks involves additional cost.
- Sharing risks will bring freedom to the contractor to quote against known scope only.
- Carrying soil investigation in city limits by the tenderer is very difficult.
- Employer should enclose a detailed soil investigation report with tender documents.
- Reduced risk may attract more players for tunneling works.
- Risk sharing methods / procedures need to be finalized in consultation with Geologists and Experts from Contract, finance and legal sections.



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