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7 COST ESTIMATE FOR ROAD WORKS

7.1 METHODOLOGY FOR QUANTIFICATION

The project consists of Two Lane New Construction of Road Approaches and Z Morh Tunnel on NH-1, from Village Rezan (Km 69) to Village Shetkari (Km 82.0), in the state of Jammu & Kashmir. Quantification for various identified items to be executed for new construction of hill road based on the provision of schedule B and stipulations of IRC: SP: 73-2007, pavement compositions based on preliminary pavement design and various existing carriageway features captured during inventory survey.

The consultant has designed the 'Approach Roads' by latest computer applications, highway design software viz Google Earth, Global Mapper, MX and AutoCAD. The contours have been generated to prepare DTM from Global Mapper. Route & Alignment fixation has been designed using Google Earth by adopting starting point at West Portal (Coordinates taken from Design Report & Technical Schedules) and End point at merging point near km 69 of NH-1. Horizontal & Vertical alignments have been designed as per **IRC standard and Hill Road Manual**. Design parameters (*Radius, transition length, super-elevation, vertical grades, vertical curves etc*) are adopted for uniform "Design Speed" of 50km. Similarly Eastern Approach Road has been designed by start point of East Portal coordinates and merging at existing NH-1 leading to Sonamarg Town Road with connection to Sonamarg bypass road.

Highway detailed design has been done exporting alignment to MX highway design software. Plan & Profile drawings and detailed Cross sections have been generated from MX. Earthwork (Cut & Fill) and Pavement quantities are generated from MX by creating detailed cross sections with pavement layers and without pavement layers separately. All these drawings are enclosed in Volume III Drawing Folder. The earthwork and pavement quantities are summarized in Excel and attached herewith as Annexure.

Thus the BOQ has been prepared in the following sub-heads:

1. Site clearance
 2. Earthworks
 3. Sub-base and base course
 4. Bituminous course (for road approaches)
 5. Major Bridge and Minor Bridge
 6. Grade Separated Structure
 7. Culverts
 8. Drainage and protection work
 9. Traffic sign and road appurtenances
 10. Toll Plaza (Provisionally)
 11. Rest area and building works
 12. Miscellaneous works
 13. Maintenance of Road during Construction
 14. Snow removing Machineries
 15. Tunnel Works
 16. Approach Road for Construction Equipment
-

17. Electrical for highway, Toll Plaza and Structure

7.1.1 Site clearance

Clearing and grubbing and dismantling of existing carriageway, scarification and stump removal operations are considered under this head. For clearing and grubbing, Toe width of Embankment is considered as per typical cross section of 2 Lane. Tree cutting quantity is assumed as Lump sum basis 200 trees per Km in hilly terrain is also included in the cost estimate.

7.1.2 Earthworks

Embankment and Excavation quantities have been quantified based on detailed designed and plan & profile drawings. Cross-section schedule have been prepared by keeping in view the locations of retaining and breast wall in plan and profile. Height of excavation in hill and embankment depth in valley for locations of retaining/breast wall has been taken from Cross Sections generated through Design Terrain Model (DTM).

Other items covered under this head are subgrade, earthen shoulder and island fill. Besides road work, quantities have been added for miscellaneous works such as junction improvement, bus bays and truck lay byes based on their typical layout.

7.1.3 Sub-base course and base course

GSB and WMM layer have been quantified under this head. Besides road work, quantities have been added for miscellaneous works such as junction improvement, bus bays and truck lay byes based on their typical layout. GSB material is proposed to be obtained from the excavation of rock cut material.

7.1.4 Bituminous work

Items covered under this head are prime coat, tack coat, DBM and BC. Besides pavement for road works which are quantified based on the typical cross-section of 2 lanes and service/slip road. Quantities have been added for miscellaneous works such as junction improvement, bus bays and truck lay byes based on their typical layout. Variable thickness of DBM as advised by preliminary pavement design has been quantified chainage wise.

7.1.5 Rigid Pavement

Rigid pavement is calculated for typical cross sections proposed for Main Tunnel, Escape Tunnel and Ventilation Tunnel, Adit etc.

7.1.6 Major Structures

Structures covered under this item are major bridge, minor bridges. Major and Minor bridges quantities are quantified based on the stipulations of schedules and GAD based on preliminary design, there are One Major & Two Minor Bridges where the type of Super Structure are Pre-Cast RCC Girder and the type of foundation are raft foundation.

7.1.7 Overpass

There is one Overpass proposed for Sonamarg Bypass road which are quantified individually under this head. RCC return wall is considered for the overpass.

7.1.8 Culverts

There are total 40 no's of RCC Box Culverts proposed In hill section cascade and stilling basins are provided on downstream side while catch pits are provided.

7.1.9 Drainage and protection work

Items considered under this head are drain, slope protection work such as turfing, stone pitching, Retaining wall and Breast Wall. Combination of stone pitching over filter media, chute drain, channel kerb and energy dissipation chamber is considered wherever the embankment height is more than 3m in plain terrain. Stone pitched along the carriageway on hill side, covered drain in urban areas catch drains on hill and unlined drains have been quantified as per proposed cross sections. Height of Retaining/Breast wall has been referred from the table given in Chapter 5. RR Masonry Retaining/Breast wall is considered for height up to 6m and PCC retaining/breast wall is considered for height above 6m. Cost of 600mm dia Hume pipe is considered for crossing utilities at every Km in cost estimate.

7.1.10 Traffic signs and road appurtenances

Items considered under this head are road marking, traffic signs, overhead signs, kerbs, studs, delineators and Km stones. Construction of footpath and passenger shelters at bus bay location is also covered in this head. Traffic signs have been quantified based on number of villages/built-up area, public institutions and junction falling in road corridor. Full width overhead signs and cantilever signboards considered in the estimate. Reflective Studs and solar power road markers (solar studs) are calculated based on the IRC guidelines. Delineators are also considered as per the stipulation of IRC-79.

7.1.11 Toll Plaza

Two toll plazas have been proposed in project corridor at chainages 72+000 and 82+000. Estimation of toll plaza has been done in two parts, civil work and equipments required. Civil works are quantified based on typical layout details for required number of toll plaza covering rigid pavement, toll plaza administrative building, toll booths, canopy etc.

7.1.12 Rest Areas and Building Works

Two nos. Rest Area are proposed. Cost of Administrative building and base camp has been included in Cost estimate.

7.1.13 Miscellaneous work

Cost of toilet block in truck lay bye has been included in the cost estimate under this subhead.

7.1.14 Temporary Diversion and Traffic Management During construction

As the major portion of project is having new realignment and traffic will be diverted to new road after completion of project therefore no temporary diversion is required.

7.1.15 Maintenance during Construction

As the major portion of project road is realignment and traffic is to be moved on existing 2 lane roads during the time of construction therefore it is to be maintained for smooth movement of traffic. Cost of pot hole repair, patch work, crack sealing and maintenance of existing shoulder has been considered in the cost estimate.

7.1.16 Snow Removal during Winter

Due to high altitude mountainous area, snow precipitation up to 10m height on road occurs almost 6 months from October to March. Snow cutting equipment's and machineries with accessories and fuel are required to cut the snow and clear the road approaches for catering the traffic. Operation & maintenance Cost of these has been considered in the cost estimate.

7.1.17 Pavement for Tunnel

PQC, DLC, Granular sub base and embankment for tunnel is considered in the cost estimate. Cost of covered drain, kerb and guard rail has also been included in the estimate.

7.1.18 Approach Road for Construction Equipment

Cost of 18Km of earthen road 5.5m wide is considered in cost estimate for movement of construction equipment from existing NH1 to various locations of tunnel and major bridge in the new alignment.

7.1.19 Tunnel Ventilation

Cost of Tunnel ventilation has been calculated separately as per standard specifications.

7.1.20 Electrical for highway, Tunnel, Toll Plaza and Structures

Cost of electrical equipments for highways, tunnel toll plaza ,intersections bus bay ,truck lay byes and underpasses has been considered in cost estimate as per standard specifications.

7.1.21 Tunnel Construction Cost

A separate BOQ & cost Estimate for all items of construction for main tunnel, escape tunnel, ventilation tunnel, Adit has been prepared.

7.2 LIFE CYCLE COSTING OF FLEXIBLE PAVEMENT V/S RIGID PAVEMENT

"Life Cycle Costing Analysis" has been carried out for Flexible Pavement v/s Rigid Pavement for the road approaches length are **5.85km** and **7.215km** as per Technical Schedule.& Consultant Design as per following criteria:

1. Joint sealing can be done for every 4 years. For this item, the current rate would be Rs 35/m length.
2. As part of routine maintenance, repair corner breaks, slab replacement, putout removals etc, rate of 1% of total number of panels shall be considered, for which Rs 45000 has to be considered for PQC in general for the current rates. For Ex. For a project a total of 1000 slabs were constructed, then 1% of it, is 10. So, the routine maintenance for the concrete pavement is Rs 10*45000=4.5lac per year

3. Re-Texturing can done for every 10 years after the construction and at this time the rate for lane marking shall be considered. The Rate for re texturing item is Rs 170 per sqm.
4. Apart from the above, rate for various surveys during the operation period shall be considered in periodic maintenance cost.

Pavement Composition: The pavement composition of Flexible & Rigid pavement for Design Traffic 30MSA is as below:

- ❖ Flexible pavement composition is 40 BC+100 DBM+250 WMM+200 GSB
- ❖ Rigid pavement composition is 220 PQC+ 50 DLC+ 300 GSB

The construction cost of Flexible and Rigid pavement for the road having a traffic of 30msa for 10 km along with O&M costs are given below in tabular form as below:

Item	For 5.850km		For 7.215km	
	Flexible Pavement	Rigid Pavement	Flexible Pavement	Rigid Pavement
Initial Construction Cost	139150941	155701344	171619494	192031658
Periodic Maintenance cost	20221724	2063750	24940127	2545292
Routine Maintenance Cost	1052298	1184625	1297834	1461038
Total Cost	160424963	158949719	197857454	196037987
Cost (Rs Crore)	16.042	15.895	19.786	19.604

The life cycle cost analysis for the same reveals the rigid pavement option is cheap compared to flexible. The design length of Western Approach & Eastern Approach roads are 6565m & 650m respectively. While Technical Schedule shows the lengths 5250m & 550m respectively.

7.3 ESTIMATION OF QUANTITIES AND COST ESTIMATES

On comparison of Technical Schedules and Consultant's design a number of differences in lengths and other parameters have been found. following has been prepared for both cases as below:

Sl	Description	As per Consultant's Design
1	Western Approach Road	6565
2	Eastern Approach Road	650
3	Tunnel Length	6550
4	Approach to Adit	1100
5	Loops for Tunnel	900
6	Connecting U for SSG	-
4	Improvement of existing Sonamarg Bypass Road	600
5	Improvement of existing Sonamarg Town Road	300
6	Loop	90
7	Minor Bridges 2 Nos.	1x12+1x30+1x12 = 54
8	Minor Bridges 1 No	1x15+7x30+1x15 = 240
9	Box Culverts 40 Nos.	1x4m x 4m
10	Bus Bays	3 Nos.
11	Truck lay By	2 Nos

12	Toll Plaza	2Nos.
13	Junction at start km 69	1
14	Underpass for Village Road	1 (1x12m)
15	Access Roads for carrying construction Mach & Equipments	3 nos x 500m each

7.4 BOQ AND COST ESTIMATE AS PER RFP

- Western Road Approach starts at western portal and ends at Srinagar side near km 69, Length 5.5km.
- Eastern Road Approach starts at eastern portal and Ends at Sonamarg Town Road . The length of approach road is 550m.
- Horizontal and Vertical Alignment will be as per design details provided with RFP dated 19th September 2012.
- Intersection at km 69 and Interchange at Sonamarg Bypass & merging at Sonamarg town road shall be provided as per sketches/ drawings provided with updated RFP with U turn Loop.
- Cut & Fill Quantities are considered as per details provided with RFP.**
- Two minor Bridges of 1x30m span with Open foundation and Major Bridge of (1x40m+1x70m) are considered as per updated RFP and data provided.
- Super Structure of Steel confirming BIS 2062 Grade C are proposed. The Deck width of two lane bridge is 12m.
- Three Bus Bays at villages (i) Rezan,Km69; (ii) Gagangir km71.5 & (iii) Shetkari km 82.5 are proposed.
- Truck Laybys are proposed At Km.69.800 and At km 83.000.**
- Rest Areas are proposed at (i) Km.71.5 (Right Side) (ii) At Km.81.3 (Left Side).**
- No Toll Plaza is proposed.

SI	Description	As per Revised Technical Schedule
1	Western Approach Road	5250
2	Eastern Approach Road	550
3	Tunnel Length (Main and Egress each)	6500
4	Approach to Adit	1100
5	Slip Road to SMB	300
6	Access to SSG Road	70
7	Minor Bridges 2 Nos.	1x30m
8	Minor Bridges 1 No	1x40+1X70 =110m
9	Box Culverts	Nil
10	Bus Bays	(3 Nos considered)
11	Truck lay By	(2 nos considered)
12	Toll Plaza	Nil
13	Major Junction	At start km 69
14	Minor Junction	Three
15	Access Roads for carrying construction Machineries & Equipment	(3 x 500m each considered)

7.5 RATE ANALYSIS AND COST ESTIMATE

Rate analysis has been done based on the basic rate collected from the nearest project site in **Udhampur** during inventory survey. Hire charges of machineries used for rate analysis is based on Standard Data Book Published by MORT&H and escalation is considered based on RBI indices. Labor rate is adopted with reference to labour and employment department of Srinagar (Kashmir) for the year 2008 and the same has been escalated by 5% for 3 years to arrive at current rate.

Weighted average lead for earth for embankment and for subgrade for identified borrow area are worked out. 5 Major sources for aggregate are considered throughout project corridor. Quality and quantity of aggregate along with their lead to the project corridor is considered to ascertain the optimum transportation cost of aggregate.

The Standard Data Book Published by MORT&H has been used for the purpose of rate analysis. Overhead for the road works and structure works (concrete) has been kept as 8% and 20% respectively. The contractor's profit has been considered as 10%.

Unit Rates arrived through the detailed rate analysis based on Standard Data Book is used for the preparation of Cost Estimate. Abstract of cost estimate is given below:

7.6 BOQ AND COST ESTIMATE AS PER TECHNICAL SCHEDULE PROVISIONS

BOQ and Cost Estimates are prepared for the road works is as below:

7.6.1 Z-Morh Tunnel and Approaches

A) COST ESTIMATE FOR ROAD APPROACHES & ROAD WORKS AS PER RFP

ABSTRACT OF COST ESTIMATE

Bill No.	Description	Amount (in Rs)	Remarks
BILL NO. 1	Site Clearance	3019485	
BILL NO. 2	Earthworks	121526856	
BILL NO. 3	Sub Base and Base Course	34266635	
BILL NO. 4	Pavement	68908907	
Bill No 5.	Culverts /Cross Drainage Works	0	No Culvert
Bill No 6	Bridges, Underpasses, Grade Separators	122413794	
BILL NO.7	Drainage and Protective Works	5696702	Only Slope Protection
BILL NO.8	Traffic Signs ,Marking ,Safety Devices and Road Appurtenances	3393007	
BILL NO.9	Toll Plaza	0	No Toll Plaza
BILL NO.10	Bus Bays, Truck Lay bays and Way Side Amenities	12668571	
BILL NO.11	Maintenances of Existing 2 Lane	0	Maintained by BRO
BILL NO.12	Traffic Management during Construction	3500000	
BILL NO.13	Highway Lighting	8589320	

BILL NO.14	Operation & Maintenance Cost for Approach Road	66633785	
Total Civil Construction Cost of the Road Approaches		450617064	
	Cost of the Road Approaches (Rs in Crores)	45.062	
	per km Cost	6.20	
	Tunnel Construction Cost including Road works, E&M and O&M	775	
	Total Project Cost (Rs in Crores)	820	
Other Costs			
Land Acquisition Cost for 99.76 Ha Area as per details provided		15.44	(Crores)

B) COST ESTIMATE FOR ROAD APPROACHES & ROAD WORKS AS PER RFP WITH RETAINING WALL, BREAST WALLS AND CULVERTS

ABSTRACT OF COST ESTIMATE

Bill No.	Description	Amount (in Rs.)
BILL NO. 1	Site Clearance	3019485
BILL NO. 2	Earthworks	121526856
BILL NO. 3	Sub Base and Base Course	34266635
BILL NO. 4	Pavement	68908907
Bill No 5.	Culverts /Cross Drainage Works	44190689
Bill No 6	Bridges, Underpasses, Grade Separators	122413794
BILL NO.7	Drainage and Protective Works	153665671
BILL NO.8	Traffic Signs ,Marking ,Safety Devices and Road Appurtenances	3393007
BILL NO.9	Toll Plaza (No Toll Plaza is proposed)	0
BILL NO.10	Bus Bays, Truck Lay bays and Way Side Amenities	12668571
BILL NO.11	Maintenances of Existing 2 Lane (maintained by BRO)	0
BILL NO.12	Traffic Management during Construction	3500000
BILL NO.13	Highway Lighting	8589320
BILL NO.14	Operation & Maintenance Cost for Approach Road	66633785
Total Civil Construction Cost of the Road Approaches		642,776,722
	Cost of the Road Approaches (Rs in Crores)	64.28
	per km Cost	8.84
	Tunnel Construction Cost including Road works, E&M and O&M	775
	Total Project Cost (Rs in Crores)	840

Other Costs	
Land Acquisition Cost for 99.76 Ha Area as per details provided	154,375,442

7.6.2 Zojila Tunnel and Approaches

A) COST ESTIMATE FOR ROAD APPROACHES & ROAD WORKS AS PER RFP

ABSTRACT OF COST ESTIMATE

Bill No.	Description	Amount (in Rs)	Remarks
BILL NO. 1	Site Clearance	3774356	
BILL NO. 2	Earthworks	151908570	
BILL NO. 3	Sub Base and Base Course	42833294	
BILL NO. 4	Pavement	86136134	
Bill No 5.	Culverts /Cross Drainage Works	0	No Culvert
Bill No 6	Bridges, Underpasses, Grade Separators	153017243	
BILL NO.7	Drainage and Protective Works	7120878	Only Slope Protection
BILL NO.8	Traffic Signs ,Marking ,Safety Devices and Road Appurtenances	4241259	
BILL NO.9	Toll Plaza	0	No Toll Plaza
BILL NO.10	Bus Bays, Truck Lay bays and Way Side Amenities	15835714	
BILL NO.11	Maintenances of Existing 2 Lane	0	Maintained by BRO
BILL NO.12	Traffic Management during Construction	4375000	
BILL NO.13	Highway Lighting	10736650	
BILL NO.14	Operation & Maintenance Cost for Approach Road	83292231	
Total Civil Construction Cost of the Road Approaches		563271328	
	Cost of the Road Approaches (Rs in Crores)	56.33	
	per km Cost	7.75	
	Tunnel Construction Cost (Rs Crores)	1430	
	Total Project Cost (Rs in Crores)	1486	
Other Costs			
	Land Acquisition Cost for 99.76 Ha Area as per details provided	18.50	(Crores)

B) COST ESTIMATE FOR ROAD APPROACHES & ROAD WORKS AS PER RFP WITH RETAINING WALL, BREAST WALLS AND CULVERTS

ABSTRACT OF COST ESTIMATE

Bill No.	Description	Amount (in Rs.)
BILL NO. 1	Site Clearance	3774356
BILL NO. 2	Earthworks	151908570

BILL NO. 3	Sub Base and Base Course	42833294
BILL NO. 4	Pavement	86136134
Bill No 5.	Culverts /Cross Drainage Works	55238361
Bill No 6	Bridges, Underpasses, Grade Separators	153017243
BILL NO.7	Drainage and Protective Works	192082089
BILL NO.8	Traffic Signs ,Marking ,Safety Devices and Road Appurtenances	4241259
BILL NO.9	Toll Plaza (No Toll Plaza is proposed)	0
BILL NO.10	Bus Bays, Truck Lay bays and Way Side Amenities	15835714
BILL NO.11	Maintenances of Existing 2 Lane (maintained by BRO)	0
BILL NO.12	Traffic Management during Construction	4375000
BILL NO.13	Highway Lighting	10736650
BILL NO.14	Operation & Maintenance Cost for Approach Road	83292231
Total Civil Construction Cost of the Road Approaches		803470900
	Cost of the Road Approaches (Rs in Crores)	80.35
	per km Cost	12.36
Tunnel Construction Cost (Rs. Crores)		1430
Total Project Cost (Rs in Crores)		1510
Other Costs		
Land Acquisition Cost for 99.76 Ha Area as per details provided		18.50

8 OPERATIONS AND MAINTAINENCE OF APPROACH ROAD & TUNNEL

8.1 SCOPE OF WORK

8.1.1 General

- ❖ **Road maintenance** – this includes emergency; routine, periodic (if required) and disaster maintenance. Broadly routine maintenance will include maintenance of shoulders and slopes, side drains, CD works, carriageway and crust.
- ❖ **Road property management** – Identification of encroachments and ribbon development, enforcement of regulations, Liaison with the relevant authorities for above and maintenance of road signs and road furniture
- ❖ **Incident management** - road patrols and surveillance, first aid, basic automobile assistance, tow away cranes, wireless/mobile facility and road safety works.
- ❖ **Engineering Improvements** –Pavement Overlay, renewal of pavement marking, Repairing/ Providing Crash Barriers, management of access, provision of new sign boards, cats eyes, etc.
- ❖ **Inspections**

8.1.2 Road Maintenance

1. The Contractor shall be required to perform all routine road maintenance activities along the project roads.
2. The Contractor shall be required to submit Maintenance Report for each component of the works.
3. The Contractor shall be required to utilize mechanized equipment and methods to perform these obligations.
4. All maintenance activities shall be carried out in accordance with relevant specifications and IRC codes prescribed in the contract. The requisite quality control tests as per specifications and codes are to be carried out by the Contractor at his cost as per directions of the Engineer.
5. Routine road maintenance means planned works and activities required to ensure public safety, repair small defects and to maintain the road in the required condition. Ad hoc maintenance means carrying out of unscheduled maintenance occasioned by irregular events such as accidents, natural calamities, abnormal weather conditions and the like. The routine and ad hoc Road Maintenance shall include, amongst others, activities such as:
 - Repairing Local Potholes
 - Crack Sealing
 - Asphalt Treatment
 - Road Sign Maintenance
 - Road Markings
 - Guard Rail and supplementary road furniture repairs
 - Maintenance of Rigid Pavements
 - Repair of Fences
 - Repairs of Accident Damaged Assets
 - Maintenance of Culverts, Drains and Channels
 - Clearing of Litter and Debris
 - Periodic Maintenance of Flexible Pavement.

8.1.3 Horticultural Maintenance

The contractor shall maintain all existing trees, plants, shrubs and other suitable vegetation in the median and right of way strictly according to the desired density and ensure the conservation of all trees, shrubs and similar vegetation, in the median and within the right of way by promptly replacing the casualties. The

Contractor shall also take adequate and appropriate measures, during the various seasons, to ensure the survival of the vegetation.

8.1.4 Road property management

The Contractor shall ensure the maximum availability and efficient utilisation of the assets for the Employer. This shall also include the protection of the right of way from encroachments and other unauthorised activities. For this purpose, the Contractor shall draw up a comprehensive asset register detailing the condition of the entire existing road and building assets. This asset register shall be maintained and continually updated after any additions to the infrastructure and after each of the required inspections.

Any damage or loss to asset of highway like signages, delineators, boards etc. by way of theft or due to negligence of the Contractor, it shall be fully recoverable from the Contractor.

8.1.5 Un-authorised Encroachments

The strict enforcement of the requirements of the Employer shall be a significant obligation under the Contract. The BRO/ EMPLOYER shall define the Right of Way and their requirements with respect to un-authorised accesses, encroachments and the like. The Contractor shall be required to detect report, use it's best endeavors and remove all un-authorised encroachments within the right of way as soon as possible. The Contractor shall be required to record all such encroachments and seek any assistance from Police, local authorities and the BRO/ EMPLOYER as it deems fit, in order to ensure that all such encroachments are removed.

At the commencement of the Contract, the Contractor shall be required to determine all encroachments and un-authorised accesses to the highway, existing at time being granted access to site. The Contractor shall list out the encroachments with a description, location and extent of each encroachment, draw up a method statement and programme for the removal of the unauthorized accesses or encroachments for approval by the BRO/ EMPLOYER. All existing encroachments shall be removed, and un-authorised accesses closed within 3 months of the Contractor being granted access to site.

8.1.6 Incident Management

The Contractor shall set up and maintain an Incident Management System (IMS) and supply regular incident statistics to BRO/ EMPLOYER. Incident Management entails a set of co-ordinated activities initiated by the Contractor when an incident (an extraordinary event resulting in the reduction of road capacity or creates a hazard for users) occurs, in order to minimise the effects of the incident and restore normal capacity and safety levels to all affected road facilities as efficiently as possible. The Contractor has to identify relevant agencies (e.g. rescue, fire, hazardous materials, traffic, police, ambulance, hospitals, alternative routes, cleanups) and their representatives and to liaise with these representatives on behalf of the employer. The incident management centre shall be continuously staffed on a 24 hours basis. The Contractor shall maintain records of the details of all incidents (e.g. collision, hazardous material, breakdown, etc). After occurrence of any major incident, resulting in multiple loss of life, significant periods of road closure or major route rehabilitation work, an incident debriefing report shall be produced and forwarded to BRO/ EMPLOYER within fifteen days of occurrence. Contractor will keep a record of the removal accidental/damaged vehicles by taking a dated photograph of the same and will submit the report on monthly basis to the Employer/Engineer Contractor will remove dead animals/birds from the carriageway and bury them at a suitable location as directed by the engineer/employer within two hours of the incident. If contractor fails to remove the dead animals/birds from the carriageway within two hours of the incident, he will be levied a penalty of Rs. 1,500/- per such incident.

8.1.7 Route Patrols

The O&M contractor is required to provide 24 hrs per day route patrols to assist the road users of the highway, to provide information, feed back and perform functions in relation to incident management. To achieve this, the Patrol vehicles should be fully equipped as well as the patrol persons should be adequately trained in traffic management, road safety and primary first aid. The purpose of these patrols is to:

- a) Provide the users of the highway with basic mechanical help for vehicles that breakdown on the road and also protect other users from such vehicles
- b) Immediately identify traffic hazards of whatever nature, such as unauthorized parking, public transport vehicles, obstructing traffic during passenger loading and unloading, debris, stray animals and the like. The operator shall take the necessary measures to remove such obstructions.
- c) Provide emergency management at accident scenes until such time as the appropriate authorities arrive.
- d) Assist with the removal of damaged or mechanically impaired vehicles from the highway.
- e) Provide road user information and to further the image of National Highway Section.
- f) Maintain daily records of assistance provided to road users.
- g) Observe, record and report suspect aspects of the highway, hazards and incidental damage caused by vehicles, floods, storms or other random events, such that the highway maintenance records and database are continuously improved.

8.1.8 Patrol Vehicles

Vehicles should be (white colour) having sufficient rear space for the required equipment storage, fitted with rotating light and hooter, and painted with a unique color pattern for quick recognition, with the BRO/ EMPLOYER name and emblem painted prominently on sides, back and front, together with the Control Centre and Help line numbers. Vehicle should be in good condition and be not older than two years. Each vehicle should also carry the following equipment.

- a. Fire extinguisher 1 no.
- b. Gas cutter with protective glass (2 nos)
- c. Liquid container 2 no., Water container with fresh water 1 no. ,Funnel.
- d. Rubber Gloves, Leather Gloves (1 pair each)
- e. Brooms one hard bristle, other soft-2 no.
- f. Gum boot 4 pr, Rain coat 4 pr., Blanket 1.
- g. Torch lights – 4 nos., Spare Batteries. ,Flashing light 1 no.
- h. Hydraulic jack, towing chain, Animal hook, rope.
- i. Tool set (with standard set of spanners, pliers hammer etc), shovels.
- j. Digital Camera, measuring tape.
- k. Paper pad, Forms, pen/pencils, folders.
- l. First aid kit, Rain Coat, water proof sheets, stretchers (two numbers)
- m. List of hospitals

Each vehicle should also carry the following Traffic Management Equipment, (used/ worn out items shall be replaced forthwith with new ones) :

Sign boards – "Accident ahead" – 3 Nos. "Lane merging" – 3 no. "Direction Arrows" – 3 no, "Speed Limit" (80/60/40)-3 no, "Keep left / right" – 2 no (all signs 1200 mm size and of retro reflective type (high intensity grade) Sign Stand set (one for triangular and other for circular sign) 6 sets. Flags, whistle, reflective hand signal. Traffic cones 500 mm size with solar bulb mounted on top – 20 Nos. Barricades 4 No.s reflective type (100 m), tape, stands, Flags of 600 mm by 600 mm made of good read cloth secured to a staff at 1M length, Paddles of at least 600 mm wide and provided with rigid handle with markings SLOW, STOP Reflective jackets – 12 No.. As a minimum, each patrol vehicle should carry sufficient communication

equipment to render its staff capable of direct communication with the incident Management Control Center established. Manpower:

The team which is to be deployed with each patrol vehicle, needs adequate training for their tasks, especially in first aid, vehicle maintenance and minor repairs. The contractor must employ sufficient manpower to work in shifts for each patrol vehicle. Typical staffing shall be:

- a) Route Patrol In-Charge
- b) Route patrol assistant
- c) Driver, with knowledge of vehicle repairs.

Typical duties of the Route Patrol In-Charge are:

- a) Patrol the corridor to ensure obstruction free flow as per shift standards
- b) to report to police and assist injured at accident scene and remove all obstructions from road when the vehicles are cleared
- c) To provide first aid to injured, contact control room and ambulance service if needed, assist police
- d) Report all incidents on radio control, to control room.
- e) To ensure safety of traffic with minimal delay at accidents.
- f) To assist motorists on broken down vehicles and to ensure that they do not obstruct free flow
- g) Maintain relations with all emergency services, and local safety councils
- h) To report carriageway condition, especially traffic guidance aids, signs, markings condition, condition of drainage, ROW plantations, medians plantation etc.
- i) Check on Encroachment irregularities taking place within ROW , and prevent unauthorized entry into the corridor.
- j) prevent theft of assets and report
- k) attend to urgent maintenance for safety requirements.

At all times, the Route Patrol In-Charge should have with him a list of telephone numbers and address of all concerned in providing the Road

Users Services:

On duty, all staff shall wear distinctive standard jackets having company LOGO, with night visibility. They are to deal with public and hence should be well trained to be courteous and helpful.

Ambulance:

The vehicle shall be Matador Van/ Swaraj Mazda/ Tempo Traveller or equivalent preferably white colour with the provision of two stretchers, fitted with rotating light for easy recognition, with BRO/ EMPLOYER name and emblem painted prominently on sides, back and front, together with control center help numbers, The ambulance is required to have the following medicines and equipments and also the paramedical staff:

A) General Ambulance:

Folding Doctor Seat with Belt with adequate height in relation to the stretcher, Antistatic, water proof ply board vinyl/flooring, Channel/Locking system for rolling stretcher, High intensity blinkers, light bar/siren/beacon, Electronic siren with Public Addressing System, Internal lighting with three spot light embedded in ceiling, AC/DC connection and outlet points, Wash basin with Stainless Steel Tank, SS Trash bin Cabinet integrated with interiors, Head racks and cupboard, Attendant seat with seat belt to double as second stretcher for stable patients, Provision for communication system where the location of ambulance can be located, Provision for fog light on sides, Cool/Warm boxes, Provision of Fire Extinguishers, Handheld Spotlight, Inverter with the facility re-charging from 220V AC and Vehicle's alternative. Oxygen delivery system comprising of Cylinder Trolley, pressure tubing with regulators, Roof mounted Air-conditioner with appropriate cooling capacity with

additional blower for Patient Cabin, Extrication equipment and Good Suspension to cater for smooth transportation.

B) Basic Life Support system

Automatic loading stretcher, Scoop stretcher, Folding stretcher, Spine board full, Vacuum splint kit/foldable splints, C-Collars, Oxygen Cylinder with accessories mounted/with manifold and pressure indicators, Oxygen Cylinder (aluminium portable), BP Instruments (Wall mounted-Aneroid), Stethoscope, Automatic defibrillator, Resuscitation bag (ambu bag, laryngoscope, airways and mask of different size including pediatric), Manual foot operated suction pump. I.V Fluid and I.V Sets, Tourniquet, First-Aid Box (Dressing material/Antiseptic lotion/Analgesic etc), Linen/Blanket, Laryngeal mask airway of all sizes.

The following paramedical staff are required with proper uniform and name of the person written on the uniform:

- a) Trained Paramedical staff 1
- b) Nursing staff with knowledge of first aid 1
- c) Driver for ambulance 1

8.1.9 Engineering Improvements

The contractor shall execute junction improvement and other improvements as proposed by Engineers' Representative. The Contractor shall also supply and erect crash barriers at required locations along the project road. Crash barriers are to be provided as per MOST specifications and as per details provided in BOQ. The drawings for same are to be got approved from Engineer's Representative.

8.1.10 Inspection

Full and complete inspection of the highway section shall be undertaken at appropriate intervals as mentioned in this section & section VIII (Implementation Manual & Maintenance Intervention Levels). The Contractor shall provide appropriate testing equipment for qualitative inspections, such as reflectivity meters, straight edges and the like.

8.1.11 Daily followed by weekly and monthly Inspections

Items to be inspected daily on regular basis followed by weekly and monthly inspections shall include:

- ❖ Potholes
- ❖ Cracking & Patches
- ❖ Rutting
- ❖ Defective bridge decks area and bump at approach
- ❖ User information - road marking and road signs
- ❖ Blocked drains
- ❖ Toll Management System (Manual) and Tollbooth
- ❖ Tow Away Trucks, Cranes etc.
- ❖ Frequency of Highway Patrol

8.1.12 Quarterly Inspections

Items to be inspected at quarterly intervals shall includes:

- ❖ bridges – structural elements for damage
- ❖ culverts – structural elements for damage
- ❖ blocked drains

- ❖ road marking
- ❖ road signs

8.1.13 Repairs

Repairs arising out of the inspections shall be carried out by the Contractor after a joint assessment with the Engineer and approval of BRO/ EMPLOYER.

8.2 PERFORMANCE STANDARDS

8.2.1 PERFORMANCE STANDARDS FOR MAINTENANCE:

The performance standards define the level at which the proposed facility is to be maintained and operated.

A) Road Maintenance: (As per MOST Specifications)

Sl. No	Serviceability indicator required	Maintenance level	Permissible Time limit for Defect Rectification	Frequency of Inspections by the Contractor to ensure Required level of Service
1.	Potholes/km (max . Numbers)	5 nos. in a stretch of 5 km.	Two days	Daily on regular basis followed by weekly & monthly inspections
2.	Cracking & patch (max. Permissible)	5.0 per cent of road surface in a stretch of 1 km.	Seven days	- do -
3.	Rutting (20mm), max. Permissible limit	1.0 per cent in a stretch of 1 km (measured with 3 m straight edge.)	Three days	- do -
4.	Defective bridge decks area and bump at approach (max. Permissible)	Nil	Fifteen days	- do -
5	User information	All road signs, km stones & road marking in good condition	Seven days	- do -

B) Route operations (As per MOST Specifications)

Sl. No	Serviceability indicator required	Maintenance level	Permissible Time limit for Defect Rectification	Frequency of Inspections by the Contractor to ensure Required level of Service
1.	Tow away trucks, cranes & ambulances etc.	To reach the incident spot within 30 minutes	Daily	on regular basis incident occurrence
2.	Frequency of highway patrol	Every 4 hours on entire stretch (logging system)	Daily	on regular basis
3.	Removal of dead	within 60 minutes of	Daily	on regular basis

	animals /birds To reach the incident spot	incident occurrence		
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8.2.2 Performance Standards for Drainage System

The inspection and maintenance shall follow the guidelines specified in IRC: SP35- 1990 or any modification to it by Indian Roads Congress. • Pre-monsoon inspection and repairs shall include: detailed condition inspection of all bridges, culverts and the longitudinal drainage system. This shall be followed by repairs as required. Clearance of waterways of cross-drainage (CD) works and bridge waterways (vegetation, silt) within the right-of-way and 100 m on either side of the right-of-way, clearing the longitudinal and surface drains, repairs to flooring and pitching and face walls which should be brought to intact condition and painting of bridge markings shall be carried out. • During the monsoon, any blocked vent-ways shall be cleared immediately. • After monsoon a detailed inspection shall be undertaken to identify any severe damage. One month after the cessation of rain, the structures shall be given one coat of white wash or colour wash as a protective measure.

8.2.3 Performance Standards for Operations

- For incident management system:
- Staffing – 24 hrs/day and 365 days/year
- Response time to a single incident – 1/2 an hour after receiving notification
- Multiple incidents – as soon as possible
- The facility shall be kept clear of all obstructions to traffic. Broken down vehicles, accident remnants, fallen trees, or any other obstructions should be cleared at once, after completing any legal formalities. The availability of Tow-trucks, cranes, and other equipment required for this purpose shall be ensured.
- Accident relief measures, including an ambulance, shall be available round the clock.
- The response time should be 30 minutes. Traffic regulation and management to minimise the disturbance due to accident to other traffic shall be taken by providing temporary traffic signs, cones, reflective tape etc.
- The intersections at either end or in-between shall be managed such that delays to through traffic are minimised.
- Regular patrolling shall be done to ensure smooth traffic movement on the facility. The frequency of the patrol shall be at least once in 4 hours for the entire length of facility.
- In respect of route operation like patrol vehicle, ambulance and towing of vehicle, any case of non compliance as per Cl 6.8 of 'Performance Standard', a penalty of Rs.5000/ for each non compliance incident will be levied.
- The log books for route Patrols and Ambulances shall be maintained as per "Logging System". i.e. exact time reached at particular incident and time at which the spot of incidence left out. Both vehicles should not waste time unnecessarily. From the entries of log book, if it is found that time is exhausted unnecessarily / arbitrarily, reduction in the rate of concerned BOQ item shall be made. Engineer's decision in this regard shall be final.
- Signed muster rolls of staff pertaining to route patrols and Ambulances shall be maintained. Any absenteeism of route patrol staff shall attract a penalty of Rs. 300 / day / incidence and Rs. 500 / day / incidence in case of Ambulance Staff. The decision of Engineer shall be final in this context.
- The route patrol vehicles and Ambulances shall be equipped (for 24 x 7 period and total duration of contract) with equipments / medicines as mentioned in Cl.no.6.4 of "Incident Management". Any shortage of equipments / medicines shall attract penalty. The penalty in the range of Rs. 500 to Rs. 2000 / incidence shall be imposed on the contractor. The decision of Engineer shall be binding on the contractor.
- The contractor shall submit following documents along with each monthly statement of work done.
- The photographs (hard copies) of each incidence of damaged towed vehicle with use of crane for entire month.
- The undertaking of route patrol Incharge and driver of each damaged towed vehicle stating that "no charges" i.e. the services of crane made freely available to damaged vehicle. The claim for BOQ item, "use

of crane" shall not be entitled in absence of above mentioned data. Reduction in rate on prorata basis shall be proposed in absence of above data.

- The contractor shall submit the following documents along with each monthly statements of work done.
 - i) The reports as per IRC 53 – 1973 and formats approved by Engineer of accidents occurred during the month.
 - ii) The Photographs in hard and soft copies of all accidents and in soft copies for all other incidents.
 - iii) The reports of incidents other than accidents shall be submitted in the format approved by Engineer.

The photographs (hard copies) supplied shall be paid under concerned BOQ item.

- The contractor shall submit the daily report of accidents / incidents occurred on each of next day. Failure of which shall attract penalty of Rs. 100 / incidence.
- Each route patrol vehicle shall be installed with precise Vehicle Tracking System (VTS) of reputed ISO 9001 company. The VTS shall be based on Global Positioning System (GPS) and GSM / GPRS technology. The system shall also include micro, live, real time tracking web based software by use of which GIS maps shall be accessed and transit / stoppage / idle / over speed reports of vehicles shall be generated.
- For operation of this system one computer of brand approved by the Engineer with one year AMC of standard configuration shall be installed at "O & M center, by the contractor.

8.2.4 Performance Standards for "Maintenance of existing and new plants / shrubs /

A) Removal of weeds / vegetation and unwanted debris

i) The contractor shall keep median without any weeds, unwanted vegetation, debris etc. for the entire period of contract. For this purpose he should deploy at least the following for each month of contract period.

a) One labour / day (8 hours) for every four Km. of median.

b) One tractor with trolley / day (8 hours) for every 35 km. stretch of median.

c) One supervisor for every 35 km. stretch of median.

This deployment shall be made available for whole month from June to Feb of a year. From March to May one labour / day (8 hours) for every 06 km. of median and one tractor with trolley / day (8 hours) for every 50 km. of median shall be deployed.

ii) The contractor shall maintain separate signed muster rolls of deployed labours & supervisors and log books of tractors. The muster rolls and log books shall be made available for inspection. Xerox copy of log books and muster rolls shall be submitted along with each monthly statement of work done by the contractor.

iii) The deployment mentioned as per (i) is minimum and shall not relieve contractor from his obligation to keep the median without weeds, unwanted vegetation and debris from the median. He shall increase inputs as per requirements of site conditions and Engineers instructions.

iv) If a contractor fails to keep median without weeds, unwanted vegetation, debris (as per provision of BOQ) penalty of Rs. 500/ Km. / incidence to Rs. 1500/ Km / incidence shall be imposed. Engineers decision in this context is binding on contractor.

B) Watering:-

i) For the specified period of the year excluding the monsoon months (2-3 months) [period shall be specified by Engineer depending on site condition] contractor shall prepare monthly plan for deployment of water tankers in consultation with Engineer and shall submit the same seven days prior to next month. It is obligatory on contractor to deploy the number of water tankers as per plan. If Engineer observes number of water tankers deployed (as per plan) are not sufficient as per site condition, he shall instruct to increase the water tankers. Engineers decision shall be final.

ii) If contractor fails to deploy the water tankers as per Engineer's instructions and as per monthly plan each incidence of non deployment, a penalty of Rs. 8000 /day / incidence shall be imposed.

iii) The methodology suggested vide (i) to (ii) shall not relieve contractor from his obligation of non-wilting of any hedge / shrub / flowering trees of median. If any existing hedge, shrub, flowering tree etc. got dead it should be replaced by contractor at his own cost. Engineers decisions in this context is final

- iv) Deployed water tanker shall be fitted with red electric blinking signal and red flag at top of LHS back end. The safety measures as per IRC 112 shall be taken while watering
- v) The contractor shall maintain log books of each deployed water tanker and submit the Xerox copies along with each monthly statement of work done.

C) Trimming of plantation and application of insecticides / pesticides

- i) Trimming of hedges and flowering trees shall be done as and when required and as ordered by Engineer.
- ii) Supplying and application of insecticides / pesticides shall be done as and when required and as ordered by Engineer.

iii) Each incidence of failure of trimming and application of insecticides / pesticides shall be penalized at the rate of Rs. 500 / Km. / incidence. Engineers decision shall be binding on the contractor.

D) The contractor shall submit the daily reports (on next day) of out put of various men and machinery deployment for median maintenance in the formats approved by Engineer. Failure of which shall impose penalty of Rs. 100 / incidence.

8.2.5 Performance standard for "carrying out cleaning, removing of dust / silt / thrash ----

from carriageway.

i) This BOQ item is on km basis. The total length of stretch under consideration is taken under this item. However width of carriageway to be kept clean as per BOQ provision is up to ROW, it includes.

a) Total width of carriageway (LHS + RHS) including median width.

b) Width of service roads (LHS + RHS) wherever service roads are in existence.

c) Width of all structures such as flyovers, major bridges, minor bridges, culverts, subways, etc.

ii) For cleaning of carriageway contractor shall deploy mechanical broomer with tractor for total period of contract. The deployment of mechanical broomer shall be for at least 20 days / month. Contractor shall maintain log book of this mechanical broomer and submit the Xerox of this along with each monthly statements of work done.

iii) In addition to mechanical broomer contractor shall deploy following men / machinery for each month and total duration of contract.

a) One unskilled labour / day (8 hours) for every three km. of stretch of road.

b) One superior for every 30 km of stretch of road.

c) One tractor with trolley / day (8hours) for every 30 km. of stretch of road.

iv) The contractor shall maintain separate signed muster rolls of deployed labours & supervisors and log books of tractors. The muster rolls and log books shall be made available for inspection. Xerox copy of log books and muster rolls shall be submitted along with each monthly statement of work done by the contractor.

v) Any absenteeism in deployment of labour and tractor as mentioned in (iii) shall attract penalty of Rs. 150 / day and Rs. 1500 / day respectively. Engineers decision shall be binding on contractor.

vi) The deployment maintained as per (ii) & (iii) is minimum and shall not relieve contractor from his obligation to keep the carriageway clean as per BOQ provisions. It is obligatory on contractor to increase inputs as per requirements of site conditions and Engineers instructions.

vii) If contractor fails to keep the cleanliness of carriageway any one or other item as per BOQ provisions, a penalty of Rs. 1500 to 2500 / km / month shall be imposed. Engineers decision shall be binding on contractor.

viii) The contractor shall submit daily reports (on next day) of out- puts of men & machinery deployment in the formats approved by Engineer. Failure of which shall attract a penalty of Rs. 100 / incidence.

8.2.6 Performance standard for "Removal of rank vegetation / weeds / etc.

Indent for this work shall be issued once in year by the Engineer. After execution of this indented quantity, it is the sole responsibility of contractor to keep that particular area without any vegetation / weeds / grass

for the remaining period of contract (one year). For this purpose he shall make use of men / machinery deployment as in case of performance standard Cl. no. 6.10.

8.3 ADDITIONAL MAINTENANCE STANDARDS

- Maintenance standard for cleaning, clearing and repairing roadside lined drains
- Maintenance standard for routine maintenance of road signs and delineators
- Maintenance standard for replacing road signs, delineators mounted on single post/multiple posts
- Maintenance standard for treatment of bleeding bituminous surface
- Maintenance standard for treatment of closely spaced cracks at scattered locations by slurry sealing
- Maintenance standard for treatment of rutted bituminous surface
- Maintenance standard for treatment for hungry /stripped bituminous surface
- Maintenance standard for treatment & repair of potholes

8.4 SNOW REMOVAL

Snow removal and ice control usually requires the timely application of either chemicals, abrasives or a chemical-abrasive mixture to roadway surfaces in combination with aggressive snow plowing operations. Choice of material is dependent upon the weather and road conditions. Occasionally conditions such as low temperatures do not require material application. Materials available include the following:

8.4.1 Surface treatments

The surface is treated primarily by snow removal. Roads are also treated by spreading various materials on the surface. These materials generally fall into two categories: chemical and inert. Chemical (including salt) distribution induces freezing-point depression, causing ice and snow to melt at a lower temperature. Chemical treatment can be applied as a preventive measure and/or after snowfall. Inert materials (i.e. sand, brash, slag) make the surface irregular to improve traction. Both types can be applied together, but the inert materials tend to lower traction once the snow and ice has melted.

Chemical treatment materials include:

1. Sodium chloride (common table salt, NaCl)
2. Calcium chloride (CaCl_2)
3. Potassium chloride (KCl)
4. Magnesium chloride (MgCl_2)
5. Ammonium nitrate (NH_4NO_3)
6. Ammonium sulfate [$(\text{NH}_4)_2\text{SO}_4$]
7. Potassium acetate (CH_3COOK)
8. Urea [$(\text{NH}_2)_2\text{CO}$]
9. Propylene glycol ($\text{C}_3\text{H}_8\text{O}_2$)
10. Calcium magnesium acetate ($\text{C}_4\text{H}_6\text{O}_2\text{Ca}$ and $\text{C}_4\text{H}_6\text{O}_2\text{Mg}$)
11. Sodium ferrocyanide (hydrous, $\text{Na}_4\text{Fe}(\text{CN})_6 \cdot 10\text{H}_2\text{O}$)
12. Methyl alpha-D-glucopyranoside ($\text{C}_7\text{H}_{14}\text{O}_6$)

8.4.2 Rates of Application

Generally straight sodium chloride is the chemical of choice for most storm situations. Sodium chloride is used to prevent snow pack and ice build-up on the pavement and to aid removal of any build-up that occurs. The following instructional guidelines are recommended to adequately maintain highways under most conditions:

RECOMMENDED SNOW AND ICE TREATMENTS PER LANE MILE			
CONDITIONS	TEMPERATURE	TYPE 1A & 1B	TYPE
Sleet & Freezing Rain	Variable	Salt 300 lbs. per lane mile and/or abrasive as needed.	Salt 300 lbs. per lane mile and/or abrasive as needed.
Snow	20° and up	Salt 250 lbs. per lane mile. (1)	Salt 250 lbs. per lane mile. (2)
Snow	Below 20°	Salt 250 lbs. per lane mile. (2&3)	Abrasive-Chemical Mix

- ❖ For exceptionally high volume roads where traffic will enhance the action of the salt, this rate may be decreased to 200 lbs. per lane mile.
- ❖ Abrasive chemical mix may be needed at extremely low temperatures or on very lightly traveled highways.

An alternative low temperature treatment is to use a chemical mix of

2 parts salt to 1 part calcium chloride at 200 lbs. per lane mile.

Chemicals or mixes are normally applied to the middle 1/3 of pavement width and on the high side of banked curves. Spread width may be increased or decreased depending on the action of traffic. Materials are applied early in the storm so that a brine develops on the pavement and prevents build-up of packed snow. It takes much less deicing chemical to remove compacted snow when the treatment is placed between the pavement/snow layer than if it is placed on top of the snow. If snow continues and accumulates on the pavement, plowing should continue and additional chemical or mix treatments should be made if compaction develops.





13HP Power Snow Blower (C-ST013, C-ST013N)

Unit Price: US \$ 200-650 / Piece
 Min. Order: 1 Pieces
 Trade Terms: FOB Ningbo



Professional Electric Start 7HP Snow Blower (C-ST007)

Unit Price: US \$ 400.0-500.0 / Piece
 Min. Order: 1 Pieces
 Trade Terms: FOB

It is estimated that GOI spends Rs100 Crores per year on snow removal of Regan - Sonamarg – Zojila – Kargil- Leh Marg through BRO. The employees who do this work are generally the same workers who do road maintenance work during the summer months,

9 ECONOMIC ANALYSIS

9.1 INTRODUCTION

The Border Roads Organisation (BRO) is engaged in the development of border roads and as part of this Endeavour, the Authority has decided to undertake development and operation/maintenance of the Z-Morh tunnel and Zojila tunnel including road approaches on National Highway No. 1 (Srinagar –Sonmarg- Gumri- Kargil - Leh Road) in the State of J&K on Design, Build, Finance, Operate and Transfer (DBFOT) Annuity Basis Project through Public Private Partnership, and has decided to carried out the bidding process for selection of a private entity as the Bidder. Accordingly M/s SOMA Ltd has been selected for construction of Z-Morh tunnel.

The economic analysis is carried out within the broad framework of social cost-benefit analysis. The appraisal compares the total transport costs in situations of "with" the project and "without" the project alternatively called the "base case" or the "do minimum case" for the project highway.

The underlying objective of economic analysis is to maximize the returns on the investment. The concept behind the economic appraisal of the project is that if it is implemented, the resulting in minimize the total transport cost and maximize the benefits of road users with compare to the 'base (Do-Nothing)' situation.

The total transport costs comprise two basic components (**Table 9.1**), viz. road supplier costs and road user costs.

Table 9.1: Total Transport Costs

Road Supplier Costs	Road User Costs
Construction Costs	Vehicle Operating Costs (VOC) for MT & NMT
Maintenance Costs	Travel Time Costs
Replacement Costs: Costs of Environmental Impact Mitigation Measures, Costs of Rehabilitation and Resettlement (R&R) measures	

9.1.1 Methodology

All costs considered in the analysis are valued in money terms at the market prices. For economic analysis, these are expressed as economic costs for avoiding distortions in the prices of inputs such as labour, materials, equipment, and machinery i.e. market prices net of transfer payments such as taxes and subsidies arising due to market imperfections. The transport costs are estimated for the 'Do nothing' and 'With Project' scenarios. The reduction in these costs under 'With Project' scenario, alternatively called the savings, are treated as economic benefits corresponding to the incremental investment estimated over the life of project.

The economic appraisal is carried out by using the 'Highway Development and Management (HDM 4) Model'. The model is used to generate cash flow streams of VOCs, travel time and Accident costs to compute the net economic benefits, as inputs for the estimation of the IRRs and NPVs for project evaluation.

9.1.2 General Data

- Project Option : 2-lane Z-Morh tunnel and Zojila tunnel including road approaches on National Highway No. 1 (Srinagar – Sonamarg- Gumri- Kargil - Leh Road) in the State of J&K.
- Pavement Option : Flexible Pavement has been considered for proposed 2-lane with Paved Shoulder road approaches & Rigid Pavement for 2-lane Main, Adit and Escape tunnels.
- Construction Period : Construction period for the project section has been assumed as 36 months.
- Investment Schedule : For construction period, the distribution of cost for each year is given as below:
 1st Year – 20 %
 2nd Year – 35 %
 3rd Year – 45%
- Analysis Period : 30 years (2013 - 2042)
- Discount rate : 12%
- Salvage Value : 15%

9.1.3 Project Cost

The Project has been divided into two packages as under:

Package-I : Z-Morh Tunnel : Km.69 to Km.84 (Rezan to Sonamarg) including 6.5km Tunnel

Package II : Zojila Tunnel : Km.84 to Km.110 (Sonamarg to Zojila-Drass) including 13km Tunnel

Estimated cost for project option is as given in **Table 9.2**.

Table 9.2 Estimated cost for the Project for Year 2012

Package No	Total Project Cost (Rs. in Crores)	Per Km Cost (Rs. in Crores)
Package I (Rezan to Sonamarg)	840	56
Package II (Sonamarg to Zojila - Drass)	1510	58

The foreign exchange component in the total capital cost is insignificant and has been considered to be zero, as all material, machinery and labour are available within the country. Standard Conversion factor of 0.90 has been used for converting market prices of road construction and maintenance inputs into economic costs.

9.1.4 Routine Maintenance and Periodic Maintenance Cost

The details of the maintenance costs and administration charges for the **year 2012** are given below in **Table 9.3**.

Table 9.3 Routine and Periodic Maintenance

Sl. No	Description	Amount (Millions/km)
1	Routine maintenance in every year (cost per km for the two lanes.)	0.40
2	Routine maintenance in every year (cost per km for the two lanes with paved	0.65

Sl. No	Description	Amount (Millions/km)
	shoulder).	
3	Routine maintenance in every year (cost per km for the 2 lane tunnel).	10.00
4	Periodic maintenance in every 5th year (cost per km for the Two lanes only).	5.50
5	Periodic maintenance in every 5th year (cost per km for the two lanes with paved shoulder).	8.50
6	Periodic maintenance in every 5th year (cost per km for the 2 lane tunnel).	50.00

9.1.5 Homogeneous Sections based on Traffic Survey Data

Based on the data of the traffic surveys conducted by the consultants during **July 2011**, the project road has been divided into five homogeneous sections. The Average Annual Daily Traffic (AADT) on these homogeneous sections is shown in **Table 9.4**.

Table 9.4: Homogeneous Traffic Sections

S. No	Section	Length (km)	AADT (March 2011) in Vehicles	
			MT	NMT
1	Rezan - Sonamarg : Km 69 to Km 84	15		
2	Sonamarg – Zojila : Km 84 to Km 92	8		
3	Zojila – Drass : Km 92 to km 110	18		

9.1.6 Traffic Volume Composition and Growth Rates

The percentage distribution of individual vehicles for each section is given in Table 9.5.

Table 9.5: Percentage of Individual vehicles

Type of Vehicles	Percentage Distribution of Individual Vehicles		
	Section 1	Section 2	Section 3
	Fast Moving Vehicles		
Car/Jeep/Van			
Three Wheeler			
Two Wheeler			
Mini Bus			
Bus			
LGV (3 Wheeler)			
LGV (4 Wheeler)			
2 Axle			
3 Axle			
MAV			
Tractor			
Tractor with Trailer			

Type of Vehicles	Percentage Distribution of Individual Vehicles		
	Section 1	Section 2	Section 3
	Fast Moving Vehicles		
Cycle			
Cycle Rickshaw			
Hand Cart			
Animal Cart			

The Growth rate has been considered from Traffic studies chapter and details are furnished in **Table 9.6.**

Table 9.6: Traffic Growth Rate in (%)

Type of Vehicle	2011 - 15	2016-20	2021-25	2026-30	2031-47
Car/Jeep/Van	7.5	6.2	5.2	4.5	3.2
Three Wheeler	6.2	5.2	4.7	3.2	2.7
Two Wheeler	6.2	5.2	4.7	3.2	2.7
Mini Bus	4.7	4.7	4.2	3.4	2.7
Bus	4.7	4.7	4.2	3.4	2.7
LGV (3 Wheeler)	5.1	5.1	4.6	3.1	2.6
LGV (4 Wheeler)	5.1	5.1	4.6	3.1	2.6
2 Axle	5.1	5.1	4.6	3.1	2.6
3 Axle	5.1	5.1	4.6	3.1	2.6
MAV	5.1	5.1	4.6	3.1	2.6
Tractor	2.0	2.0	2.0	2.0	2.0
Tractor with Trailer	2.0	2.0	2.0	2.0	2.0

9.1.7 Basic Road Condition Parameter

Other parameters like lane configuration, geometry, pavement condition data, roughness, deflection, road side friction, capacity and accident rate for existing and proposed highway was given in the **Table 9.7.**

Table 9.7 Details of Existing Pavement Conditions

S. No	Description	Existing NH-1	Proposed Tunnel & Approach Roads
1	Length (Km)	69 to 110 = 41 km	69 to 110 = 35 km
2	Carriageway width (m)	7.0	7.0
3	Soft Shoulder (m)	1.0	1.0
4	Rise and Fall (m/km)	150.0	45.0
5	Avg. Horizontal Curvature (deg/km)	70	10
6	Speed Limit (Km/h)	20	80

S. No	Description	Existing NH-1	Proposed Tunnel & Approach Roads
7	Altitude (m)	1000	300
8	Avg. Bituminous Layer (mm)	50 - 150	140
9	Avg. Total crust Thickness (mm)	300 - 500	590
10	Avg. IRI (m/km)	3.0	1.5
11	Avg. area of all Cracks (%)	2.0	0
12	Avg. potholes (No./km)	1	0
13	Avg. Ravelled area (%)	1	0
14	Avg. Rut depth mm	3	0
15	Deflection (mm)	1.0	0.4
16	Road Side Friction	1.0	1.0
17	Ultimate Capacity (per lane per hour)	1400	1600

9.1.8 Economic Cost of Vehicle Parameters

The economic cost of vehicle parameters like new vehicle cost, new tyre cost, fuel cost, lubricating oil cost, time value cost and cargo cost taken from Manual on Economic Evaluation of Highway Projects in India, SP: 30-2009 (second revision). The summary of these values are furnished in **Table 9.8**.

Table 9.8 Summary of Economic Cost of Vehicle Data

S. No	Vehicle Type	New Vehicle Cost (Rs)	New Tyre Cost (Rs)	Fuel Cost (Rs/Lit)		Engine Oil (Rs/Lit)	Time Value (Rs/Hr)	Cargo Holding Cost (Rs/Hr)
				Petrol	Diesel			
1	Car/ Jeep/ Van	4,99,950	2,500	25.00	-	100.00	60	-
2	Mini bus	5,08,250	3,020	-	20.00	100.00	40	-
3	Bus	7,21,050	6,525	-	20.00	100.00	40	-
4	3 Wheeler	80,000	400	-	20.00	100.00	50	-
5	2 Wheeler	35,380	650	25.00	-	100.00	30	-
6	LCV	4,26,900	3,020	-	20.00	100.00	-	5.00
7	2 Axle & 3 Axle	7,46,800	6,120	-	20.00	100.00	-	15.00
8	MAV	8,42,325	6,120	-	20.00	100.00	-	25.00

9.1.9 Economic Analysis – Results

Table 9.9 Result of Economic Evaluation (with Time Saving)

Package No	IRR (%)	NPV (Rs. Million)
Package I (Rezan to Sonamarg)	14.4	5,137.18
Package II (Sonamarg to Zojila - Drass)	11.2	-916.33

9.1.10 Sensitivity Analysis

Sensitivity Analysis has been carried out to examine the effect on economic viability of the project due to change in the level of the key input factors, including construction cost, variation in traffic etc. The sensitivity of the IRR and NPV has been studied under the following change in conditions.

Condition I : 15% increase in project cost, benefits remain unchanged.

Condition II : 15% decrease in benefits, project cost remains unchanged.

Condition III : 15% increase in project cost & 15% decrease in benefits.

The results of sensitivity analysis are given in **Table 9.10**.

**Table 9.10: Sensitivity Analysis Results (with Time Saving)
Package I (Rezan to Sonamarg)**

Condition	IRR (%)	NPV (Rs. Million)
I.	13.4	3,205.75
II.	13.2	2,446.44
III.	12.3	515.01

Package II (Sonamarg to Zojila - Drass)

Condition	IRR (%)	NPV (Rs. Million)
I.	10.2	-2,299.77
II.	10.0	-2,157.26
III.	9.0	-3,540.71

The output from HDM 4 indicating the savings in VOC, Travel Time, NPV and IRR is given in **Annexure 9.1** and **9.2**.

10 FINANCIAL ANALYSIS - REQUIRED OR NOT – PLEASE ONFORM

10.1 INTRODUCTION

The Border Roads Organisation (BRO) is engaged in the development of border roads and as part of this Endeavour, the Authority has decided to undertake development and operation/ maintenance of the Z-Morh tunnel and Zojila tunnel including road approaches on National Highway No. 1 (Srinagar –Sonmarg- Gumri- Kargil - Leh Road) in the State of J&K on Design, Build, Finance, Operate and Transfer (DBFOT) Annuity Basis Project through Public Private Partnership, and has decided to carried out the bidding process for selection of a private entity as the Bidder. Accordingly M/s SOMA Ltd has been selected for construction of Z-Morh tunnel.

The project area of the approximately 6.5 km long Z-Morh Tunnel and 13.0km long Zojila Tunnel the road approaches to the portals is located north-east of the city of Srinagar along the National Highway 1 (Srinagar – Sonamarg – Zojila – Drass – Kargil - Leh section) in the State of Jammu and Kashmir. The Z- Morh tunnel and road approaches shall be constructed between the villages Rezan (Km 69) and Shetkari (Km 82), approximately 2 km west of the village Sonamarg. The Zojila tunnel and road approaches shall be constructed between the villages Zojila (Km 92) and Drass (Km 105).

There are stretches where the intensity of traffic has increased significantly and there is requirement for augmentation of capacity for safe and efficient movement of traffic and the up gradation is required to cater to the current level of traffic.

For the smooth implementation of the Civil Works Contract, the project road has been divided into two packages as under:

Package-I : Z-Morh Tunnel : Km.69 to Km.84 (Rezan - Sonamarg) including 6.5km Tunnel

Package-II: Zojila Tunnel: Km.84 to Km.110 (Sonamarg-Zojila-Drass) including 13km Tunnel

Financial Analysis for Package I : Km.69 to Km.84 (Rezan - Sonamarg)

The basic objective of the Financial Analysis is to determine whether the build, operate, transfer (BOT) model is workable for the above stretch, and if so, under what conditions.

The Financial Analysis has been carried out under the following three scenarios in Pk-I Option, considering concession period for 25 years;

- Without GOI Equity Support
- With GOI Equity Support (40% during construction and Nil during O&M)
- VGF

Project Capital Cost

The civil construction cost has been estimated as:

- Civil Cost of Construction: **Rs. 85 Cr.**
- Length: 8.5 Km
- Tollable Structure:
 - Z-Morh Tunnel

- Civil Cost of Construction: Rs.775 Cr.
- Length: 6.5 Km.

Assumptions

The financial analysis is prepared on the following assumptions:

- **Construction Schedule & Total Project Cost**
 - Construction Starts : **Oct 2013**
 - Construction period: **36 months**
 - Construction allocation: 10%, 30%, 40% & 20% in respective years
 - Opening of Traffic: **Oct 2016**

To be modify from here onwards---- after analysis and Program Run

		(Rs/Cr)		
Description	Total	Total	Total	
GOI Support	Nil	40%	VGf	
Civil cost of construction (2012)	860	860	860	
Escalation	54.40	54.40	54.40	
Civil Construction Cost (2013)	1142.44	1142.44	1142.44	
Cost of Investigation, Detailed Design and Testing on Completion	22.85	22.85	22.85	
Escalated	99.99	99.99	99.99	
Contingencies/QC on Civil Cost	34.27	34.27	34.27	
Cost of Independent Engineer	11.65	11.65	11.65	
IDC	180.72	96.87	124.46	
Financing charges	21.18	11.36	14.59	
Total Project Cost	1513.11	1419.44	1450.26	
GOI Equity Support	0.00	567.78	408.18	
Concessionaire Equity	453.93	283.89	312.62	
Debt	1059.18	567.78	729.45	

- **Toll Plaza Location**

Toll Plaza Location and Tollable Stretch

Toll plaza No	Location Km.	Distance Km.	Lane
TP1 : Before start of Tunnel	72+000	15	2

Toll able Structure (TPC)

SI. No.	GOI Support (during construction)	0.00%	40.00%	28.15%
1	Road Approaches	194.39	182.35	186.31
2	Z- Morh Tunnel	113.70	106.66	108.98

• **Tollable Traffic**

Tollable Traffic is taken as follows (Base Year 2011):

Toll- Plaza 1: Tollable Traffic

Vehicle Type	Car Jeeps/Vans	LCV/LGV	Mini Bus	Truck	Bus	MAV
Single pass	1377	293	64	424	343	1040
Daily Pass	602	269	41	135	46	28
Mtly. Pass	310	88	22	46	14	13
Local	172	0	0	0	0	0
Total	2461	650	127	605	403	1081

O&M Cost and Other Assumptions (prices escalated @5% p.a.)

Routine maintenance in every year (cost per km for the Four lanes- 2010). (Cr./Km)	0.051
Periodic maintenance in every 5th year (cost per km for the Four Lane- 2010). (Cr./Km)	1.276
Elec.& Patrolling Exp. (4Lane,Cr./Km/p.a-2005)	0.015
Toll Collection Exp (4 Lane, Cr./p.a/per toll plaza-2005)	1.25
Office Exp. (Cr./p.a.-2005)	2
Insurance Exp. (of TPC-2005)	0.15%
Estimated Escalation in Cost (%) Per Annum	5%
Tax Rate (As Applicable)	
Tax Holiday (80 I A)	10
(In 20 years block period of Concession Period)	
Depreciation Rate SLM (During the life)	
Depreciation Rate WDV	10%
Loan Repayment (during operation) Years	10
Moratorium (after construction) (year)	1
Interest Rate	11.00%
Toll Plaza	2
Growth Rate Traffic	5%
Growth Rate Revenue	5%
Traffic Leakage	3%

10.2.2.3 Results

(A) Without GOI Support

2007	94	146	297	452

(B) With GOI Support (40% during Construction)

Toll Plaza-1: Toll Rate (Rs.)				
Year	Car/Jeep/Van /LMV	Mini Bus & LCV/LGV	Trucks & Bus	MAV
2007	93	143	290	441

(C) With GOI Support VGF

Toll Plaza-1: Toll Rate (Rs.)				
Year	Car/Jeep/Van /LMV	Mini Bus & LCV/LGV	Trucks & Bus	MAV
2007	94	144	293	445

The summary of the financial results are given below:

Particulars	Out come		
GOI support (during construction)	Nil	40%	28.15%
NPV (Rs./Cr.)	-248.60	198.13	75.89
Project IRR	9.70%	14.77%	12.92%
Equity IRR	10.05%	17.80%	15.00%

Out Come

• Without GOI Support

The project without GOI support shows NPV Rs. (248.60) Cr. Project IRR 9.70% and Equity IRR 10.05%. The Project is **not viable**. The Project has to fulfill the prevailing criteria of Project IRR 12% and Equity IRR 15%

• With 40% GOI Support (during construction)

The project with GOI support (40% during construction) shows NPV Rs. 198.13 Cr., Project IRR 14.77% and Equity IRR 17.80%. The Project becomes **viable**.

• VGF

The project with GOI support of **28.15 %** during construction shows NPV Rs. 75.89 Cr., Project IRR 12.92% and Equity IRR 15.00%. The Project becomes **viable**.

It has been seen from the above analysis that considering 25 years of concession period, the project is **not viable** without GOI Support. However, with GOI support of **28.15%** during construction, it becomes **viable**.

The details of the above financial analysis are enclosed as **Annexure 10.3, 10.4,**

10.5 and 10.6

10.2.2 Financial Analysis of Package II –Km.246.300 to Km.401.680 (Kotkapura to Sri Ganga Nagar)

10.2.2.1 Project Capital Cost

The civil construction cost has been estimated as:

- Civil Cost of Construction: Rs. 659.99.
- Length: 148.533 Km
- Tollable Structure: Tunnel
 - Civil Cost of Construction: Rs.70.13 Cr.
 - Length: 20.933 Km.

10.2.2.2 Assumptions

The financial analysis is prepared on the following assumptions:

- **Construction Schedule & Total Project Cost**
 - Construction Starts : Oct 2011
 - Construction period: 36 months
 - Construction allocation: 10%, 30%, 40% & 20% in respective years
 - Opening of Traffic: Oct 2014

	(Rs/Cr)
Description	Total
Civil cost of construction (2010)	659.99
Escalation	33.00
Civil Construction Cost (2011)	692.99
Cost of Investigation, Detailed Design and Testing on Completion	13.86
Escalated	60.65
Contingencies/QC on Civil Cost	20.79
Cost of Independent Engineer	7.07
IDC	58.76
Financing charges	6.89
Total Project Cost	861.01
GOI Equity Support	344.40
Concessionaire Equity	172.20
Debt	344.40

• Toll Plaza Location

Toll Plaza Location and Tollable Stretch

Toll plaza No	Location Km.	Distance Km.
TP3	270+000	85.533

• Tollable Traffic

Tollable Traffic is taken as follows (Base Year 2010):

Toll- Plaza 3: Tollable Traffic

Vehicle Type	Car Jeeps/Vans	LCV/LGV	Mini Bus	Truck	Bus	MAV
Single pass	1128	211	15	183	125	318
Daily Pass	493	176	14	64	22	9
Mtly. Pass	254	84	5	33	5	11
Local	141	0	0	0	0	0
Total	2016	471	34	280	152	338

O&M Cost and Other Assumptions (prices escalated @5% p.a.)

Routine maintenance in every year (cost per km for the two lanes. -2010) (Cr./Km)	0.032
Routine maintenance in every year (cost per km for the four lanes- 2010). (Cr./Km)	0.051
Periodic maintenance in every 5th year (cost per km for the Two lanes-2010). (Cr./Km)	0.766
Periodic maintenance in every 5th year (cost per km for the Four Lane-2010). (Cr./Km)	1.276
Elec.& Patrolling Exp. (2 Lane, Cr./Km/p.a-2005)	0.01
Elec.& Patrolling Exp. (4Lane,Cr./Km/p.a-2005)	0.015
Toll Collection Exp (2 Lane, Cr./p.a/per toll plaza-2005)	0.75
Toll Collection Exp (4 Lane, Cr./p.a/per toll plaza-2005)	1.25
Office Exp. (Cr./p.a.-2005)	2
Insurance Exp. (of TPC-2005)	0.15%
Estimated Escalation in Cost (%) Per Annum	5%
Tax Rate (As Applicable)	
Tax Holiday (80 I A)	10
(In 20 years block period of Concession Period)	
Depreciation Rate SLM (During the life)	
Depreciation Rate WDV	10%
Loan Repayment (during operation) Years	10
Moratorium (after construction) (year)	1
Interest Rate	11.00%
Toll Plaza	5
Growth Rate Traffic	5%
Growth Rate Revenue	5%
Traffic Leakage	3%

10.2.2.3 Results

Toll Rate (Rs.)

Toll Rates (Rs.): Base Year 2007				
Toll Plaza	Car/Jeep/Van/LMV	Mini Bus & LCV/LGV	Trucks & Bus	MAV
3	40	63	130	201

4	9	14	29	46
5	22	37	77	119

The summary of the financial results are given below:

Particulars

GOI support (during construction)	40%
NPV (Rs./Cr.)	-373.93
Project IRR	Negative
Equity IRR	Negative

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 ECONOMIC ANALYSIS CONCLUSIONS

From the above results of the economic analysis including sensitivity analysis, it can be seen that for all the scenarios, the EIRR is getting higher than the accepted value of 12% for **Package I** and is slightly below the acceptable value of 12 % in case of **Package II**. **And therefore it can be concluded that the project shall ensure favourable economic rate of return.**

11.2 FINANCIAL ANALYSIS CONCLUSIONS

The project with GOI support (40% during construction) shows NPV Rs. (373.93) Cr. Project IRR Negative and Equity IRR Negative.

It has been seen from the above analysis that considering 25 years of concession period the project is not viable even with GOI support (40% during construction).

11.3 RECOMMENDATIONS

The project with GOI support (40% during construction) shows NPV Rs. (373.93) Cr. Project IRR Negative and Equity IRR Negative.

It has been seen from the above analysis that considering 25 years of concession period the project is not viable even with GOI support (40% during construction).

Table 11.1 : Classified Volume Count Survey Data July 2011 as per Technical Schedules

Station – 1 (Gangangir Z Morh at Km. 73.00 on Srinagar – Leh Road)

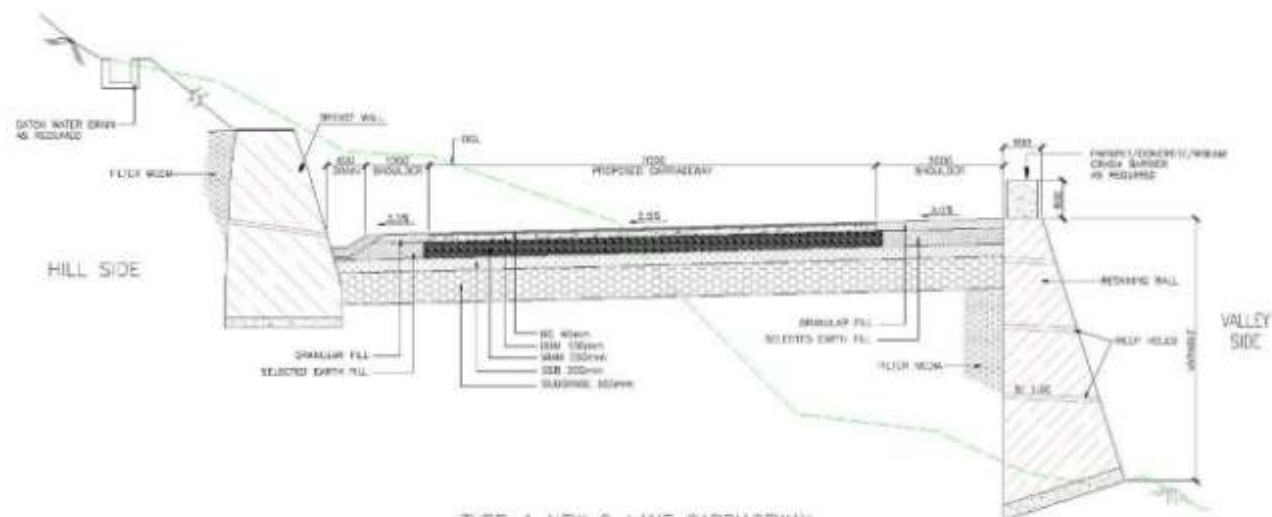
Traffic Details	Two Wheeler		Auto Rickshaw		Car/Jeep/ Van		Bus				LCV		Truck						Tractor		Cycle		Animal/ Hand Drawn		Army Jeep		Army Truck/ bus		Hourly Total	PCU's
							Mini/ RTVs	Stand.	2-Axle	3-Axle			MAV																	
	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN		
7 days	293	377	69	65	5297	5416	440	534	258	319	683	677	2493	2309	13	10	0	0	1	1	43	31	2	0	144	138	769	795	21177	35915
ADT	42	54	10	9	757	774	63	76	37	46	98	97	356	330	2	1	0	0	0	0	6	4	0	0	21	20	110	114	3025	5131
Total Up & Down		96		19		1531		139		83		195		686		3		0		0		10		0		41		224	3027	

Station – 2 (Ranga at Km. 82.00 on Srinagar – Leh Road)

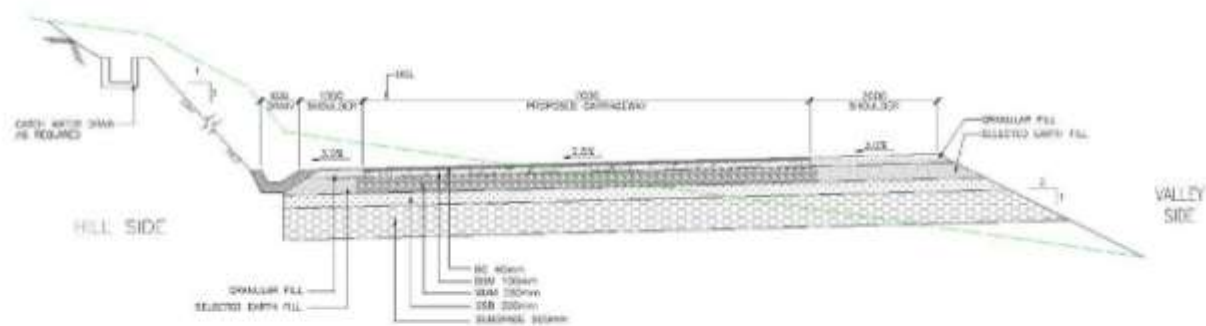
Traffic Details	Two Wheeler		Auto Rickshaw		Car/Jeep/ Van		Bus				LCV		Truck						Tractor		Cycle		Animal/ Hand Drawn		Army Jeep		Army Truck/ bus		Hourly Total	PCU's
							Mini/ RTVs		Stand.				2-Axle		3-Axle		MAV													
	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN		
7 days	116	190	69	64	3944	4174	366	415	237	270	711	753	2715	2337	196	20	0	1	1	1	2	3	0	0	183	127	594	682	18171	33245
ADT	17	27	10	9	563	596	52	59	34	39	102	108	388	334	28	3	0	0	0	0	0	0	0	0	26	18	85	97	2596	4749
Total Up & Down		37		19		1159		111		73		210		692		31		0		0		0			44		182	2596		

Station – 3 (Ranga Morh Zojila at Km. 97.00 on Srinagar – Leh Road)

Traffic Details	Two Wheeler		Auto Rickshaw		Car/Jeep/ Van		Bus				LCV		Truck						Tractor		Cycle		Animal/ Hand Drawn		Army Jeep		Army Truck/ bus		Hourly Total	PCU's
							Mini/ RTVs		Stand.				2-Axle		3-Axle		MAV													
	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN		
7 days	34	104	2	7	1111	958	66	50	45	51	158	140	2563	2314	3	4	2	0	0	0	2	3	0	0	38	42	367	423	8487	20169
ADT	5	15	0	1	159	137	9	7	6	7	23	20	366	331	0	1	0	0	0	0	0	0	0	0	5	6	52	60	1212	2881
Total Up & Down		20		1		296		16		13		43		697		1		0		0		0		0		11		112	1210	

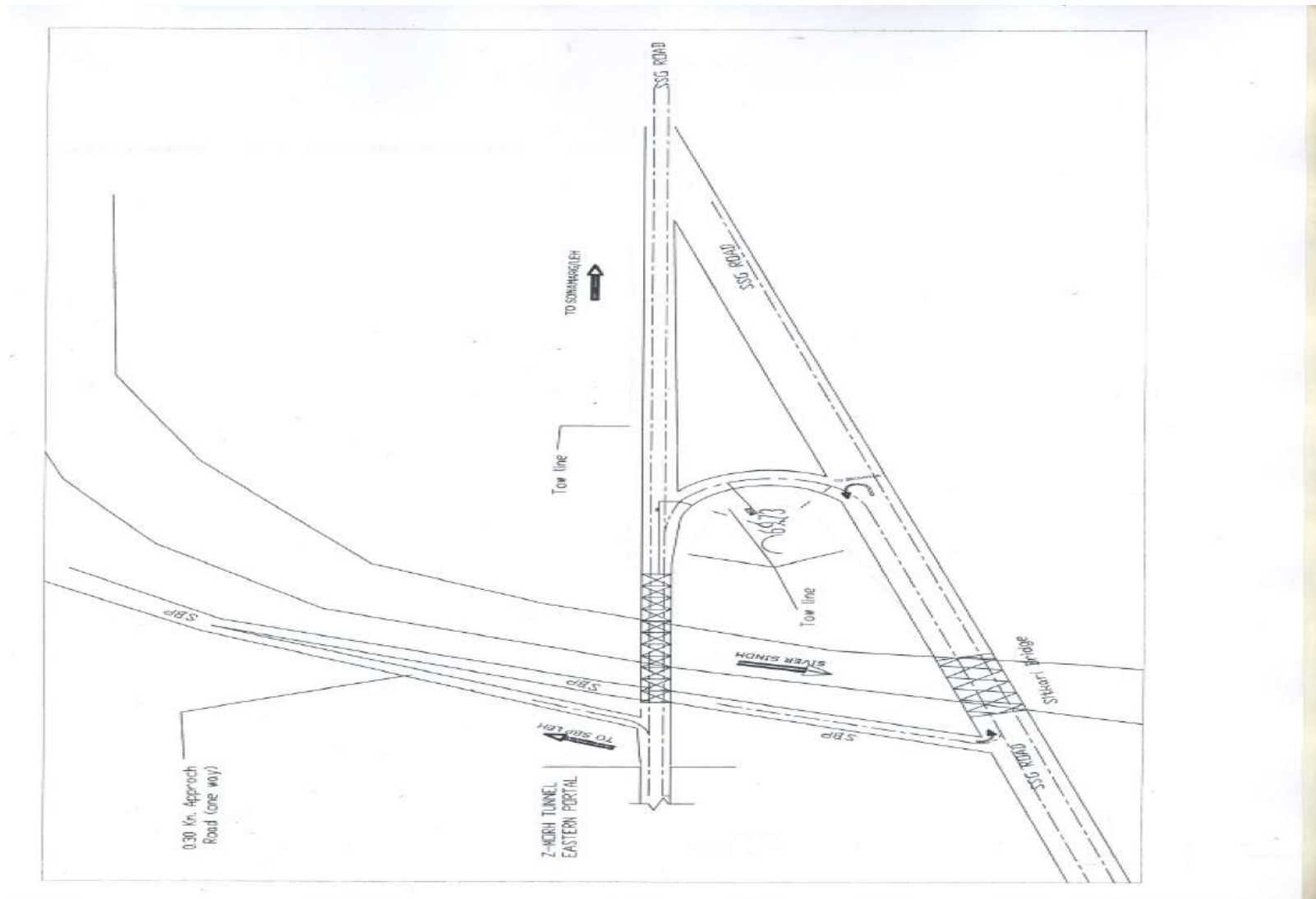


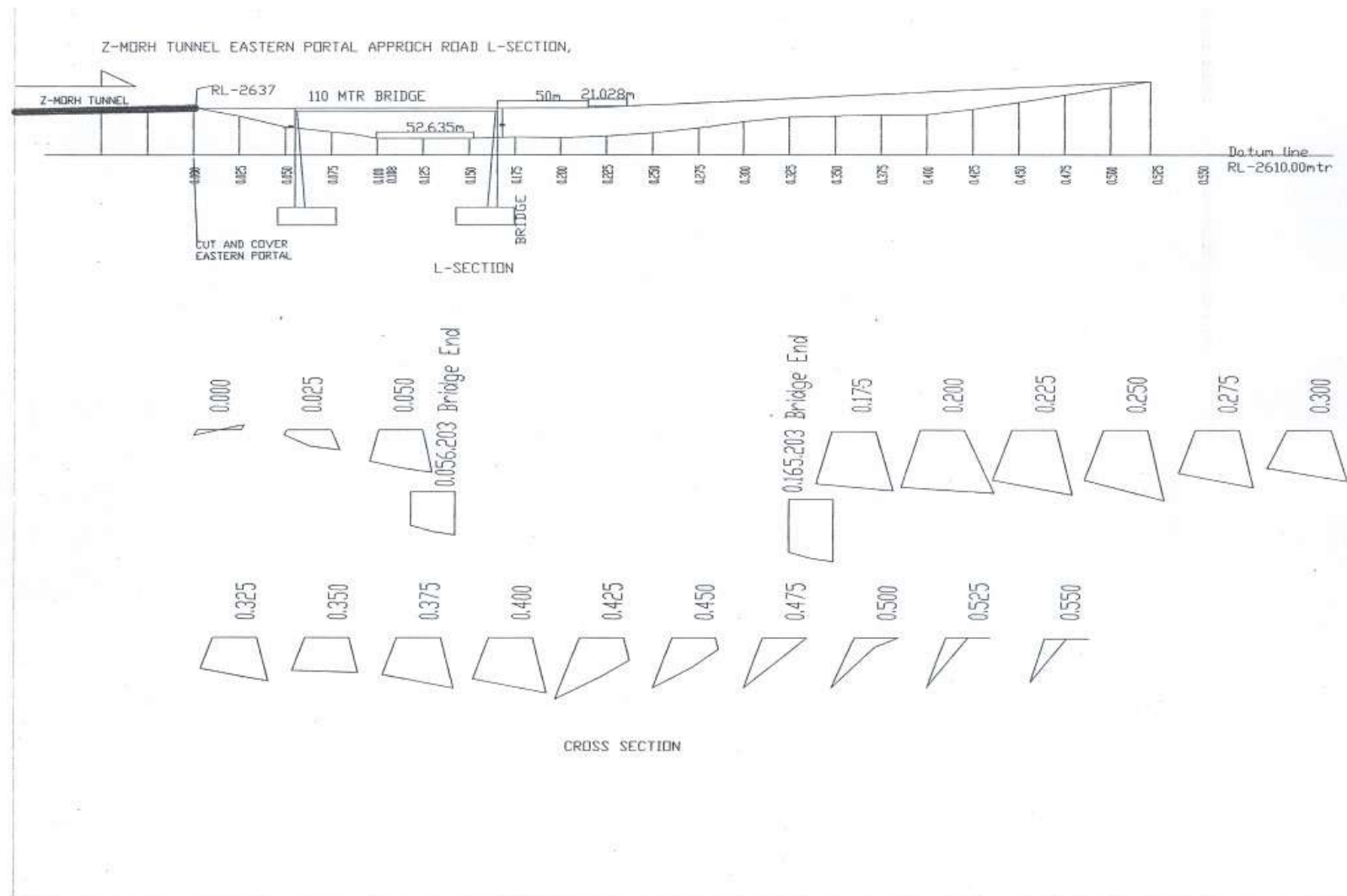
TYPE-1 NEW 2-LANE CARRIAGEWAY
(WITH ONE SIDE BREAST WALL & OTHER SIDE RETAINING WALL)

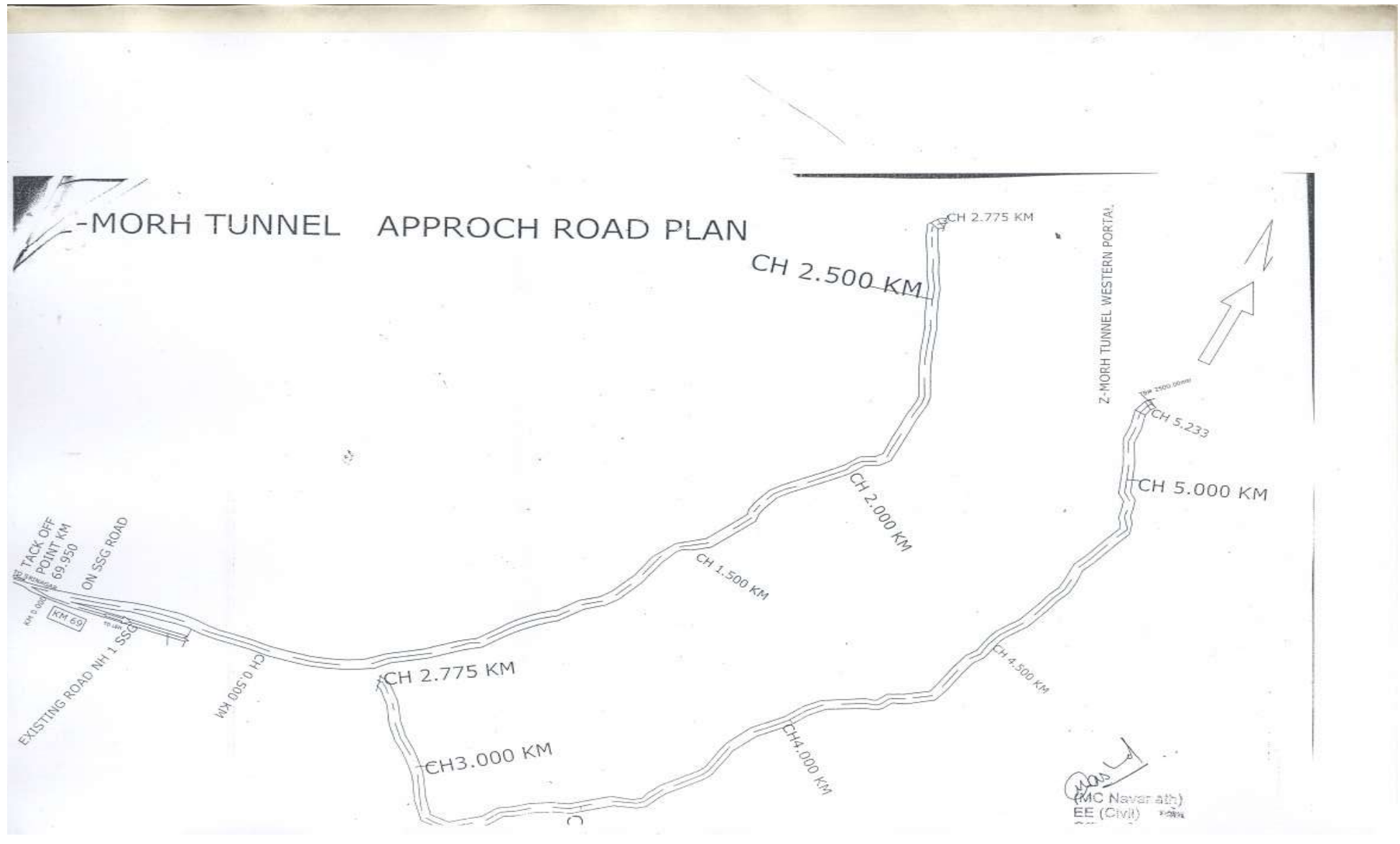


TYPE-2 NEW 2-LANE CARRIAGEWAY
(WITH BREAST WALL & RETAINING WALL)

NOTE:-
(1) All Dimensions are in mtrs.
(2) Breast and ditch water drain is per site condition







Area Calculation of Z-morh Tunnel Approach Road WESTERN PORTAL

Ch	Length mtr	Area in Sqm		Qty in Cum.		Remarks
		Cutting	Filling	Cutting	Filling	
0.000 C	0	5.0015				SMB
0.005 C	25.00	13.043			226.09	
0.050 F	25.00		3.444		163.04	206.09
0.075 F	25.00		21.783		0.00	315.31
0.100 F	25.00		39.56		0.00	760.51
0.125 F	25.00		64.601		0.00	1296.46
0.150 F	25.00		95.016		0.00	1995.88
0.175 F	25.00		136.908		0.00	2898.93
0.200 F	25.00		135.786		0.00	3408.54
0.225 F	25.00		95.22		0.00	2887.46
0.250 F	25.00		48.193		0.00	1792.59
0.275 C/F	25.00	1.07	30.71	13.37	986.22	SMB
0.300 C/F	25.00	2.91	22.92	49.75	670.32	
0.325 C/F	25.00	13.59	1.37	206.22	303.55	
0.350 C	25.00	48.07		781.23	17.06	
0.375 C	25.00	66.79		1441.98	0.00	
0.400 C	25.00	99.22		2068.73	0.00	
0.425 C	25.00	144.15		3041.89	0.00	
0.450 C	25.00	171.00		3964.17	0.00	
0.475 C	25.00	182.94		4449.06	0.00	
0.500 C	25.00	223.30		5077.78	0.00	
0.525 C	25.00	165.03		4853.94	0.00	
0.550 C	25.00	137.72		3784.17	0.00	
0.575 C	25.00	124.67		3279.63	0.00	
0.600 C	25.00	111.97		2957.86	0.00	
0.625 C	25.00	159.98		3395.20	0.00	
0.650 C	25.00	159.74		3996.75	0.00	
0.675 C	25.00	181.93		4270.62	0.00	
0.700 C	25.00	185.14		4588.07	0.00	
0.725 C	25.00	203.42		4856.68	0.00	
0.750 C	25.00	206.17		5119.60	0.00	
0.775 C	25.00	256.88		5787.93	0.00	
0.800 C	25.00	347.61		7555.86	0.00	
0.825 C	25.00	401.71		9366.09	0.00	HR
0.850 C	25.00	361.19		9535.89	0.00	
0.875 C	25.00	375.52		9208.54	0.00	
0.900 C	25.00	360.13		9195.28	0.00	
0.925 C	25.00	328.82		8611.53	0.00	
0.950 C	25.00	261.88		7383.40	0.00	
0.975 C	25.00	308.43		7128.56	0.00	
1.000 C	25.00	325.92		7929.06	0.00	
1.025 C	25.00	414.86		9259.43	0.00	
1.050 C	25.00	410.51		10316.71	0.00	
1.075 C	25.00	391.37		10023.05	0.00	
1.100 C	25.00	228.00		7741.80	0.00	
1.125 C	25.00	349.52		4718.84	0.00	
1.150 C	10.04	150.52		1506.82	0.00	
1.150 C	25.00	127.65		3464.54	0.00	
1.175 C	25.00	149.70		3466.74	0.00	
1.200 C	25.00	123.96		3420.58	0.00	
1.225 C	25.00	108.17		2901.51	0.00	
1.234 C	9.18	103.01		969.09	0.00	
1.250 C	15.82	97.84		1629.65	0.00	SMB
1.275 C	25.00	101.76		2494.94	0.00	
1.300 C	25.00	103.53		2566.10	0.00	
1.325 C	25.00	96.75		2503.46	0.00	
1.350 C	25.00	91.01		2346.88	0.00	
1.375 C	25.00	135.16		2826.90	0.00	
1.400 C	25.00	168.18		3791.50	0.00	
1.425 C	25.00	203.51		4645.91	0.00	
1.436 C	11.11	231.43		2822.52	0.00	
1.450 C	25.00	276.67		6002.02	0.00	
1.475 C	25.00	244.11		6509.49	0.00	
1.500 C	25.00	244.03		6101.51	0.00	
1.525 C	25.00	169.53		5169.27	0.00	
1.550 C	25.00	120.69		3627.58	0.00	
1.575 C	25.00	80.06		2509.24	0.00	
1.600 C	25.00	51.40		1643.08	0.00	
1.625 C	25.00	22.62		925.14	0.00	
1.650 C	25.00	13.24		448.26	0.00	HR

1.875 C	25.00	64.17		967.62	0.00	"
1.700 C	25.00	57.35		1518.96	0.00	"
1.725 C	25.00	36.95		1178.69	0.00	"
1.730 C	5.46	12.73		135.57	0.00	"
1.750 C	19.54	21.25		332.03	0.00	SMB
1.775 C	25.00	37.06		728.91	0.00	"
1.800 C	25.00	34.02		888.50	0.00	"
1.825 F	25.00		8.049	425.23	100.61	"
1.850 F	25.00		52.576	0.00	757.78	"
1.875 F	25.00		91.846	0.00	1885.20	"
1.900 F	25.00		138.974	0.00	2885.13	"
1.925 F	25.00		215.196	0.00	4425.95	"
1.950 F	25.00		172.74	0.00	4849.01	"
1.975 F	25.00		176.249	0.00	4562.19	"
2.000 F	25.00		147.104	0.00	4041.75	"
2.025 F	25.00		128.394	0.00	3443.59	"
2.050 F	25.00		199.44	0.00	4097.76	"
2.075 F	25.00		177.091	0.00	4706.45	"
2.100 F	25.00		119.15	0.00	3702.86	"
2.125 C/F	25.00	16.422	10.63	205.27	1622.19	HR
2.150 C	25.00	91.538		1349.45	132.87	"
2.175 C	25.00	51.251		1784.79	0.00	"
2.200 C	25.00	19.706		886.93	0.00	"
2.225 C/F	25.00	10.063	6.077	372.10	75.96	"
2.250 C	25.00	49.569		750.37	75.96	SMB
2.275 C	25.00	91.315		1765.98	0.00	"
2.300 C	25.00	113.483		2559.87	0.00	"
2.325 C	25.00	131.101		3057.18	0.00	"
2.350 C	25.00	132.803		3298.67	0.00	"
2.375 C	25.00	125.16		3224.41	0.00	"
2.400 C	25.00	136.638		3272.34	0.00	"
2.425 C	25.00	157.77		3679.95	0.00	"
2.450 C	25.00	103.546		3266.19	0.00	"
2.475 C	25.00	110.157		2671.06	0.00	"
2.500 C	25.00	123.988		2926.70	0.00	"
2.525 C	25.00	175.278		3740.68	0.00	"
2.550 C	25.00	113.534		3610.01	0.00	"
2.575 C	25.00	109.489		2787.68	0.00	"
2.600 C	25.00	189.495		3737.15	0.00	"
2.625 C	25.00	232.69		5277.10	0.00	"
2.650 C	25.00	159.897		4907.14	0.00	"
2.675 C	25.00	105.319		3315.07	0.00	"
2.700 C	25.00	142.799		3101.35	0.00	"
2.725 C	25.00	123.075		3323.29	0.00	"
2.750 HR	25.00	0		1534.38	0.00	"
2.766 HR	16.17	0		0.00	0.00	"
2.775 C	8.83	76.169		336.29	0.00	"
2.800 C	25.00	58.845		1687.61	0.00	"
2.825 C	25.00	84.229		1788.35	0.00	"
2.850 C	25.00	65.143		1867.08	0.00	"
2.875 C	25.00	39.161		1303.75	0.00	"
2.900 C/F	25.00	6.456	11.14	570.19	139.24	"
2.925 F	25.00		38.925	80.70	625.79	"
2.950 F	25.00		411.506	0.00	1005.35	"
2.975 F	25.00		22.412	0.00	798.94	"
3.000 C	25.00	42.212		527.63	280.14	"
3.025 C	25.00	105.768		1849.68	0.00	"
3.050 C	25.00	272.966		4733.99	0.00	"
3.075 C	25.00	422.533		8693.39	0.00	"
3.100 C	25.00	555.53		12225.30	0.00	"
3.125 C	25.00	469.514		12812.54	0.00	"
3.150 C	25.00	489.388		11985.80	0.00	"
3.175 C	25.00	194.736		8551.21	0.00	"
3.200 C	25.00	273.394		5401.40	0.00	"
3.225 C	25.00	346.008		7492.23	0.00	"
3.250 C	25.00	209.155		6639.26	0.00	HR
3.275 C	25.00	138.954		4351.19	0.00	"
3.300 C	25.00	160.638		3744.75	0.00	"
3.325 C	25.00	73.094		2921.53	0.00	"
3.350 C	25.00	210.32		3542.53	0.00	"
3.375 C	25.00	176.807		4838.89	0.00	"
3.400 C	25.00	153.564		4129.47	0.00	"
3.425 C	25.00	174.978		4105.99	0.00	"

(M. K. Venkath)
EE (Civil)
R. Srinivas

4.50/C	25.00	200.981		4698.67	0.00	*
4.475/C	25.00	336.041		6712.51	0.00	*
4.500/C	25.00	400.895		9211.33	0.00	*
4.525/C	25.00	482.944		11047.55	0.00	*
4.550/C	25.00	149.416		7904.18	0.00	*
4.575/C	25.00		57.507	1867.63	718.81	SMR
4.600/C	25.00		241.594	0.00	3738.61	
4.625/C	25.00		208.218	0.00	6747.38	
4.650/C	25.00	12.775	13.698	0.00	5558.63	
4.675/C	25.00	191.231		2549.97	171.22	*
4.700/C	25.00	285.34		5956.90	0.00	*
4.725/C	25.00	235.167		6506.01	0.00	*
4.750/C	25.00	140.064		4690.14	0.00	*
4.775/C	25.00	103.555		3042.62	0.00	HR
4.800/C	25.00	116.338		2746.05	0.00	*
4.825/C	25.00	72.54		2360.88	0.00	*
4.850/C	25.00	79.44		1899.67	0.00	*
4.875/C	25.00	117.891		2466.54	0.00	*
4.900/C	25.00	158.748		3457.85	0.00	*
4.925/C	25.00	83.82		2138.01	0.00	*
4.950/C	25.00	87.228		3074.58	0.00	*
4.975/C	25.00	95.259		2273.95	0.00	*
4.000/C	25.00	86.664		2130.96	0.00	*
4.025/C	25.00	95.259		2273.95	0.00	*
4.050/C	25.00	135.163		2880.16	0.00	*
4.075/C	25.00	217.771		4411.50	0.00	SMR
4.100/C	25.00	258.282		5950.42	0.00	*
4.125/C	25.00	241.55		6302.65	0.00	*
4.150/C	25.00	237.492		6093.51	0.00	*
4.175/C	25.00	264.881		5987.79	0.00	*
4.200/C	25.00	282.258		6279.41	0.00	*
4.225/C	25.00	306.617		6838.96	0.00	*
4.250/C	25.00	406.748		7360.64	0.00	*
4.275/C	25.00	341.789		8916.71	0.00	*
4.300/C	25.00	183.662		9356.34	0.00	*
4.325/C	25.00	73.88		6561.63	0.00	*
4.350/C	25.00	49.013		3212.90	0.00	*
4.375/C	25.00	44.065		1536.10	0.00	*
4.400/C	25.00	18.236	7.925	778.73	99.06	*
4.425/C	25.00	13.98	4.06	402.68	159.81	*
4.450/C	25.00	75.346		1116.53	60.75	HR
4.475/C	25.00	69.895		1815.44	0.00	*
4.500/C	25.00	41.7		1394.88	0.00	*
4.525/C	25.00	51.23		1161.58	0.00	*
4.550/C	25.00	20.698	7.49	899.06	93.62	*
4.575/C	25.00	33.217	2.175	673.91	120.81	*
4.600/C	25.00	27.211	8.796	755.32	137.13	*
4.625/C	25.00	277.855		1313.27	109.95	*
4.650/C	25.00	158.563		2955.36	0.00	SMR
4.675/C	25.00	215.788		4679.45	0.00	*
4.700/C	25.00	265.287		6013.20	0.00	*
4.725/C	25.00	318.824		7301.10	0.00	*
4.750/C	25.00	58.025		4710.42	0.00	*
4.775/C	25.00	17.1	18.342	939.02	229.27	HR
4.800/C	25.00	89.593		1333.61	229.27	*
4.825/C	25.00	116.124		2571.36	0.00	*
4.850/C	25.00	120.087		2952.52	0.00	*
4.875/C	25.00	113.051		2914.11	0.00	*
4.900/C	25.00	118.62		2895.77	0.00	*
4.925/C	25.00	152.74	10.684	3391.86	133.54	*
4.950/C	25.00	24.958	10.25	2221.14	261.66	SMR
4.975/C	25.00	37.124		775.99	128.12	*
5.000/C	25.00	13.523	2.039	633.06	25.49	*
5.025/C	25.00		32.552	169.03	432.37	*
5.050/C	25.00		76.396	0.00	1361.80	*
5.100/F	25.00		109.694	0.00	2326.03	*
5.125/F	25.00		32.35	0.00	1775.48	*
5.150/F	25.00		37.212	0.00	869.49	*
5.175/F	25.00		66.33	0.00	1294.22	*
5.195/F	20.21		67.33	0.00	1350.37	*
5.200/B	4.79		0	0.00	0.00	
5.215/B	25.00		48.748	0.00	0.00	
5.233	8.21		20.606	0.00	284.63	

HR= 680427.60 91894.42
SMR= 168347.26
512080.34

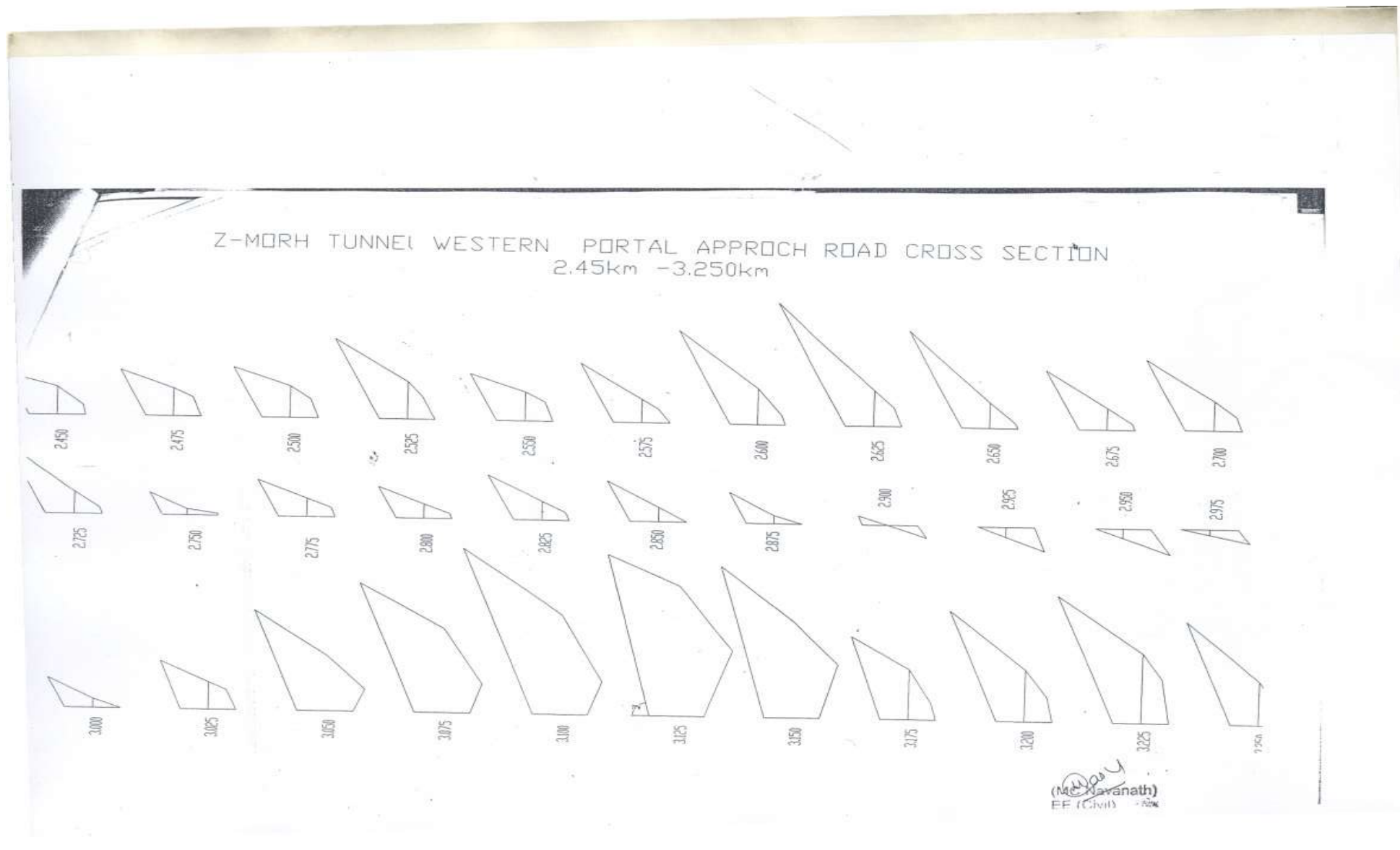
(M. Navarath)
EE/Civil
09/05/2020

Area Calculation of Z-morh Tunnel Approach Road Eastern portal						Remarks
0.000 C/F	0	4.48	4.32	0		
0.025 F	25.00		53.807	55.998	107.80484	
0.050 F	25.00		169.116		841.7035	
0.055 F	5.16		191.405		627.72428	
0.155 F	100.00		251.12		9821.37	
0.175 F	19.84		306.652		2797.7624	
0.200 F	25.00		266.819		4099.969	
0.225 F	25.00		279.791		3615.0285	
0.250 F	25.00		224.396		3721.7835	
0.275 F	25.00		288.691		3093.641	
0.300 F	25.00		142.677		3751.3145	
0.325 F	25.00		154.926		1938.3885	
0.350 F	25.00		187.946		2124.521	
0.375 F	25.00		212.698		2562.023	
0.400 F	25.00		172.278		2831.003	
0.425 F	25.00		120.8478		2174.3228	
0.45 F	25.00		82.333		1592.9305	
0.475 F	25.00		61.466		1090.6285	
0.500 F	25.00		40.217		808.542	
0.525 F	25.00		36.03		538.7425	
0.550 F	25.00		0		450.375	
Total					48689.578	

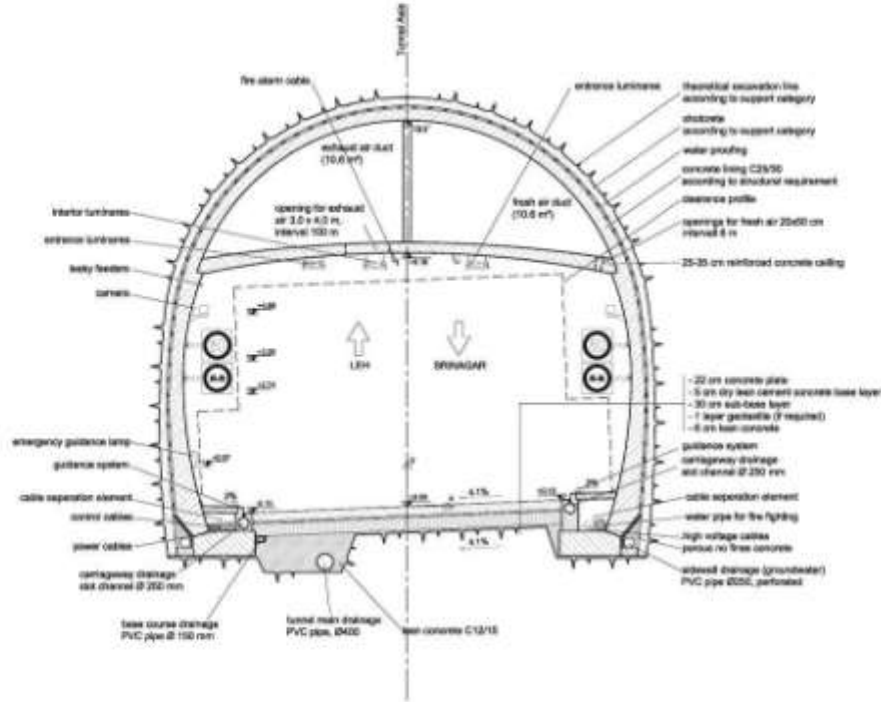
Area Calculation of Z-morh Tunnel Approach To SBP Connecting Road						Remarks
0.000 F	0		70.309			
0.025 F	25.00	0	53.807	0.000	932.666	
0.050 F	25.00	0	233	0.000	905.588	
0.075 F	25.00	0	145.54	0.000	3058.040	
0.100 F	25.00	0	115.741	0.000	1934.991	
0.125 F	25.00	0	85.88	0.000	1532.643	
0.150 F	25.00	0	71.31	0.000	1144.810	
0.175 C	25.00	15.022	13.27	0.000	904.645	SMB
0.200 C	25.00	0	27.18	187.775	193.055	SMB
Total					187.775	
Area Calculation of Z-morh Tunnel Approach To 556 Connecting Road					10606.437	
0.000 F	0		239.51	0.000	239.510	
0.025	25.00		113.55	0.000	3107.413	
0.05	25.00		52.62	0.000	1471.995	
0.07	20.00		5.4	0.000	531.600	
Total					5350.518	

Sum Of Earth Work in Cum		
Cutting	HR	SMB
	168347	512268
Filling		107851

(MC Navanath)
EE (Civil)
Officer Commanding
122 RCC (GREF)



TYPICAL CROSS SECTION,
CLEARANCE PROFILE AND
INSTALLATIONS WITHOUT INVERT SLAB



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Client
Jammu & Kashmir Road Development Corporation
J&K Road Development Corporation
The Chief Engineer
Project 16 m20
Border Roads
Organisation
J&K Road Development Corporation

Project
Consultancy Services for Detailed Feasibility Study and Framing up of Phase-wise proposal (DFP) for construction of two tunnels at Z-Morh and at Zojila for All weather connectivity from Srinagar to Leh in Jammu & Kashmir State
Z-MORH TUNNEL

Contract No. J&K RD/2019/001/001

Document
PRELIMINARY TUNNEL DESIGN PHASE II
TYPICAL CROSS SECTION,
CLEARANCE PROFILE AND INSTALLATIONS WITHOUT INVERT SLAB

REVISION

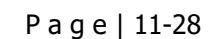
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CHECKED: [Signature]
APPROVED: [Signature]
DESIGN: [Signature]
DRAWING: [Signature]

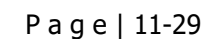
3G
vayamtech
Vayam Technologies Ltd
Plot No. 11, Sector 10, Gurgaon
Haryana 122001, India
Phone: +91 122 4151111
Email: info@vayamtech.com

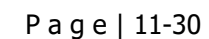
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Checked: [Name]
Approved: [Name]
Design: [Name]
Drawing: [Name]

Scale: 1:100
Sheet No: 1 of 1





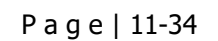


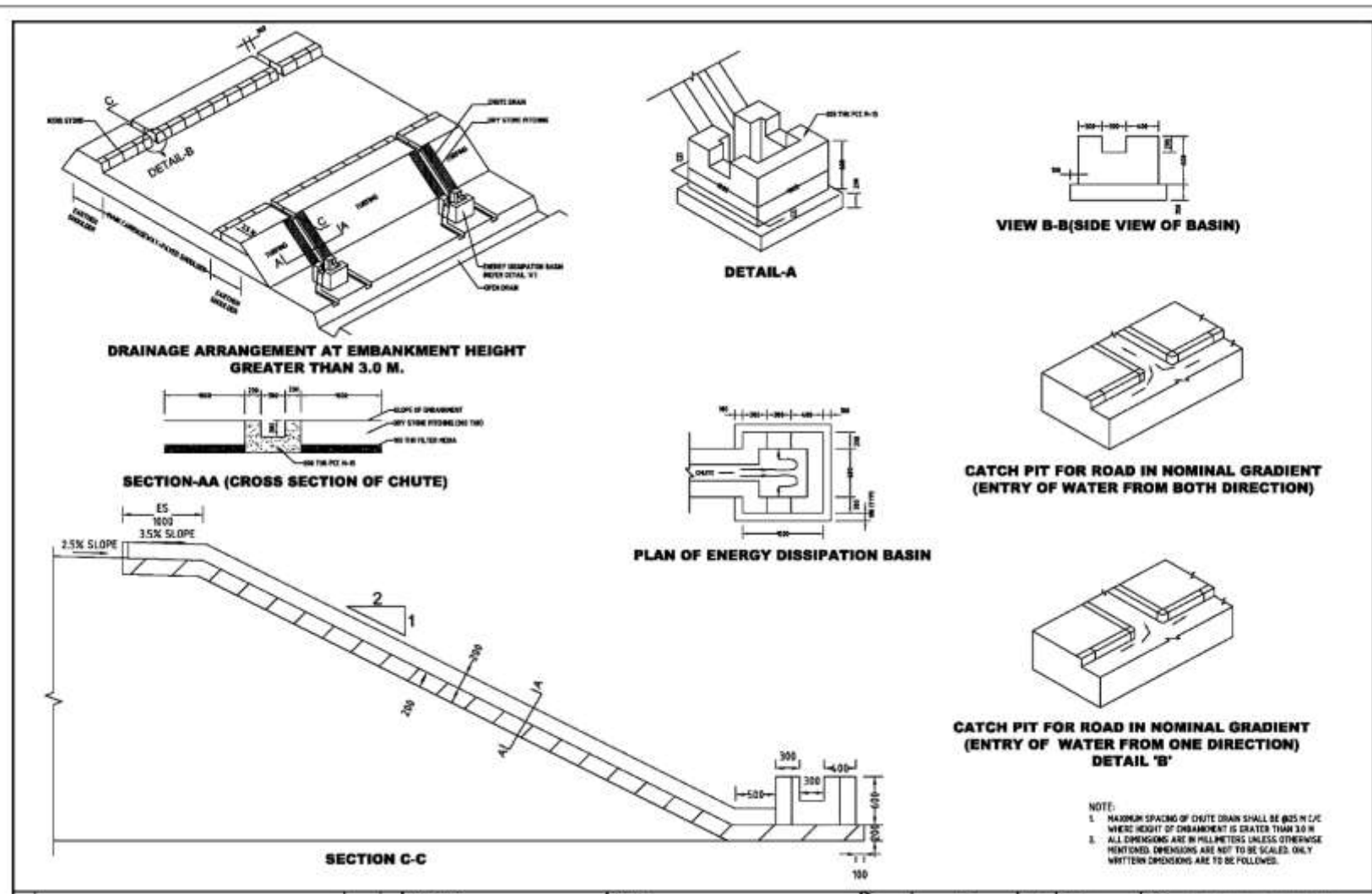












(a) **EASTERN PORTAL BRIDGE 110 MTR SPAN**

- (i) Design discharge of bridge = 1420 cum / sec
- (ii) Proposed RL of bridge = 2637.00 Mtr
- (iii) Maximum snow accumulation in 24 hrs = 125 cm
- (iv) Type of substructure = A₁- open foundation
A₂ – Well foundation/ pile foundation
P₁ - Well foundation/ pile foundation
- (v) Type of superstructure = steel superstructure
- (vi) Span arrangements :-

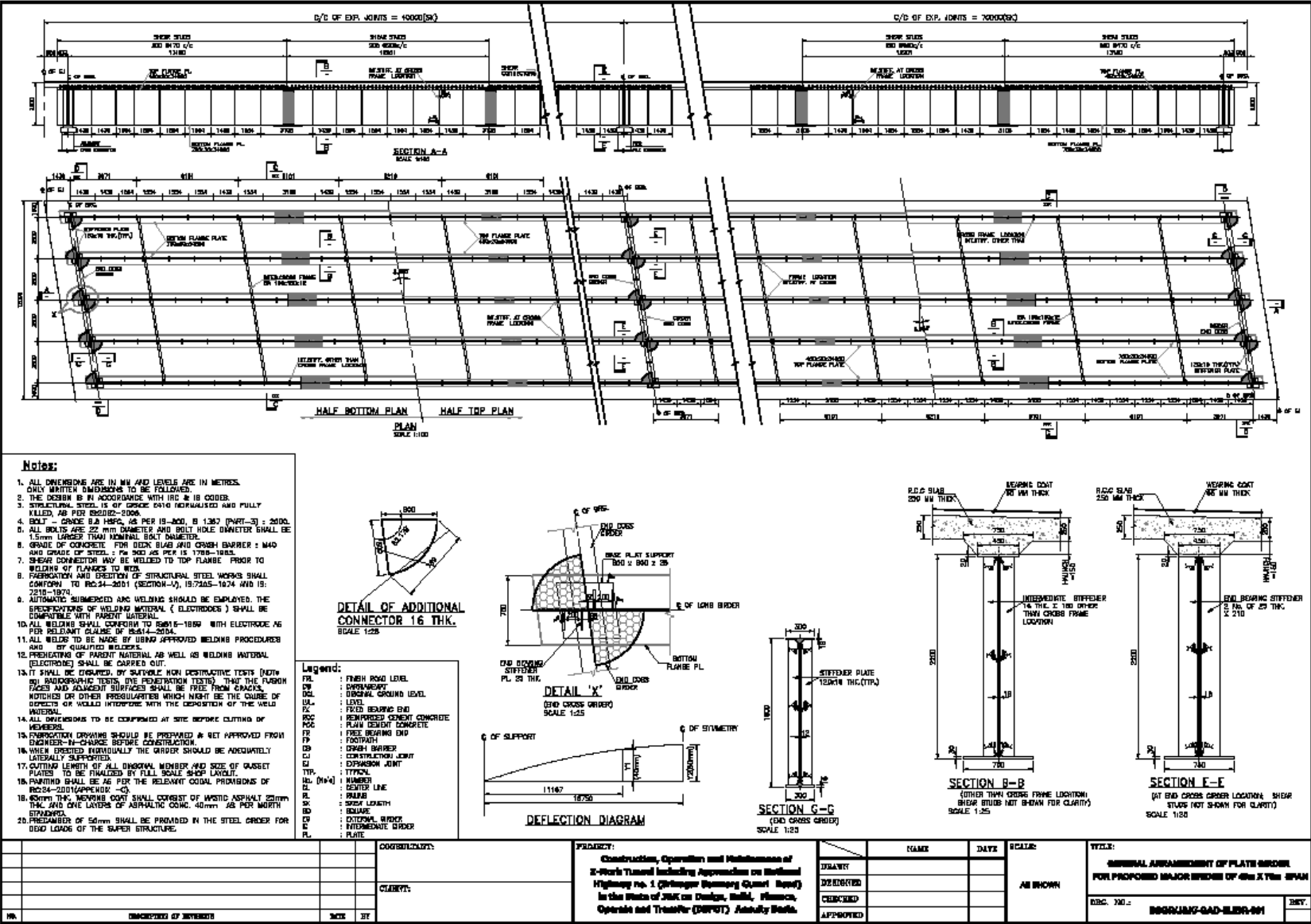


(b) **WESTERN PORTAL BRIDGE – 01ST AT KM 2.75**

- (i) Design discharge of bridge = will be submitted in a 10 days time 100.48 cum/sec.
- (ii) Proposed RL of bridge = 2409.60 Mtr
- (iii) Maximum snow accumulation in 24 hrs = 100 cm
- (iv) Type of substructure = open foundation
- (v) Type of superstructure = steel superstructure
- (vi) Span arrangements = Single span

(c) **WESTERN PORTAL BRIDGE – 02ND AT K M 5.200**

- (I) Design discharge of bridge = will be submitted in a 10 days time 31.57 cum/sec.
- (II) Proposed RL of bridge = 2500 Mtr
- (III) Maximum snow accumulation in 24 hrs = 100 cm
- (IV) Type of substructure = open foundation
- (V) Type of superstructure = steel superstructure
- (VI) Span arrangements = Single span





REVNEU LAND INVOLVED FOR APPROCHES OF Z-MORH TUNNEL (WESTERN PORTAL)

Sl	Width	Avg. Width	Length	Area in Sqm
1	0.0000	0.0000	0.0000	0.0000
2	10.0900	5.045	61.5500	308.5600
3	15.545	12.8200	30.480	390.7540
4	21.336	18.3950	30.48	616.7445
5	21.0310	21.1830	34.43	645.6500
6	22.8600	22.4450	30.3600	629.3570
7	22.8600	22.8600	30.9800	850.0620
8	21.9456	22.4028	37.7900	477.9861
9	22.8600	22.4030	22.1700	204.8500
10	20.7264	21.7950	8.9600	770.4500
11	20.7264	20.7264	34.0000	631.7410
12	18.8976	19.8120	29.1100	603.8690
13	21.9460	20.4218	29.4500	622.4560
14	20.7264	21.3360	30.0300	650.3270
15	20.7264	20.7264	30.7900	631.7400
16	18.1600	18.4430	30.5900	564.1770
17	23.6300	20.8950	37.2900	779.1740
18	23.3900	23.5100	37.2500	875.7470
19	23.5800	23.4800	40.2800	945.9700
20	23.5800	23.5800	41.2000	971.4960
21	23.5800	23.5800	44.8700	1058.0340
22	23.5800	23.5800	37.0700	874.1110
23	23.5800	23.5800	40.9000	964.4200
24	23.5800	23.5800	45.0800	1064.9500
Total				16149.5309

16149.5309 Sqm
= 173832.1038 Sqft
= 31 Kanal
19 Marla

Taking
COTI SURVEY - 1980/81
20.00 Meter - 66 Feet

TO SRINAGAR
TAKE OFF POINT EXISTING ROAD NH 1 SSG
KM 69
KM 69 EXISTING ROAD NH 1 SSG

