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1 INTRODUCTION

1.1 GENERAL

Border Roads Organization (BRO) assigned a consulting contract to Vayam Technologies Ltd (formerly iBilt Technologies Ltd.) for Detailed Feasibility Study and Framing up of Phase wise proposal (DPR) for construction of the Z-Morh tunnel. Accordingly, 3G Gruppe Geotechnik Graz ZT GmbH (3G) prepared the Phase II report (DPR) based on the specifications in May 2012.

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 implementation of the project has been proposed to be under the **BOT (Annuity) Toll type of** Public Private Partnership Projects, on Design, Build, Finance & Operate (DBFO) Pattern. **M/s SOMA Ltd.** is the selected organization after bidding evolution of the project.

M/s Vayam Technologies Ltd have entrusted the Traffic Report to M/s Geeta B R Sharma, Group of Tunnel Experts accordingly a team of experts comprising Highway Expert, Traffic Engineer and Transport Economist are engaged in order to carryout traffic analysis, growth analysis, traffic forecast, future projection economic evaluation of the project. This report endeavors to bring out the Traffic Analysis, Growth Rates, Future Projections and Economic evaluation and outline the methodologies adopted for the study.

1.2 PROJECT LOCATION

The Project comprises of two tunnels (Z-Morh & Zojila) and their road approaches as below:

1.2.1 Z- Morh Tunnel

The project highway from villages Rezan Km 69) and Shetkari (Km 82) is a section on the Kashmir-Leh road i.e. the **NH-1**. It joins North Indian states viz Delhi, Haryana, Punjab, Himachal Pradesh to Jammu, Srinagar, Sonamarg, Kargil, Leh Laddakh of J&K state. The major towns and built up areas along the project highway are Kangun, Gund, Rezan, Gagangir, Sonmarg, Gumri. The physical location of the project road section is illustrated in **Figure 1.1**.

The project starts at the Rezan village from existing km 69+000 of NH-1 and ends at Shetkari village at km 82+000. The first major town, the Kangan town comes across at km 40+000 and **Sonamarg** Town comes across at 84+000 where new alignments comprising of 6.5km Z Morh Tunnel and 5.8km Road Approaches have been proposed. The next major settlement of Sonamarg comes near km 82+000 to 84+400 from where Sonamarg bypass is constructed

One 2-lane Z Morh tunnel is proposed. Its "West Portal" is at approx. km 73.5 NH-1 in the area of Rezan/ Gagangir approximate 30 km east of Kangan East Portal at approximate. km 81 on NH-1, approximate 3 km west of Sonamarg Portal of ventilation tunnel & construction adit at km 76.5 NH-1 West Portal at elevation approx. 2500 m. East Portal at elevation approx. 2637 m Portal of ventilation tunnel & construction adit at km 77.5 on elevation approx. 2570 m

The salient features of Project Highway are:-

- ❖ **6.5 km long two lane bidirectional single tube tunnel** with parallel 6.5 km long escape tunnel on new alignment between Rezan & Sonamarg along the existing NH-1 in the State of J&K.
- ❖ **Approach to the Western(Srinagar side) Portal-** The takeoff point of the estimated 5.25 KM long approach road to the western portal is approximately at KM stone 69 on the Srinagar-Sonamarg section of NH1. The approach is to be constructed as two lane highway as per given/approved specifications and includes construction of two minor bridges.
- ❖ **Approach to the Eastern (Sonamarg side) Portal-** The junction of the estimated 0.550 KM long approach road to the eastern portal is approximately at KM stone 81.3 on the Srinagar-Sonamarg section of NH1. The approach is to be constructed as two lane highway as per given/approved specifications and includes construction of one major bridge.
- ❖ **Approach to the Construction/Ventilation adit (intermediate) Portal-** The junction of the estimated 1.0 KM long approach road to the intermediate portal is approximately at KM stone 76.5 on the Srinagar-Sonamarg section of NH1. The approach is to be constructed as two lane highway as per given/approved specifications.
- Tunnel length: Estimated 6.5 km
- Egress tunnel length: Estimated 6.5 km
- Construction/ventilation tunnel length: Estimated 575 m
- Max. overburden: approx. 1075 m
- Gradient: +2.11 % (1:47) from "West Portal to East Portal"
- Approach roads:
 - I. From Tunnel Western Portal km 73.5 to Rezan Village near KM stone 69 on Srinagar-Sonamarg section of NH 1; Estimated Length 5.25km .
 - II. From Eastern Portal from near KM 81.3 to Sonamarg town road on Srinagar-Sonamarg section of NH 1 ; Estimated Length 0.55km.
 - III. Construction of 1.1km road approach to adit from near KM 77.5. on Srinagar-Sonamarg section of NH 1

1.2.2 Zojila Tunnel

Zoji La (Hindi: जोजि ला or जोजि दर्रा) is a high mountain pass in India, located on the Indian National Highway 1 between Srinagar and Leh in the western section of the Himalayan mountain range. Though often referred to as Zojila Pass in the foreign press, the correct English translation is Zoji Pass or simply Zojila, since the suffix 'La' itself means pass in several Himalayan languages. In modern-day North Indian languages, 'La' (ला) and 'Darra' (दर्रा) are both used interchangeably to mean pass. This pass is 13,000 feet (4,000 m) above sea level, at 74.50 longitude and 34.17 latitude. The pass connects a valley of Kashmir with Ladakh. Different trade routes led to Tibet, China and Central Asia. Renchen Shah of Leh entered Kashmir through this pass and became the monarch of the land in the 14th century. Mirza Haider Dughlat also advanced through this pass to invade Kashmir. The old historical name of the pass was Shurji La meaning lord Shiva's mountain. Zoji La is 9 km (5.6 mi) from Sonamarg and provides a vital link between Ladakh and Kashmir. It runs at an elevation of approximately 3,528 metres (11,575 ft), and is the second highest pass after Fotu La on the Srinagar-Leh National Highway. It is often closed during winter, though the Border Roads Organisation (BRO) is working to extend traffic to most parts of the year. The Beacon Force unit of the BRO is responsible for clearing and maintenance of the road during Winter. During the Indo-Pakistani War of 1947, Zoji La was seized by Pakistani raiders in 1948 in their campaign to capture Ladakh. The pass was captured by Indian forces on 1 November in a

daring assault codenamed Operation Bison, which achieved success primarily due to the surprise use of tanks, then the highest altitude at which tanks had operated in combat in the world. The longitude & Latitude details of Zojila pass are as below:

WGS84	34° 16' 44" N, 75° 28' 19" E 34.278889, 75.471944	UTM	43S 543440 3793180
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Figure 1.1 : Location Map

1.3 PROJECT OBJECTIVES

The main objective of the present services as per ToR is reproduced as below:

“Carryout traffic studies and analysis of economic return ratio for two proposed road tunnels at Z-Morh and at Zojila and road sectors Srinagar – Sonamarg – Zojila – Drass – Kargil – Leh.” The study will include-

- Collection of traffic data from various Govt/ Private agencies (data concerning defence vehicles shall be supplied by BRO)
- Estimation of the volume of the traffic using the alternative route via tunnel and envisaged road stretch.
- Estimation of savings in cost of travel/ movement of traffic, travel time, inventory costs, reduction in accidents and possible positive environmental impact vis a vis the alternate method of movement.
- Economic appraisal of the project with the project cost components of the tunnel and the envisaged road stretch so as to estimate the Economic Internal Rate of Return (EIRR)

For achieving these goals, the consultant will review the provided Traffic Surveys Data, Socio-Economic & Statistical data of Jammu & Kashmir State, RFP, Technical Schedules, Drawings, Pre-Bid Replies, details of proposed & existing road approaches & bridges, earlier feasibility & detailed engineering studies, conducted by the BRO, pre-bid technical services etc. Thereafter, on the basis of these analyses, Traffic Report shall be prepared.

1.4 REPORT ORGANIZATION

This report is the Draft Traffic Report for Z-Morh & Zojila Tunnels including Approaches on National Highway no. 1 (Srinagar – Sonamarg – Zojila – Drass – Kargil – Leh.road) in the State of J&K on Design, Build, Finance, Operate and Transfer (DBFOT) Annuity Basis. The report comprises of following chapters, covering all aspects of the project preparatory studies:

Volume 1 : Traffic Report

- Chapter 1: Introduction
- Chapter 2: Project Highway Appreciation
- Chapter 3: Project Proposal
- Chapter 4: Traffic Studies
- Chapter 5: Traffic Analysis and Forecast
- Chapter 6: Pavement Design
- Chapter 7: BOQ and Cost Estimate
- Chapter 8: Operation & Maintenance
- Chapter 9: Economic Analysis
- Chapter 10: Financial Analysis
- Chapter 10: Conclusions and Recommendations.

Volume 2 : Annexure

2 PROJECT HIGHWAY APPRECIATION

2.1 GENERAL

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).

2.2 Z- MORH TUNNEL

The construction of Z Morh tunnel and approaches joining to NH-1 under study will be one of the most important link to join Rezan – Shetkari villages leading to the most important, sensitive and defence stations Srinagar and Kargil in the state of Jammu & Kashmir. It also provides the most important connecting link to a large area of the state including the capital "Srinagar" & Sonamarg. The emergence of nearby towns of Jammu, Kashmir as tourist and army camp centers, the disturbances in the neighboring state of Jammu and Kashmir and its proximity to Delhi have only added up to the growth of tourism and related activities. It is therefore proposed that the present 2-lane road be rehabilitated, improved and upgraded to 2-lane Tunnel and carriageway configuration.

The project area of the approximately 6.5 km long Z-Morh Tunnel and 6.5km long road approaches to the portals is located north-east of the city of Srinagar along the NH-1 (Srinagar-Leh section) in the State of Jammu and Kashmir. The tunnel shall be constructed between the villages Rezan (Km 69) and Shetkari (Km 82), approximately 3 km west of the village Sonamarg.

2.2.1 Description of the Project Highway

The salient features of the Project Highway as described in **Schedule A** of the revised RFP and Technical Schedule are as below:

Road: Srinagar to Leh

Object: Single tube highway tunnel with two traffic lanes in bi-directional traffic

Main structures: traffic tunnel, separate parallel egress tunnel, cross passages, construction/ventilation tunnel,

Additional structures: Portal structures, cut and cover tunnel, ventilation cavern, retaining structures in muck disposal areas, Mountable median in main traffic tunnel.

Approaches to the western, eastern and intermediate portals including bridges. Service and control buildings and other project facilities as specified.

Portals: West Portal at approx. km 74 NH-1 in the area of Rezan/Gagangir approx. 30 km east of Kangan
East Portal at approx. km 81 on NH-1, approx. 3 km west of Sonamarg
Portal of ventilation tunnel & construction adit at approx. km76.5 NH-1

Elevation: West Portal at elevation 2500 m
East Portal at elevation 2637 m

Portal of ventilation tunnel & construction Adit at elevation. 2570 m

Tunnel length: estimated 6.5 km

Egress tunnel length: estimated 6.5 km

Construction/ventilation tunnel length: 575 m

Max. overburden: approx. 1075 m

Gradient: +2.11 % (1:47) from the West Portal to the East Portal

Approach roads: Western Portal from near KM stone 69.5 on Srinagar-Sonamarg section of NH 1 Eastern Portal from near KM 81.3 on Srinagar-Sonamarg section of NH 1

Construction adit from near KM 76.5. on Srinagar-Sonamarg section of NH 1

2.2.2 Latitudes & Longitudes

The approximate longitude and latitude of the region is 34°-17' Northing and longitude 75°-10' to 75°-16'Easting.

2.2.3 Seismicity

The project area lies within seismic zone V(Five) as per IS 1893 Part 1 : ZWL, Srinagar and nearby areas of the seismic zoning map of India. Earthquakes of sizeable magnitude are not uncommon to the area. In the last 50 years, several major earthquakes with a magnitude in excess of 6 on the Richter Scale have occurred in North-West Himalayas. The last significant seismic activity struck the area in October 2005, and with a magnitude of 7.6, it was with catastrophic results throughout the entire region.

2.2.4 Terrain

The project highway from Rezan Village to Sonamarg bypass passes mainly through Hilly/ Mountainous and Snowy terrain.

2.2.5 Carriageway & Shoulder

The existing roadway has a 2-lane undivided carriageway configuration in the entire stretch. No existing service roads exist anywhere including the built-up and inhabited areas. The road typically has a 7.0/7.5m wide carriageway without paved shoulder. The road geometry & pavement condition is poor to fair.

2.2.6 Land Use

The largest proportion along existing road of abutting land use is forest (70%), followed by agriculture land (15%), and rest Built-up/semi urban/commercial/residential/industrial (15%) etc. Some agricultural activities employing terrace farming methods, typical in the hilly and sloppy areas.

2.2.7 Cut and Fill characteristics

The cut and fill assessment is of crucial importance in hill stretches. It becomes obvious that the extent of cutting and filling would be highly variable as the topography has varying characteristics.

Approach Road run parallel to existing road. From km 69 to km 73.5 a range of hills falls on left hand side and valley section on right hand side. Hill/ valley heights are upto 25-30m.

It is observed that two lane road will require significant width of hill cutting as the valley side slopes are often steep. A large number of locations will therefore require breast walls to retain the cut on the hill side retaining walls to retain the fill material on the valley side. Further, it is likely that the requirement to retain the cut side with breast walls will be higher in the most part of project corridor.

2.2.8 Cross Drainage Structures and Slope Protection Works

There is no Minor and major Bridge. There are 12 existing culverts which are partly choked and poor in condition.

2.2.9 Towns and Built up Areas

The important towns and rehabilitation on the section are Rezan, Gagangir, BEACON site camp, Shetkari and Sonamarg in between km 69 to km 82.

2.2.10 Horizontal Alignment

The horizontal alignment of the existing road is generally deficient from the stipulated standards. The sharp curves exist throughout the serpentine alignment which includes numerous hairpin bends in hilly terrain.

2.2.11 Service Roads

No service roads exist anywhere on the corridor.

2.2.12 Vertical Alignment

The vertical geometry generally satisfies the design guidelines of the IRC standards. There are some deficient & substandard curves causing sudden rise and fall causing discomfort to road users and accidents. The vertical gradient is varying from 1.5% to 18%

2.2.13 Maintenance of the Existing Road

The existing National Highway is under BEACON and being maintained as per yearly sanctioned funds, standards and specifications of BRO.

2.2.14 Plantation along Highway

As indicated earlier the largest proportion of land use is forest. Along the corridor, mostly precious pine, chinar, peepal, eucalyptus and other shrubs were observed.

2.2.15 Submergence Area

No submergence area was observed during the reconnaissance.

2.2.16 Bypasses and Realignment

2 Lane Sonamarg Bypass from Shetkari Bridge (km82) is being constructed by BEACON, Border Roads Organisation. Intersection to SSG road shall be constructed by BEACON. Approaches to SMB and SSG roads with Eastern Portal shall be constructed by the concessionaire.

2.2.17 Rail Level Crossing

There is no rail level crossing along the corridor.

2.2.18 Road Intersections

The road being in hilly terrain has two numbers intersecting cross roads leading to interior villages and their agricultural fields, hutments. All of the intersecting highways are of gravel road of lower category.

2.2.19 Underpasses and Overpass

No vehicular or pedestrian underpasses or overpasses exist on the corridor.

2.2.20 Longitudinal Drains

Longitudinal drains were generally provided on the hill side. The hill side drains were usually of triangular shape lined with concrete layer. At most of the locations the drains were fully choked due to the soil and debris falling from the hill during storms. The width of the drains was ranging from 0.15 to 0.5 outside to outside whereas the depth varied. In built up areas usually the drains were functional but damaged badly.

2.2.21 Pavement Condition

The complete stretch has a flexible pavement with bituminous topping. The condition of the existing surface generally varies between fair to poor. The most common type of surface distress was longitudinal, alligator cracking near village Gagangir and BEACON camp area. Pavement overlay is in progress.

2.2.22 Bus Stops and Shelters

There is no proper bus stops along the corridor. The villagers stand and wait for the Bus on the main road at Village Rezan, Gagangir & Shetkari.

2.2.23 Right of Way (ROW)

Very few pillars were traceable at random isolated locations on the hill sides. As per Sign Boards installed at Gagangir Village near BEACON camp site right of way is 79ft (24m).

2.2.24 Utilities along the Project Highway

Major utilities observed along the corridor were underground water pipe line, overhead electric lines.

2.2.25 Toll Plaza

There is no Toll Plaza on existing highway.

2.2.26 Retaining structures

Breast walls and Retaining walls are frequently observed along the alignment. Most of the walls are stone masonry whether used as breast or Retaining walls. Even the wing walls and head walls in the culverts have been built with stone masonry. Breast walls are on the hill sides to protect the uphill slope from failing. The condition of breast/ retaining wall, drains are poor to fair in general.

2.2.27 Truck Parking

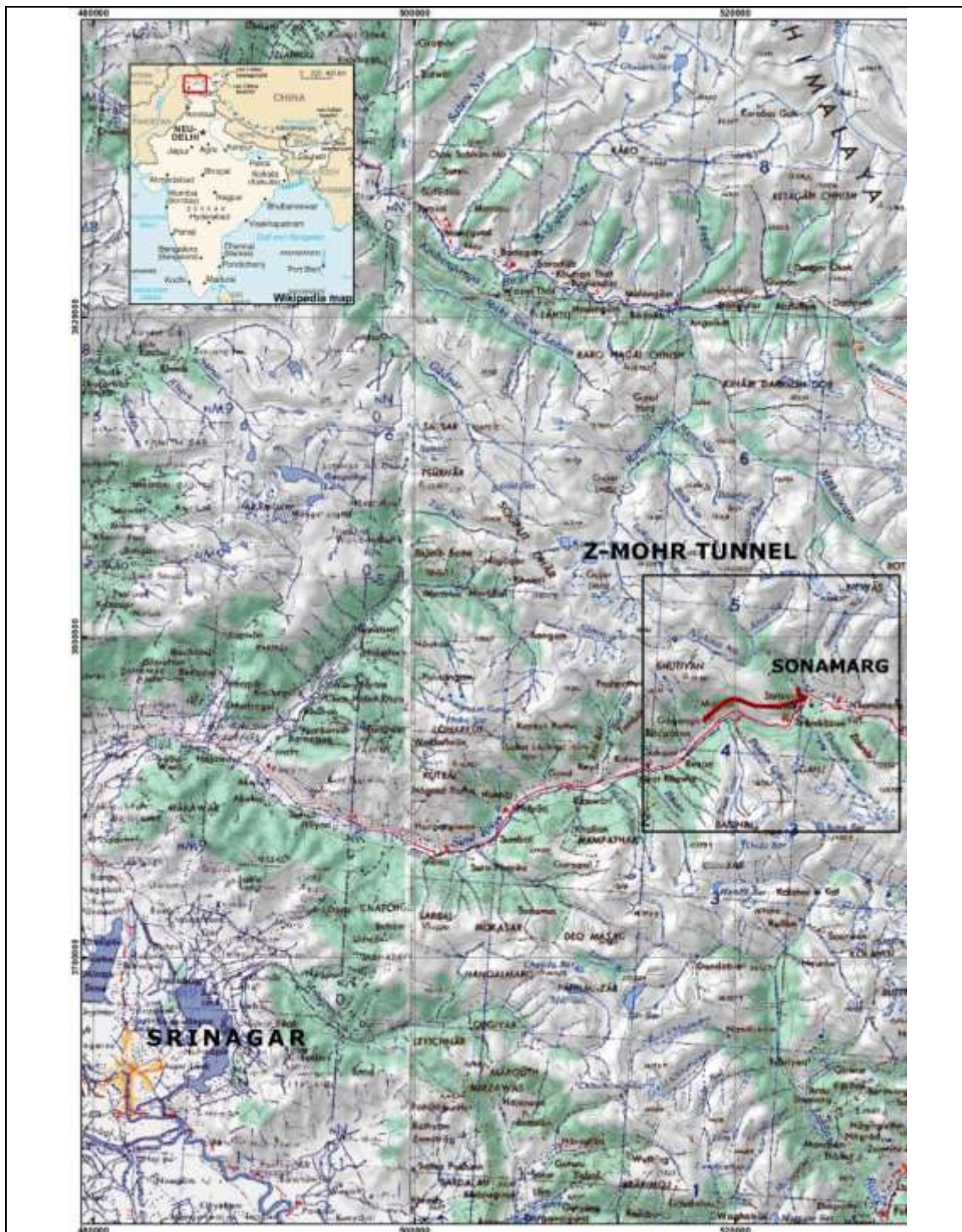
No existing truck parking facility or truck lay-byes are observed on the project highway section. Trucks are being parked on the main road as and where.

2.2.28 Religious Structure & Buildings

The roadway is flanked on the sides at places by some important social activity centers such as Mosques in Rezan and Gagangir village.

2.2.29 Road Safety





Road safety measures are not observed as per IRC standards. No W-beam crash barriers are observed anywhere along the Project corridor. Parapet walls are observed continuously along the project corridor but their condition varies from fair to poor.











2.3 Z- MORH SITE PHOTOGRAPHS







Site Photographs showing the salient features of the existing road, adjoining hills, are attached herewith for ready reference:







	
Start of Approach Road km 69, (Gund 7km)	Km stone 69 of NH-1 (7km Gund)
	
Accident due to Loose Overburden at km (69+500)	Km stone 70 of NH-1 (7km Gund)
	
Bore Hole Location near West Portal (km 73+500)	Western Portal of Z Morh Tunnel (km73.5)
	
Survey Point near Western Portal	BECAON Board of Western Portal km 73.500




	
Approach Road Alignment following track	Road Approach near western Portal km 73.5
	
Gagangir Village and Sub Station (km 73+900)	33KV Power Sub Station (km 73+900)
	
Proposed Minor Bridge 1x30m span at km 73.400 near West Portal	Existing Culvert at proposed MIB (km 73.500)






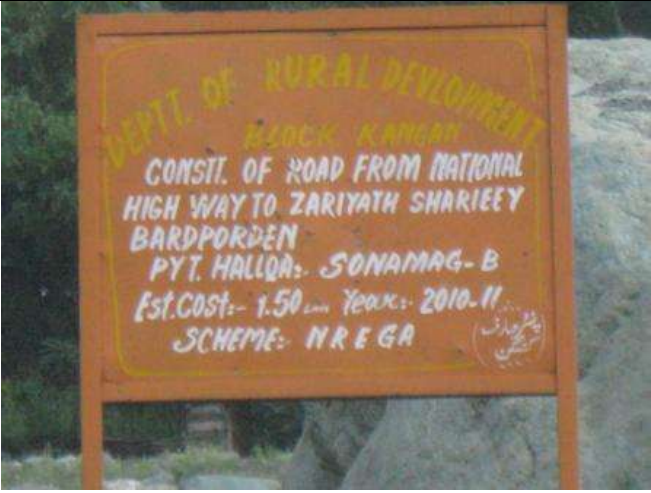
	
Existing Rock Profile	Rock Characteristics
	
Tracking Area	Rock Strata
	
Addict Tunnel at km 77.50	Addict Tunnel at km 77.50






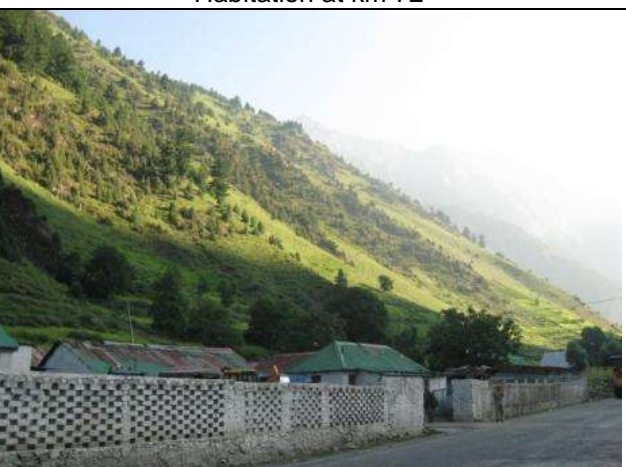
	
<p>Rock Characteristics Study</p>	<p>Soft Soil and Overburden near East Portal</p>
	
<p>Brest Wall construction in Progress near East Portal</p>	<p>East Portal near km 81</p>
	
<p>Sonamarg Bypass Road under construction</p>	<p>Retaining Wall Under Construction near Proposed Major Bridge</p>

	
East Portal and Bore Hole Location	Discussion with BEACON officials at East Portal
	
Rock Study at East Portal	Avalanche Area at east Portal
	
Avalanche Area at east Portal	Existing Road to Sonamarg with steep gradient

	
Existing Bridge (1x55m span) on Sonamarg Road	Major Bridge Location at East Portal km 81
	
Road Approach at Steep Mountain Slope	Road Approach at Steep Mountain Slope
	
Road Approach near Reznan Village	Road Approach near Reznan Village

	
Primary School	Primary School Building
	
Culvert and Retaining Wall on Existing Road	Culvert and Retaining Wall on Existing Road
	
Road Approaches in Hard Rock cutting Area	Long route due to gap in two Mountains

	
Existing Cart Track and hutment near km 70	Habitation below proposed Road Approaches
	
Gagangir Village at km 71	Gagangir Village at km 73
	
Cross Road to Zariyath Bardporden under construction	

	
Cattle pass is required for road user safety	Primary School at Gagangir near km 72
	
Habitation at km 72	Habitation at km 72
	
Road Overlay in progress by BEACON	BEACON (BRO) Office at km 72

Existing NH- Right of Way 79ft (24m) in urban area	School at Bardiporden
Minor Bridges and Culverts are required at regular interval on water Channels locations	
Minor Bridges and Culverts are required at regular interval on water Channels locations	



2.4 ZOJILA TUNNEL

The construction of Zojila tunnel and approaches joining to NH-1 under study will be one of the most important link to join Shetkari – Sonamarg – Zojila – Drass - Kargil - Leh towns leading to the most important, sensitive and defence stations Srinagar and Kargil in the state of Jammu & Kashmir. It also provides the most important connecting link to a large area of the state including the hill station Leh. The emergence of nearby towns of Kashmir and Leh as tourist and army camp centers, the disturbances in the neighboring state of Jammu and Kashmir and its proximity to Delhi have only added up to the growth of tourism and related activities. It is therefore proposed that the present 2-lane road be rehabilitated, improved and upgraded to 2-lane Tunnel and the project area of the approximately 13 km long Zojila Tunnel and 5km long road approaches to the State of Jammu and Kashmir. The tunnel shall be constructed between the villages Zojila (Km 92) and Drass (km105), approximately 10 km west of the village Sonamarg.

Zoji La is a high mountain pass in India, located on the Indian National Highway 1 between Srinagar and Leh in the western section of the Himalayan mountain range. Zojila Pass is located at an elevation of 3529 meters and about 100 kilometers from of Srinagar on National highway 1D connecting Srinagar with Leh. It is normally closed during winter,

During1947-48 tribal raiders and Pakistan regulars had occupied Zojila, Dras and Kargil. This road was used as supply line to Leh as such it was essential to clear it and save Leh from enemy occupation. Between Kargil and Leh only two J&K State Forces platoons were guarding the bridge at Khaltse. Indian Armylaunched campaign to liberate these areas named it “Operation Duck

Drass in the Kargil District of Jammu and Kashmir. It is the second coldest place in the desert. The valley came into prominence during the Kargil war of 2009. Set at close to 11,000 ft, the valley is sometimes called the Gateway to Ladakh. The Himalayan mountains range to about 21,000 ft. The valley starts at the base of the Zojila pass. The pass has long been considered the gateway to the Himalayas. The hardy inhabitants of Indo-Aryan origin has long survived the harsh winters and rugged terrain of the place. Isolated from the rest of the world, in a region that is blocked by fierce snow storms and landslides for part of the year. A trek from Drass through the Umbala pass offers spectacular views of the most undiscovered places of the Himalayas. Many short treks can be made to the surrounding upland villages and meadows. Do visit the Dras war memorial and the Mushko valley. Trek to the top of the Sando top to the tiger hill for a glimpse of the Pakistan posts.

2.5 ZOJILA PASS SITE PHOTOGRAPHS

Site Photographs showing the salient features of the existing road, adjoining hills, are attached herewith for ready reference:



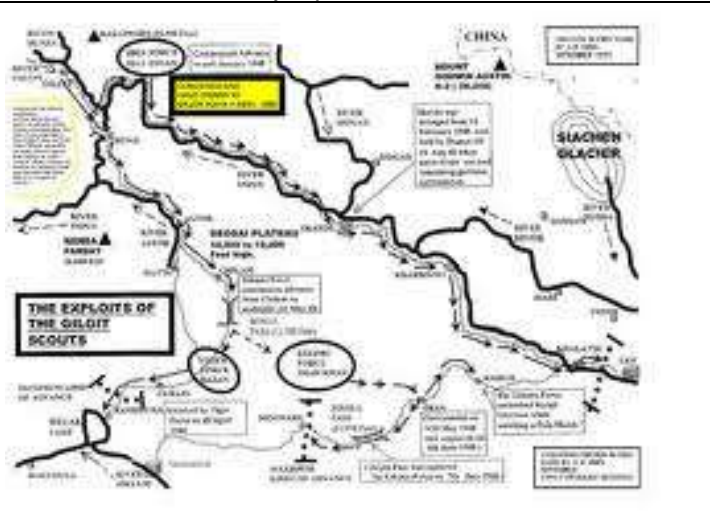
Project Vijayak - Zozila Pass



Zojila pass location



Proposal of All Weather Zojila Tunnel



Route Map



National Highway No 1 D Srinagar – Leh Marg



Mark Stone Zojila Pass



Ponies are used for carrying local materials



Sharp Bend Snowy Road



Mountainous Road with steep gradient



Half Cut & Fill Mountainous Road



Snowy Road in Deep Cut



Mountainous Road with steep gradient



Traffic Jam during Snowy Season



Snow Removing Machines









View of Nature Paradise - Zojila Pass











Traffic Jam on Mountainous Road



NH-1 D : Maintained by Border Roads Organisation

	
<p>NH-1 D : Mountainous Road</p>	<p>Road near to Zojila Pass</p>
	
<p>Snow Cutting Machine for passing Traffic</p>	<p>Road in Half Cut & Fill</p>
	
<p>Project Road during Snow season</p>	<p>Traffic on Project Road</p>

	
<p>Task Force on Job</p>	<p>Our Brave Hero : National Security First</p>
	
<p>Hard Winter & Chilled Weather</p>	<p>Agriculture Fields near project road</p>
	
<p>Yeh Desh Hai Beer Jawano Ka</p>	<p>Nation First : Salute to Maa ka Lal</p>
	
<p>Street up to Zoji La (coming from Srinagar)</p>	<p>Dras War Memorial</p>

3 PROJECT PROPOSAL

3.1 Z-MORH TUNNEL

Single tube highway tunnel with two traffic lanes in bi-directional traffic Main structures: traffic tunnel, separate parallel egress tunnel, construction/ventilation tunnel Additional structures: Portal structures, cut & cover tunnel, ventilation cavern, muck disposal areas, cross passages Approaches to the western, eastern and intermediate portals including the bridges. service and control buildings and other project facilities as specified.

West Portal at approx. km 73.5 NH-1 in the area of Rezan/Gagangir approx. 30 km east of Kangan East Portal at approx. km 81 on NH-1, approx. 3 km west of Sonamarg Portal of ventilation tunnel & construction adit at approx. km 77.5 NH-1.

West and East Portal are at elevation approx. 2500m & 2637 m respectively. The Portal of ventilation tunnel & construction adit at elevation approx. 2570 m. Tunnel length is 6.5 km. Egress tunnel length is also estimated as 6.5 km. Construction/ventilation tunnel length is approximate 575 m. Maximum overburden is approx. 1075 m. Vertical Gradient for tunnel is +2.11 % (1:47) from the West Portal to the East Portal.

Table 3.1: Alignment / Construction of Tunnel and Its Salient Details

S. No	Description	Location on Existing Road (km)		Elevation	Length(m)
		From	To		
1	Z Morh Tunnel	73.500	81.000	2500m & 2637m at West & East Portal	6500m
2	Egress (Escape) Tunnel	73.500	81.000		6500m
3	Ventilation Tunnel				575m
4	Adit Location	77.500		2570m	
5	Vertical Gradient	73.500	81.000	2.11%	6500m
6	Maximum Overburden				1075m

3.2 DESCRIPTION OF THE TUNNEL SYSTEM AS PER TECHNICAL SCHEDULE

3.2.1 Portals

3.2.1.1 Western Tunnel Portal

Final portal elevation:	2500 m
Final portal location:	Pos. Y: 518104.2 m UTM Pos. X: 3794909.4 m
Mined tunnel portal location:	Pos. Y: 518130.7 m UTM Pos. X: 3796046.2 m
Cut & cover tunnel length:	42 m. Cross section as indicated in Appendix B-I
Ventilation building:	Situated above the cut & cover tunnel, two axial fans, electrical supply installations
Service and control buildings:	tentative floor space of 800 m². To be constructed as per drawings approved by the Engineer-in-Charge
Approach road to portal:	Two lane approach road of approx. 5250 m length with an inclination of approx 1 in 20 from Rezan . Take off point at approx Km 69 on Srinagar-Sonamarg section of NH 1. Approach roads includes two minor bridges. The junction of the approach road with the existing NH shall enable unhindered traffic flow in both directions without conflict.

3.2.1.2 Eastern Tunnel Portal

Final portal elevation:	2637 m
Final portal location:	Pos. Y: 524066.2 m UTM Pos. X: 3796057.8 m
Mined tunnel portal location:	Pos. Y: 524038.2 m UTM Pos. X: 3796046.2 m
Cut & cover tunnel length:	31 m. Cross section as per Technical Schedule Appendix B-I
Ventilation building:	situated above the cut & cover tunnel, two axial fans, electrical supply installations
Service building:	Floor space of 800 m ² . To be constructed as per the drawings approved by the Independent Engineer.
Approach road to portal:	Two lane approach of 550 m from existing Highway NH1 including bridge construction with a span of 110 m. Take off point near Km 81.3 on Srinagar-Sonamarg section of NH1. The junction of the approach road with the existing NH shall enable unhindered traffic flow without conflict in both the directions. This approach road to also allow unhindered flow of traffic on the Sonamarg bypass road. Additionally, all tunnel traffic flowing in both the directions should have suitable access to the Sonamarg bypass Road

3.2.1.3 Vertical and Horizontal Alignment

The vertical and horizontal alignment of Tunnel is given in the Technical Schedule: drawings volume at Appendix B-I.

3.2.2 Cross Section Width and Height

3.2.2.1 Cut & Cover Tunnel

The cut & cover tunnel is defined as the tunnel section from the final portal to the mined tunnel portal. The length of the cut & cover section shall be 42 m at the western and 31 m at the eastern portal area. The typical cross section is given in the drawings in Technical Schedule Appendix B-I.

A clearance profile with a height of 5.5 m over the carriageway and 2.3 m over the walkway shall be provided. The width of the cut & cover tunnel shall be 10.8 m with the sections as described below including paved carriageway with a width of 7.50 m and walkways on both sides of the carriageway each 1.4 m wide.

Tab.3.2: Cross section elements cut & cover tunnel

Cross Section Element	Width
Walkway:	1.40 m
Hard shoulder:	0.25 m
Driving lane	3.50 m
Mountable Median	0.50 m
Driving lane:	3.50 m
Hard shoulder:	0.25 m
Walkway:	1.40 m
Overall:	10.80 m

3.2.2.2 Mined Tunnel

The mined tunnel is defined as section between the mined tunnel portal West and East with a length of 6419 m. The typical cross section is given in the drawings in Appendix B-I.

A clearance profile with a height of 5.5 m over the carriageway and 2.3 m over the walkway shall be provided. The width of the clearance profile shall be 10.0 m as per the table below:-

Tab. 3.3: Cross section elements mined tunnel

Cross Section Element	Width
Walkway:	1.00 m
Hard shoulder:	0.25 m
Driving lane:	3.50 m
Mountable Median	0.50 m
Driving lane:	3.50 m
Hard shoulder:	0.50 m
Walkway:	1.00 m
Overall:	10.00 m

The excavation cross section of the main tunnel based on the construction design of the for the different support categories, varies between 110 m² and 138 m².

3.2.2.3 Ventilation Concept

The ventilation system consists of a fully transversal ventilation system with four ventilation sections, including one intermediate ventilation cavern and ventilation tunnel. The length of the ventilation sections and cross sections of the ventilation ducts are given below.

Ventilation section length:	Section 1:	2059 m (from western portal)
	Section 2:	1484 m (from ventilation cavern)
	Section 3:	1186 m (from ventilation cavern)
	Section 4:	1762 m (from eastern portal)
Ventilation cross section:	Exhaust air duct:	10.6 m ²
	Fresh air duct:	10.6 m ²

3.2.2.4 Ventilation Cavern

The ventilation cavern is situated perpendicular to the main tunnel at km 3.631 south of the lay-by and with a length of 30 m. The main characteristics of the ventilation cavern are as follows.

Cavern excavation height:	10.5 m
Cavern excavation width:	21.0 m
Cavern length:	30.0 m

3.2.3 Intermediate Ventilation & Construction Access Tunnel

An intermediate ventilation tunnel connects the ventilation cavern to the outside.

An approach road shall be constructed from the National Highway NH-1 to the construction adit portal. During construction of the main tunnel, the ventilation tunnel can be used as intermediate construction adit.

Tunnel length:	575 m
Gradient:	+0.9 % inclined from portal towards cavern

Portal location:	Elevation: 2570 m Pos. Y: 521004.7 m UTM Pos. X: 3795199.3 m
Approach Road:	Length: 1100 m Estimated gradient: 10 % and 2.5 % in hair-pin curves respectively This approach road shall be a permanent road for maintenance purposes but it is not deemed to be a road for public use. Final configuration shall be as per concessionaire's detailed design subject to approval by the Independent Engineer.

3.2.4 Separate Parallel Egress Tunnel and Cross Passages

The separate egress tunnel shall be constructed parallel to the main tunnel. Distance between the axes of the main and the egress tunnel shall be maintained at 25 m depending upon the actual ground conditions. The egress tunnel shall have a cross section suitable for emergency vehicle. Additionally the egress tunnel can be used for site traffic during construction of the main tunnel. The typical cross section is given in the drawings at Appendix B-I.

Egress tunnel length:	6.5 km
Clearance profile:	6.0 m width and 3.5 m height

Cross Passages: At every 250 m, cross passages connect the main tunnel with the separate parallel egress tunnel.

Drivable cross passages connecting the egress tunnel with the main tunnel with interval of 750 m and at lay-bys on the left highway side (L.H.S.). The typical cross section of the drivable cross passage shall be equal to the egress tunnel.

Pedestrian cross passages connect the egress tunnel with the main tunnel with interval of 250 m. The typical cross section of the pedestrian cross passage is 3.5 m width.

The length of cross passages shall be as per the concessionaire's detailed design.

The locations of the cross passages are given in the schematically in the drawing "Tunnel system and installation" in Appendix B-I.

3.2.5 Lay-by Cabinet

Lay-bys are located on both highway sides (B.H.S.) of the tunnel with interval of 750 m and a length of 40 m. The detailed locations is given in the drawing "Tunnel system and installation" in Appendix B-I

3.2.6 Jet Fan Cabinet

Jet fan cabinets are located with an interval of 400 to 600 m. The jet fan cabinets are situated at both highway sides (B.H.S.) with a length of 30 m (three inner lining block segments). The detailed location is given in the drawing "Tunnel system and installation" in Appendix B-I.

3.2.7 Emergency Telephone & Fire Fighting Cabinet

Emergency telephone and fire fighting cabinets are located with an interval of 125 m. The emergency telephone cabinets are situated at the right highway side and the fire fighting cabinets are situated on the left highway side looking along tunnel meterage. The detailed location is given in the drawing "Tunnel system and installation" in Appendix B-I.

3.2.8 Mountable Median

Mountable median of 0.5 m width shall be provided in the centre of the carriageway to divide the two traffic lanes. Other features of the median shall be as per concessionaire's detailed design in accordance with relevant codes

3.2.9 Final Interior Finish.

The main traffic tunnel shall have a final interior finish of a fire resistant material of suitable surface characteristics as per concessionaire's detailed design subject to approval by Independent Engineer

3.2.10 E&M Facilities

As per concessionaire's detailed design subject to approval by the Independent Engineer.

The main equipment shall consists of switchgears, transformers, power distribution boards, luminaries, safety facilities and associated equipment. Details are given in the relevant drawing in Appendix B-I .For the Z-Morh tunnel a high voltage facility with electrical feed from both sides shall be provided. Electrical substations are located at an interval of 750 m in separated niches at each lay-by and in the ventilation cavern near the middle of the tunnel.

Tunnel safety facilities such as CCTV-Cameras, traffic lights, variable message signs, traffic loop detectors, emergency communications, alarm push buttons, fire detection systems etc. shall be provided as per concessionaires detailed design

An alternative source of power –uninterruptible power supply (UPS) equipment shall be provided to maintain supplies of the essential equipment for duration of 80 minutes.

An adequate lighting system shall be provided as per concessionaire's detailed design The light intensity of the entry and exit zones shall be adapted to the actual outside lighting level according to external conditions (day/night, regulation through measurement of luminous density).

A fire-extinguishing water pipe to be installed at one highway side providing fresh water supply to the hydrants in case of an incident or maintenance measures.

The egress tunnel shall also be equipped with lighting and safety facilities such as CCTV-Cameras, fire detection system etc.

Tunnel service buildings to be located close to both tunnel portals. The following equipment and installation, contained in the service buildings, to be provided as per concessionaire's detailed design.

- control room
- facilities for the electrical power supply: main electricity substation, HV switchroom, LV switch room, UPS room, battery room, space for transformers;
- diesel generator, fuel tanks
- plant rooms for the tunnel maintenance and future requirements, stores;
- staff room and toilet facilities (if building is manned);

3.2.11 Drainage Concept

The tunnel shall be designed as a dry and drained tunnel as per concessionaire's detailed design.

Allowable infiltration in the main traffic tunnel ≤ 0.002 gal/sq. ft/day(US Gallon).

The tunnel high point is equal to the eastern portal which leads to a drainage to the lower western portal (Srinagar) with a gradient of 2,11% over the whole tunnel length of 6,5 km.

The tunnel vault is sealed against ground water inflows with a water proofing system. The water is drained along the bottom of the side walls with perforated drainage pipes..

3.2.12 Construction Concept

The construction of the main and the egress tunnel to include the cross passages to be carried out preferably by NATM method. However the concessionaire may adopt other internationally accepted method as per concessionaire's choice with prior approval of BRO in consultation with the Independent Engineer.

The final choice of number of working faces/attack points rests with the concessionaire, however as guideline, the Z-Morh tunnel may be constructed from both tunnel portals and from the intermediate ventilation/construction tunnel at tunnel km 3.631. During winter season construction works from the eastern portal and from the ventilation/construction tunnel may not be feasible due to closure of the National Highway NH-1 and approach roads.

The parallel egress tunnel in combination with the drivable cross passages may be used for the construction of the main tunnel.

3.2.13 Site Installation

Three site installations are visualised . A main site installation in the area between Rezan and Gagangir close to the National Highway approx. 1.0 km from the western portal and two additional site installations in the direct vicinity of the eastern portal and the ventilation/construction tunnel portal. After making the assessment of requirement, the concessionaire has to ascertain the availability of the land with the local BRO authorities.

3.2.14 Muck Dump Disposal

Muck dump disposal sites are available in the project area. Upto six pockets have been proposed These disposal area are located between approx. km stone 69 (southwest from the western tunnel portal) and Km stone 90 on existing NH 1. Prior to any disposal of muck dump material, necessary permission shall be obtained from the local authorities(Civil administration/Forest/Wildlife) as per law for which the local BRO office will provide necessary assistance. For estimation of capacity of the individual pockets the concessionaires are required to carry out reconnaissance in coordination with local BRO authorities. Muck disposal and management shall be carried out in accordance with the Environmental Laws of State/Central Govt.

3.3 IMPROVEMENT PROPOSALS AND FACILITIES AS PER PROPOSED DESIGN

3.3.1 Intersections

It is envisaged that the major at grade intersections will require significant improvements to provide safe and smooth traffic flow at demerging & merging of the project road with existing National Highway NH-1. There shall be three intersections at start of road approach, cross road at Rezan, Gagangir and Shetkari Village.

3.3.2 Grade separated structures

There is no proposal of grade separated structures as per revised RFP and details of Road Approaches dated 19th September 2012..

3.3.3 Slip Roads

The project road approach from Eastern Portal to Sonamarg town (End of Project) is passing through newly constructed Sonamarg Bypass, Sindh River and Sonamarg Town Road. Both roads are constructed on the bunds of the Sindh River ends. The Major Bridge (1x40+1x70m spans) is proposed on Sindh River. Sonamarg Bypass & Sonamarg Town Road (Existing NH-1) are under BEACON, BRO. The construction and maintenance of these roads shall remain with BRO. An "U" shape connector of 70m length is provided to Sonamarg Bypass road and Sonamarg town road. A Slip Road of 300m length will be constructed by the concessionaire to join Eastern Portal to Sonamarg Bypass Road. The alignment plan showing general

arrangement of the these connecting approaches are provided with REVISED RFP and Details of Road Approaches dated 19th September 2012.

3.3.4 Cut and Fill section

Western road approach starts from west portal of the tunnel and ends on the NH-1 at km 69, near Rezan village. The alignment passes through a series of mountains & hills with steep slopes towards existing road. The alignment provided with REVISED RFP and Details of Road Approaches dated 19th September 2012 is adopted. The details of horizontal & vertical alignments are not provided. It is observed that the road geometry are not as per design speed (80kmph) and IRC guidelines. Vertical profile is designed for ruling gradient, up to 5% (1:20 - 1:30 gradient) to the maximum extent. The design chainages are considered from km 69 (Srinagar side) Start CH. 0+000 on NH-1 and the End chainage is CH. 5+250 at West Portal entry. The Eastern approach length is 550m. The slip road to SMB and U length to SSG are 300m & 70 m respectively. The details of Cut & Fill section (Lengths and Areas) taken from provided details of Road approaches are as below:

Table3.4: Summary of CUT and FILL

Description	Cut (m)	Fill (m)	Half Cut & Fill (m)	Bridge (m)	Total (m)
Western Approach	3940	850	400	60	5250
Eastern Approach		400	40	110	550
Loop for U turn		70			70
Slip Road to SMB	200	50	50		300
Approach to Adit	600	300	200		1100
Total	4740	1670			

Total Cut Length = 4740m and Total Fill Length = 1670m for both Left & Right sides.

Description	Cutting Hard Rock (Cum)	Cutting SMB (Cum)	Fill SMB (Cum)
WP, EP, APPROACH TO SBP, APPROACH TO SSG	168347	512268	107851

It is assumed that the quantities of Hard Rock Cutting will be 50% under Blasting Prohibited and 50% Controlled Blasting.

3.3.5 Retaining and Breast wall

AS PER CROSS SECTIONS SHOWN IN THE ATTACHED DETAILS OF APPROACH ROADS & BRIDGES (PDF FILE), NORMAL CUT AND FILL SLOPES ARE PROPOSED. THERE IS NO PROVISION OF RETAINING / BREAST WALL AS PER THESE DETAILS. HENCE BOQ AND COST ESTIMATES ARE PREPARED ACCORDINGLY.

However, as per terrain, existing constraints of land availability (24m Proposed ROW), practicality, stability of side slopes, difficulty in road construction in real etc, retaining walls & Breast walls shall be provided for major cut & fill sections.

New alignment will require cutting on the slope in the hillside and filling on the valley side. Breast walls are proposed for support in hillside cut and retaining walls on valley side for retaining earth fill. Retaining/ Breast walls are proposed to be constructed in random rubble stone masonry in cement mortar upto height 6.0m and PCC beyond 6.0m. The tentative details of retaining and Breast wall are taken from Cross Sections Sketches are given in the table below.

Table 3.1: Summary of Breast, Retaining Wall

Description	Total	Retaining Wall	Breast Wall
Western Approach	5250	200	4575
Eastern Approach	550	450	300
Loop for U turn	70	100	
Slip Road to SMB	300		300
Approach to Adit	1100	400	300
Total		1150	5475

Total Breast Wall Length = 5475m and Total Retaining Wall Length = 1150m for both Left & Right sides.

3.3.6 Bus Bays and Bus Shelter

NO details of the Bus Bays & Bu Shelter are given in the Technical Schedule. Provision of three nos of Bus bays & Bus Shelters are considered for BOQ & Cost Estimate as listed below.

- At Village Rezan near Km.69.000
- At Village Gagangir km 71.500
- At Village Shetkari km 82.500

3.3.7 Truck Lay By

NO details of the Truck lay byes are given in the Technical Schedule. Provision of two nos of Truck lay byes considered for BOQ & Cost Estimate. Two locations were considered suitable, as listed below.

- At Km.69.800
- At km 83.000

3.3.8 Rest area and way side amenities

NO details of the Rest Areas & way side amenities are given in the Technical Schedule. Provision of two nos of Rest Areas are considered for BOQ & Cost Estimate. Two locations were considered suitable near toll plaza, as listed below.

- At Km.71.500 on Right Side
- At Km.81.300 on Left Side

3.3.9 Toll Plaza Locations

There is NO proposed Toll Plaza as per Revised RFP and Technical Schedule.

3.3.10 Land Acquisition

The land use type details, area calculations, tentative rates and Land Acquisition Cost have been provided with the documents updated as on 19th September 2012. The details are as below:

Table3.5 : Total Area Required for Z-Morh Tunnel

Sl	Area Required for	Type of Land	Measurement	Area (Hect)	Rate per Hect (Rs in Lakh)	Amount (Rs in Lakh)
1	Approach Road West Portal	Revenue	795x20.3138	1.6149471	316.589	511.274
2	Approach Road West Portal	Forest	4288 x 24.1	10.33408	10.52	108.715
3	Service Building and HS West Portal	Forest	150 x 150	2.25	10.52	23.670
4	Z-Morh Tunnel	Forest	6500 x 42	27.3	10.52	287.196
5	Ventelation Shaft	Forest	900 x 20	1.8	10.52	18.936

Sl	Area Required for	Type of Land	Measurement	Area (Hect)	Rate per Hect (Rs in Lakh)	Amount (Rs in Lakh)
6	Service Building and HS East Portal	Forest	200 x 200	4	10.52	42.080
7	Approach Bridge Eastern Port	Forest	150 x 100	1.5	10.52	15.780
8	Approaches Eastern Port	Forest	100 x 60	0.6	10.52	6.312
9	Approaches Eastern Port	Forest	150 x 24	0.36	10.52	3.787
10	Muck Disposal	Forest	300 x 200	50.0	10.52	526.004
		Forest	Total	99.7594		1543.754
				Say (Rs Crores)		15.44

3.4 PRELIMINARY DESIGN PROPOSAL FOR STRUCTURES

3.4.1 Minor Bridges

Existing Bridge: There is no existing Bridge.

The proposals for new minor bridges as per documents dated 10th September 2012 are based on the following considerations:

As per Schedule B, new 2-Lane bridges of 1 x 30m span have been proposed at km 2/775 and km 5/200 on Western Road Approaches. Super Structure of Steel confirming BIS 2062 Grade C is proposed. The Deck width of two lane bridge is 12m. Open Foundation and Steel Girder Superstructure is proposed. Type of superstructure & span arrangement has been kept same as given in schedule. The General Arrangement Drawing are prepared accordingly and enclosed herewith.

Structural System for Bridge:

Superstructure:

Composite Steel Structure The overall deck width for 2-lane bridges is kept 12m in hilly areas comprising of 7.0m of carriageway 1.5m footpath with 0.5m RCC crash barrier on both side of carriage way & 0.5m of steel railing with kerb on outer side with footpath.

Bearings Arrangement & expansion Joint: The Superstructure is proposed to be supported on a series of Free POT cum PTFE, Pin & metallic guided bearings as bridge lies in zone V except solid slab bridges where tar paper is provided. The Bearing arrangement will be such as to cater for vertical and lateral loads transferred from the superstructure and allowing for rotations at the joints.

Strip seal type expansion joint is proposed for all the bridges except solid slab bridges where filler type expansion joint is provided.

Substructure: The superstructure is supported on cast-in-place RCC cantilever abutment & RCC circular piers for Composite Bridge. As Bridge lies in seismic zone-V, seismic arrestors are provided in transverse & longitudinal direction for safety against dislodgment of superstructure during seismic activity.

Foundation: As per the site stratigraphy and open foundation is proposed for abutments & piers.

Material & Grade:

Steel Girder Superstructure	-	BIS 2062 Grade C
RCC deck	-	M40

RCC abutment & abutment cap, pier & pier cap		
Supporting RCC superstructures	-	M30
RCC abutment & abutment cap		
RCC Foundation	-	M30
RCC Foundation	-	M35
Cables	-	19K13/12K13
Structural steel	-	BIS 2062 Grade C
Steel	-	Fe 500 HYSD

3.4.2 Major Bridges

The proposals for new major bridges are based on the following considerations:

Proposed Bridge: One new 2-Lane Major Bridge of **(1x40m+1x70m=110m)** is considered as per updated RFP and provided data is proposed. Span arrangement has been fixed depending on type of superstructure, bridge length, site location & construction feasibility.

Structural System for Bridge:

Superstructure:

The overall deck width for 2-lane bridges is kept 12.0m in hilly areas comprising of 7.0m of carriageway and 1.5m footpath with 0.5m RCC crash barrier on both side of carriage way & 0.5m of steel railing with kerb on outer side with footpath.

Bearings Arrangement & expansion Joint: The Superstructure is proposed to be supported on a series of Free POT cum PTFE, Pin & metallic guided bearings as bridge lies in zone V. The Bearing arrangement will be such as to cater for vertical and lateral loads transferred from the superstructure and allowing for rotations at the joints.

Strip seal type expansion joint is proposed for the bridge.

Substructure: The superstructure is supported on cast-in-place RCC cantilever abutment & RCC circular piers. As Bridge lies in seismic zone-V, seismic arrestors are provided in transverse & longitudinal direction for safety against dislodgment of superstructure during seismic activity.

Foundation: As per the site stratagraphy open foundation is proposed for abutment A1 (Eastern Portal side) and Pile Foundations are proposed for Pier (P) and Abutment A2 (Sonamarg town side). As per available information, in lean season either river bed is dry or water depth at proposed pier locations is on very lower side and excavation for open foundation is feasible, therefore open foundation is preferred over well.

However one central pier may be provided with well foundation seeing the difficulty in construction of open foundation due to high flow velocity and deep water.

Material & Grade:

Steel Girder Superstructure	-	BIS 2062 Grade C
RCC deck	-	M40
RCC abutment & abutment cap, pier & pier cap		
Supporting RCC superstructures	-	M30
RCC abutment & abutment cap		
RCC Foundation	-	M30
RCC Foundation	-	M35

Cables	-	19K13/12K13
Structural steel	-	BIS 2062 Grade C
Steel	-	Fe 500 HYSD

Structural System for Overpass:-

The structural system of proposed Overpass is single cell box structure as given in schedule. The deck width will be kept same 12m as that of roadway.

RCC crash barrier with pipe railing and asphaltic wearing coat is proposed.

Bearings Arrangement & expansion Joint:

No bearings will be required in case of underpasses. Bitumen plug type expansion joint will be provided between box & approach slab.

Foundation: Open raft foundation is proposed assuming top of base slab at 0.75m below cross-road level.

Material & Grade:

RCC Box	-	M30
Steel	-	Fe 500 HYSD

3.4.3 Culverts

3.4.3.1 General

1. As per Schedule no culverts are provided.
2. But as per site requirements, RCC Box culverts are required at regular interval for catering water from hill slope longitudinally. Accordingly 40 RCC Box culverts 1x4mx 4m height are proposed.
3. Box culverts have been proposed in all locations.
4. Vent height of culvert at some locations are kept higher so that thes can be used as pedestrian/ cattle pass during dry season.
5. While calculating vent height above culvert, maximum height of cushion is kept 4m wherever it is required and earth is retained with retaining wall constructed monolithically with top slab.
6. In culverts with fills it has been decided to provide higher vent heights instead of increasing the width of culverts with earth spills because of following reasons
 - a) Increasing height is found to be more economical than increasing width.
 - b) As ground levels on valley/hill side is not known and therefore practically it may not be feasible to increase width of culvert as ground level falls sharply or if ground is sloping.

3.4.3.2 Concept for box type structure construction

- a) Maintain the stream in natural condition.
- b) Construct box with the earth fill of height of max. 4.0m. Retaining wall of suitable section and height is to be provided at end to retain the earth above box structure.
- c) Provide a 2 m deep cut off wall structurally connected to the box.
- d) If required provide CRM cascade on downstream from invert level of box on downstream to ground level. The cascade shall be splayed beyond inner dimensions of box in an angle of 30 degrees on both sides. A side wall of 300 mm thickness and 500 mm height shall be provided at end to channelize water flow in cascade.
- e) It is proposed to provide gabion mattress in the direction of flow on downstream side.

3.4.3.3 Approach Slab

It is proposed not to provide Approach slab for the culverts as per clause no. 13.5.3 Page no. 43 of IRC: SP 13 - 2004

3.5 TUNNEL ALIGNMENT

The proposed tunnels alignment comprises of straight/gentle curves.

3.5.1 Horizontal Alignment of Tunnel

Horizontal alignment of tunnel is re-designed as per drawings provided in Technical Schedule. The coordinates of the tunnel alignments are as below.

Table3.6: Horizontal Alignment Details

Point Nt \	Chainage	Length of Section [m]	Pos Y [m]	PosX[m]]	RW [GON]	Radius [m]
PS	KM 0+000	0	518056.251	3794835.	015	30.8318	500
CE	KM 0+169.391	169.391	518158.77	3794968.	843	52.3994	500
TCE	KM 0+220.591	51.2	518197.474	3795002.	351	55.6589	0
TCS	KM 1+582.663	1362.072	519242.301	3795876.	179	55.6589	0
CS	KM 1+633.288	50.625	519281.407	3795908.	327	57.2704	1000
CE	KM 2+067.966	974.678	520202.175	3796079.	55	119.3203	1000
TCE	KM 2+658.591	50.625	520250.223	3796063.	608	120.9318	0
TCS	KM 3+571.038	912.447	521113.792	3795768.	976	120.9318	0
CS	KM 3+621.663	50.625	521161.84	3795753.	035	119.3203	-1000
CE	KM 3+873.359	251.696	521408.922	3795708.	677	103.2968	-1000
TCE	KM 3+923.984	50.625	521459.515	3795706.	91	101.6854	0
TCS	KM 4+936.433	1012.449	522471.609	3795680.	109	101.6854	0
CS	KM 4+987.058	50.625	522522.224	3795679.	196	100.0739	-1000
CE	KM 5+220.084	233.026	522753.179	3795705.	956	85.239	-1000
TCE	KM 5+270.709	50.625	522802.244	3795718.	419	83.6276	0
TCS	KM 6+472.017	1201.308	523964.043	3796023.	974	83.6276	0
CS	KM 6+523.217	51.2	524013.324	3796037.	838	80.3681	-500
CE	KM 6+736.267	213.05	524196.667	3796143.	161	53.2418	-500
TCE	KM 6+787.467	51.2	524233.469	3796178.	748	49.9823	0
PE	KM 6+962.226	174.759	524357.008	3796302.	356	49.9823	0
PS...	Project Start	PE.. CE..	.Project End .Curve End				
CS...	Curve Start	Start	...Transition Curve End				
TCS.	..Transition Curve	TCE					

3.5.2 Vertical Alignment of Tunnel

A continuous gradient of +2.11 % from West Portal to the East Portal is designed

3.5.3 Typical Cross Section

The typical cross section is designed according to Indian and International Standards and Guidelines for road tunnels. The proposed cross section of the carriage way consists of the following elements:

- ❖ Walkway: width = 1.0 m
- ❖ Hard clearance: width = 0.50 m including edge lane marking (0.12 m) with longitudinal ribs (0.20 m x 0.15 m x 0.7 cm) which provides an acoustical signal if

vehicles deviate from the driving lane

- ❖ Driving lane: width = 3.50 m
- ❖ Borderline between driving lanes: The driving lanes are divided by two traffic lane markings consisting of two continuous lines (each 0.12 m with a distance of 0.26 m) and two rows of longitudinal ribs (0.20 m x 0.15 m x 0.7 cm) which provide an acoustical signal if vehicles deviate from the driving lane. Additionally a reflecting guidance system between the two continuous traffic lane markings is installed

3.5.4 Pavement Composition

The road pavement in Tunnel consists of 570mm thick layers as below :

- ❖ 220 mm Concrete Surface Pavement (PQC)
- ❖ 50 mm Dry Lean Cement Concrete (DLC) Sub-Base Layer
- ❖ 300 mm Granular Sub-Base (GSB) layer

3.5.5 Footpath

Tunnel is provided 1.0m footpath on both side of road for pedestrian, safe movement of service personnel and free access in case of emergency repair.

3.5.6 Side Drains for draining seepage Water

Suitable side drains 1000mm x 1000mm for draining seepage water are proposed on both sides of road. Smaller section of drain can be adopted for cross passes and escape tunnels.

3.5.7 Tunnel Safety Concept

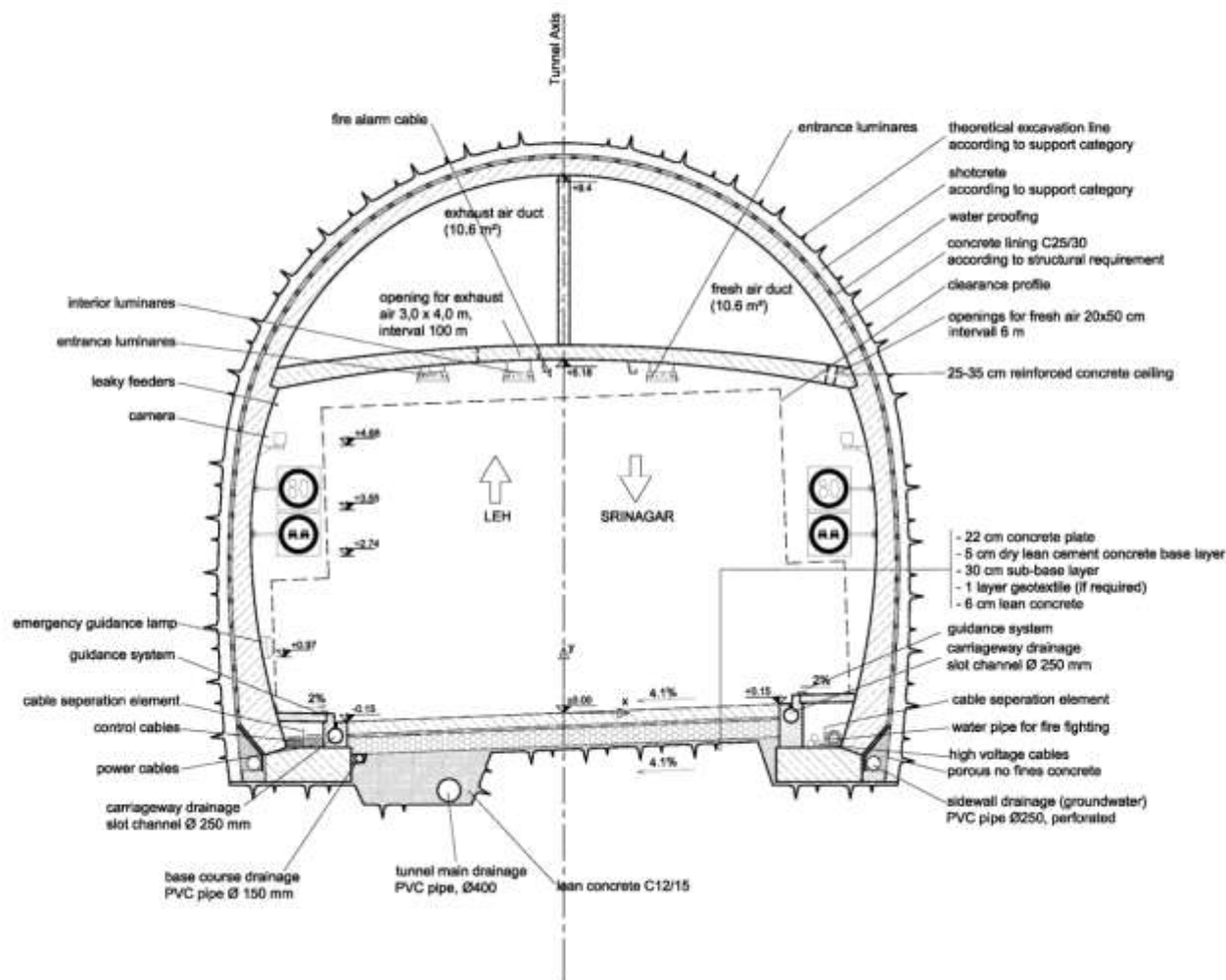
The tunnel safety concept is designed according to International Standards and Guidelines. The following safety and operational facilities are designed.

- Egress tunnel parallel to the main tunnel
- Cross passage driveable each 750 m
- Cross passage pedestrian each 250 m
- Lay-bys each 750 m
- Emergency telephone niche each 125 m
- Hydrant niche each 125 m
- Jet fan niche approx. each 750 m
- Electrical supply cabinet each 750 m

The emergency route for passengers in case of an incident in the tunnel leads through cross passages (driveable or for pedestrian only) to the parallel separate egress tunnel which leads to the outside and is supplied with fresh air and lighting with an independent ventilation and power supply system. Due to the distance of cross passages of max. 250 m, every passenger is able to get to the emergency exits within 4 minutes.

The typical cross sections for the main tunnel with and without invert are given in Figures below. More details concerning the typical cross sections of the main tunnel and the other tunnel elements are given in the drawings 8482B_II-ZMT_GEOM-01-12-00 to 8482B II-ZMT GEOM-20-12-00.

TYPICAL CROSS SECTION, CLEARANCE PROFILE AND INSTALLATIONS WITHOUT INVERT SLAB



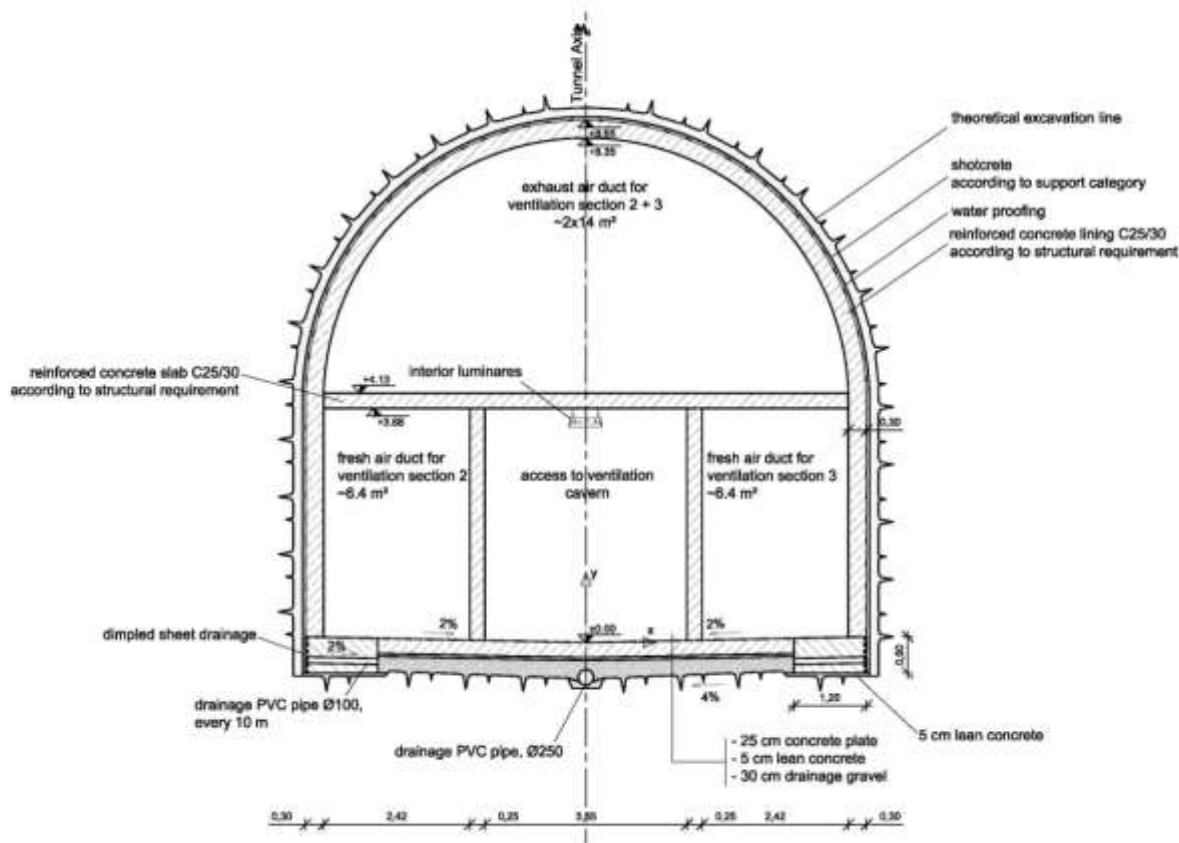
As per Technical schedule and Drawings given in Appendix B1, the length of tunnel is 6500m.

Tunnels Cross Sections shown in the drawings have following Road components:

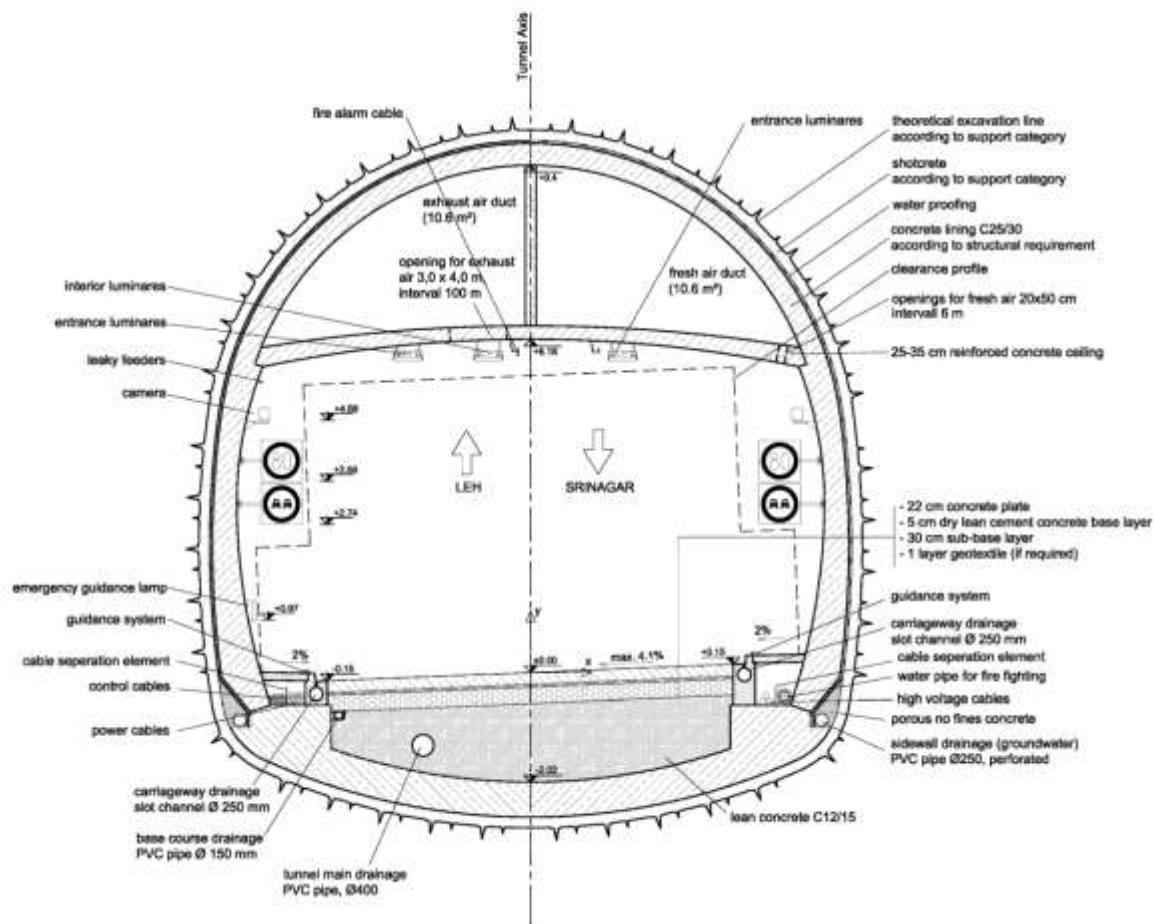
Sl	Description	No.	Length (m)	Width (m)	Height/Thick (m)	Quantity
1	Main Tunnel	1	6500			6500
2	Egress (Escape) Tunnel	1	6500			6500
3	Ventilation Tunnel	1	750			750
4	Adit	1	575			575
5	Cross passage drivable @750m	9	25			225
6	Cross passage pedestrian @250m	27	25			675
7	Lay-bys @ 750m interval	9	25			225
8	Carriageway (Main Tunnel)	1	6500	7.0		
9	Carriageway (Escape Tunnel)	1	6500	7.0		
10	Carriageway (Ventilation Tunnel)	1	750	7.0		
11	Carriageway (Adit)	1	575			
12	Walkway	2	13325	1.0		
13	Hard Clearance on sides	2	13325	0.50		
14	Edge Marking	2	13325	0.12		
15	Longitudinal Ribs	3	0.70	0.20	0.15	
16	Border Line between driving lanes	2		0.12		
17	Carriageway drainage 250mm dia	2	13325			

SI	Description	No.	Length (m)	Width (m)	Height/Thick (m)	Quantity
18	Base Course drainage PVC pipe @150mm dia	1	13325	7.0		
19	Tunnel main drainage PVC pipe @ 400mm dia	2	13325			
20	Side wall drainage PVC pipe 250mm dia	1	13325			
21	RCC Kerb	2	13325			
22	Cautionary Traffic Sign					
23	Mandatory Traffic Signage					

TYPICAL CROSS SECTION, VENTILATION TUNNEL



TYPICAL CROSS SECTION, CLEARANCE PROFILE AND INSTALLATIONS WITHOUT INVERT SLAB



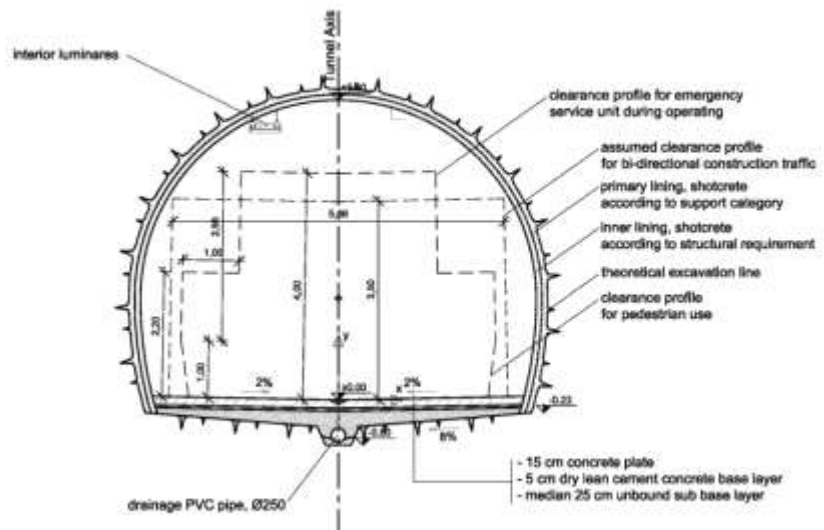
Pavement Quantity for Tunnel

S#	Description	Unit	Total qty	Unit Rate	Amount
TUNNEL					
1	Levelling Course	Cum	6939	3900	27063563
2	G. S. B.	Cum	35396	1800	63713250
3	Dry Lean Concrete	Cum	5599	2500	13998438
4	Pavement Quality Concrete	Cum	26137	5915	154601834
5	Pavement Marking	Sqm	6600	550	3630000
6	Drainage Pipe 250mm dia	Rm	27500	2000	55000000
7	PVC Drainage Pipe 150mm dia	Rm	13750	500	6875000
8	PVC Drainage Pipe 250mm dia	Rm	13750	1000	13750000
9	PVC Drainage Pipe 400mm dia	Rm	13750	1500	20625000
10	RCC Kerb	Rm	27500	300	8250000
11	Walkway	Sqm	27500	1500	41250000
12	Cautionary Signs	No.	8	4500	36000
13	Mandatory Signs	No.	8	4500	36000

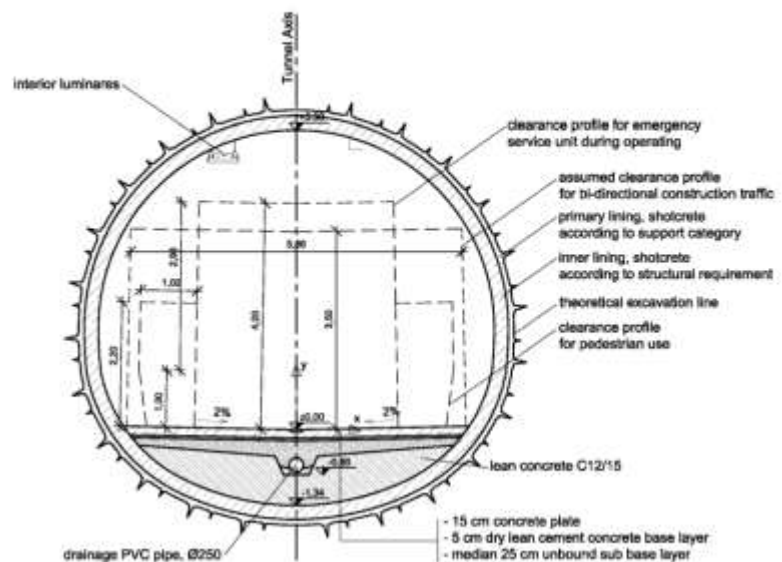
408829084

Say Rs 40.88 Crores.

TYPICAL CROSS SECTION, EGRESS TUNNEL



TYPICAL CROSS SECTION, EGRESS TUNNEL WITH INVERT SLAB





4 TRAFFIC STUDIES

4.1 GENERAL

Traffic is an important parameter in deciding the feasibility of a highway project as it provides the sole revenue stream for the project. Hence traffic estimates assume further importance in deciding the viability as well as the concession period.

Considering the above aspects comprehensive assessment of the existing traffic, travel pattern, assessment of developments in the project influence area to work out the traffic growth rates are made.

This chapter gives details about traffic surveys, secondary data collection, and analysis of the data, toll traffic forecast and estimates of revenue.

4.2 PROJECT ROAD DESCRIPTION

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).

4.3 HOMOGENEOUS SECTIONS

Detailed reconnaissance survey was done to understand the travel pattern on the project road. Based on the reconnaissance survey, the project road is divided in to two homogeneous sections.

Table 4.1: Homogeneous Sections

S. No.	Description	Existing Kilometre	
		From	To
HS 1	Rizvan -Sonamarg	69	92
HS 2	Sonamarg-Leh	92	105

4.4 TRAFFIC SURVEYS

The feasibility and design of any highway facility (or a corridor) basically depends on the volume and intensity of traffic likely to flow on it in the design year. The estimation of the likely traffic scenario in the design year on the highway/corridor proposed for improvement, with an optimal lane configuration as in the present case, requires basic information regarding the current level of traffic and its characteristics on it. Thus, the collection of basic data on the nature and extent at present of different traffic parameters assumes greater significance.

The traffic on the Project corridor is characterized by high degree of motorized vehicles which consist of Cars, two wheelers, and Trucks. Non-motorized vehicles in the traffic stream consist mostly of cycles.

Traffic studies detail mode wise traffic estimates, travel pattern of passenger and freight (goods) vehicles, speed and delay (travel time) characteristics and axle load characteristics. Traffic surveys were conducted as per the guidelines given in IRC:SP-19. The locations and type of various traffic surveys have been carefully finalized on the basis of a reconnaissance survey.

The traffic surveys undertaken for this project include:

- ✓ Classified 7-day, 24 hours continuous traffic volume counts.
- ✓ 1 day 24 hour Origin-Destination surveys

4.4.1 Classified Volume Counts

Classified Traffic Volume Count (CTVC) (7 days 24 hour continuous) surveys have been carried out at 3 stations. The length of Solapur - Leh section is 105 km. Hence, Consultants decided to conduct CTVC surveys at 3 locations. The location and schedule of survey locations are given in table below:

Table 4.2: Locations & schedule of Classified Traffic Volume Count Stations

S. No.	Traffic Volume Count			Date	
I	Chainage	Location	Survey	Start Date	End Date
1	20+200	Past Tamalwadi village	7 day TVC	3-Jun	10-Jun
2	52+100	Before Wadagaon Village	7 day TVC	31-May	7-Jun
3	76+500	Before Yedeshi Village	7 day TVC	30-May	6-Jun

4.4.2 Origin - Destination Survey

An Origin-Destination (O-D) survey was carried out adopting Road Side Interviews (RSI) method at Shetkari Bridge, km 82 which is in between classified volume count stations for a continuous period of 24 hours. The random sampling method was adopted for this survey. The local police assistance was available to stop the vehicles for interviewing the road users. The RSI was carried out through pre-planned and structured questionnaires suitable for computer analysis.

The information collected during these surveys for passenger vehicles included the origin and destination; purpose, occupancy and frequency of the trip and income of the main passenger in the vehicle. In the case of freight vehicles the information sought included type and quantity of commodity being transported, in addition to origin and destination, and frequency of travel on the route.

Information sought on willingness to pay toll included the amount of toll (in rupees) likely to be paid by the road users due to savings in travel time and acceptability level of toll rates. Location & Schedule of the Origin and Destination Surveys are presented in **Table 4.4**.

Table 4.3: Location & Schedule of Origin-Destination Surveys

S. No.	Orgin-Destination Survey			Date	
I	Chainage	Location	Survey	Start Date	End Date
1	20+200	Past Tamalwadi village	OD	7-Jun	8-Jun

5 TRAFFIC ANALYSIS AND FORECAST

5.1 TRAFFIC ANALYSIS

5.1.1 Classified Traffic Volume Counts

Classified Traffic Volume counts were conducted manually for 7 continuous days for 24 hours at four locations. The analysis of the same is done as below:

- Average Daily Traffic (ADT)
- Temporal Variation
 - Daily Variation
 - Hourly Variation
 - Peak Hour factor
- Directional Distribution
- Traffic composition
- Average Annual Daily Traffic (AADT)
 - Seasonal Correction Factor
 - Average Annual Daily Traffic (AADT)

5.1.1.1 Average Daily Traffic

The traffic volumes counted in 15 minute intervals have been aggregated to one-hour volumes. These are presented in **Annexure 4.2**. The hourly volumes have been aggregated into daily volumes for the entire survey period (7-days). The daily volumes are then averaged for ADT. To express the classified vehicular count in terms of PCUs, the PCU factors as given in IRC-64: 1990 have been considered. For ready reference, the PCU Factors considered in the analysis are given in **Table 4.6**.

Table 5.1: PCU Factors Adopted for Study

Fast Vehicles	PCU	Slow Vehicles	PCU
Car	1.0		
Mini Bus	1.5		1.5
Standard Bus	3.0	Agricultural Tractor	4.5
LCV/LGV	1.5	Agricultural Tractor & Trailer	
2-Axle Truck	3.0	Animal/Hand Cart	6.0
3 Axle Truck	3.0	Cycle	0.5
MAV	4.5	Cycle Rickshaw	2.0
Two Wheeler	0.5		
Auto Rickshaw	1.0		

Source: IRC: 64-1990

The summary of ADT, as observed on the Project Road, in terms of vehicles and PCUs at different survey locations is given in **Table 4.7**.

Table 5.2: Average Daily Traffic

Vehicle Type		Near Tamalwadi Ch 20+200	Near Wadagaon Ch 52+100	Near Yedeshi Ch 76+500
Two Wheeler				
Three Wheeler				
Car/Van/Jeep/Tempo				
Taxi				
Mini Bus				
School/Company Bus				
Bus				
LCV				
2 Axle Truck				
3 Axle Truck				
MAV				
MAV >6A				
HCE/EME				
Agricultural Tractor				
Agricultural Tractor & Trailor				
Non Motorised Vehicles	Animal & Hand drawn			
	Cycle			
	Cycle Rickshaw			
	Others			
Toll Exempted Vehicles	Car / Van/Jeep			
	Ambulance			
	Bus / Truck			
Vehicles	Motorised			
	Non Motorised			
	Total			
PCU	Motorised			
	Non Motorised			
	Total			

- The number of vehicles are highest at Km 76.5 and lowest at Km 20.2.
- Two wheelers and three wheelers are the major differentiating factor between these three locations. The number of two wheelers and three wheelers are highest at Km 52.1 and lowest at Km 20.2.
- Commercial vehicles are more or less uniform across the three counting stations.

The summary of the seven day volume counts are presented at **Annexure 4.3**.

5.1.1.2 Temporal Variation

Analysis has been carried out to understand the following parameters of temporal variation of traffic on the project road.

- Daily variation of Traffic
- Hourly variation of Traffic

5.2 PEAK HOUR FACTOR (PHF)

6 PAVEMENT DESIGN

6.1 GENERAL

This section presents the preliminary pavement design for new /existing carriageway based on assessed sub-grade CBR and estimated traffic loading.

The following IRC guidelines have been used to develop the designs.

- IRC: 37 – 2001, "Guidelines for the Design of Flexible Pavements, 2nd Revision".
- IRC: 37 – 2012, "Guidelines for the Design of Flexible Pavements, 3rd Revision"
(Published recently)

Also, IRC:SP-73:2007 the Manual of Specification & Standards for Two-Laning of Highways through Public Private Partnership published by IRC was followed as appropriate.

6.2 EVALUATION OF DESIGN TRAFFIC (MSA) FOR FLEXIBLE PAVEMENT DESIGN

Base year traffic volumes (vehicle category-wise) in terms of AADT, traffic growth rates, design period, vehicle damage factors and lane distribution factors are required to estimate the design traffic in terms of equivalent standard axles. The basis of evaluating each parameter is described below:

6.2.1 Base Year Traffic Volumes

A detailed traffic survey for the project road has been conducted at **three** locations in **July 2011** by the design consultant during FSR. This year 2011 is hereinafter called, "**Base Year**". The classified volume count details for count station 1 and 3 for both up & down direction traffic are summarized herewith at the end of this **Chapter**. Detailed traffic projections over the design life and growth rates obtained for different types of vehicles are considered as per IRC guide lines. For the purpose of pavement design, commercial vehicles of gross vehicle weight more than 3 tonnes has been considered. Such vehicles consisted of buses, LCVs, 2 axle trucks, 3 axle trucks and multi axle trucks.

As per Technical Schedules, for the conceptual tunnel design the design traffic for the highway section is considered at 2500 trucks (3 tons and above) and 5000 passenger cars (below 3 tons) per day and both lanes (traffic projection for year 2024).

Table 6.1 gives the base year (2011) traffic volumes in terms of ADT at two survey locations to be used for the calculation of design MSA for pavement design.

Table 6.1: Base Year ADT July 2011

Type of Commercial Vehicles	Total Number of commercial vehicles (ADT*) Up & Down (July 2011)	
	Location 1 : Gagangir (km73)	Location 3: Ranga Morh Zojila (km 97)
LCV	195	43
Mini Bus/ RTV	139	16

Type of Commercial Vehicles	Total Number of commercial vehicles (ADT*) Up & Down (July 2011)	
	Location 1 : Gagangir (km73)	Location 3: Ranga Morh Zojila (km 97)
Bus	83	13
2 axle trucks	686	697
3 axle trucks	3	1
Multi axle vehicles	0	0
Total ADT 2011	1,106	770
Total ADT 2012 considering 7.5% annual growth	1,189	828

- Due to non-availability of AADT, Seasonal Factor is considered as 1 so that ADT = AADT .

6.2.2 Traffic Growth Rates

As part of detailed traffic study carried out for the project, traffic growth rates predicted by the consultant are based on techno-econometric-social reforms along the project influence area. Likely change in traffic due to proposed all weather tunnel facility and/or future development plans, land use etc. was duly considered in estimating the traffic projections. The details of such study are presented in Traffic Study Report and not repeated here. The minimum annual rate of growth of commercial vehicles was taken as 7.5 per cent in the estimation of design msa as suggested by IRC 73, IRC SP 37:2001 & 2012. From base year AADT and traffic growth rates as above, vehicle category-wise traffic volume projections have been made for various design periods.

6.2.3 Design Period

In compliance to Clause 5.4.1 of the Manual of Specification & Standards for two-Laning of Highways through Public Private Partnership published by IRC, the thickness of sub-base and base of pavement for the main highway is designed for 15 years and the initial bituminous surfacing is designed for 10 years. Taking 3 years time required for design development, financial closure and construction after the award of concession, it is assumed that the road will be operated & toll will be collected by the concessionaire from year 2016.

6.2.4 Vehicle Damage Factors

As per IRC 37:2012 clause 4.4.6, where sufficient information on axle loads is not available and the small size of the project does not warrant an axle load survey, the default values of vehicle damage factor as given below may be used.

Table 6.2: Indicative VDF Values

Vehicle Type	Indicative VDF Values			
	0-150	150-1500	More than 1500	Adopted average VDF
Vehicles equal & > 3 MT Gross Weight: LCV, Bus, 2 & 3 Axle Trucks, MAV & HCE	0.5	1.5	2.5	2.5

Although the traffic plying on the project road is less than 1500 numbers but this road will cater "Army vehicles and 'Defense' heavy machineries". This road is most important road as per

"Defense and Country Security" concerns. Considering the importance of the project road average VDF 2.5 is considered for pavement design.

6.2.5 Lane Distribution Factors

For flexible pavements, the percentage of vehicles in heaviest loaded lane can be determined as per IRC:37-2012 and IRC:81-1997 guidelines given below:

Table 6.3: Lane Distribution Factor

Type of facility	Lane distribution factor, LDF
2- lane Dual carriageway	75 % of the number of commercial vehicles in each direction.

6.2.6 Design Traffic Loading in terms of MSA

Based on shorter project length and uniform traffic, there is only one homogeneous section. Design traffic loading in terms of MSA is calculated for one homogeneous section. The cumulative number of repetitions of axles during the design period due to a given commercial vehicle is computed from the following formula:

$$C = 365 \times A \times \frac{(1+r)^n - 1}{r} \times \text{VDF} \times \text{LDF}$$

C = Cumulative number of axles during the design period for a given category of commercial vehicle.

A = Opening year AADT (two directional)

r = Annual rate of growth of given commercial vehicle

n = Analysis period in years

VDF = Vehicle damage factor

LDF = Lane distribution factor described in the preceding section.

The formula is valid for a period of constant growth rate. The cumulative numbers for all constant growth rate period should then be added together. Finally, contribution of each category of commercial vehicle (viz., Bus, LCV, 2AT, 3AT & MAV) is added to derive cumulative msa. The details of MSA calculations are given in Table below.

Table 6.4: Design MSA

Road Approaches near Rezan (km69) to Shetkari Village km 82 From - To	Configuration	New Construction / Overlay	Traffic Loading in terms of million standard axles (MSA) for different Design Periods		
			10yrs (for initial construction)	15yrs (for 1 st Structure Overlay)	20yrs (for 1 st Structure Overlay)
Location 1: km 73	2 Lane (7m wide) carriageway	New Construction	12	21	35
Location 3: km 97			8	15	25

Design period of 15 & 10 years for non-bituminous and bituminous layers is considered for pavement design. Design period starts from base year 2012 and it includes construction period

also. Considering snowy mountainous terrain, large number of army vehicles, heavy equipment, construction machineries and defense materials running on the only connective project road, **Average 30msa load is adopted for pavement design as the major approach road (5.25km) is lying close to Location 1 (km73).**

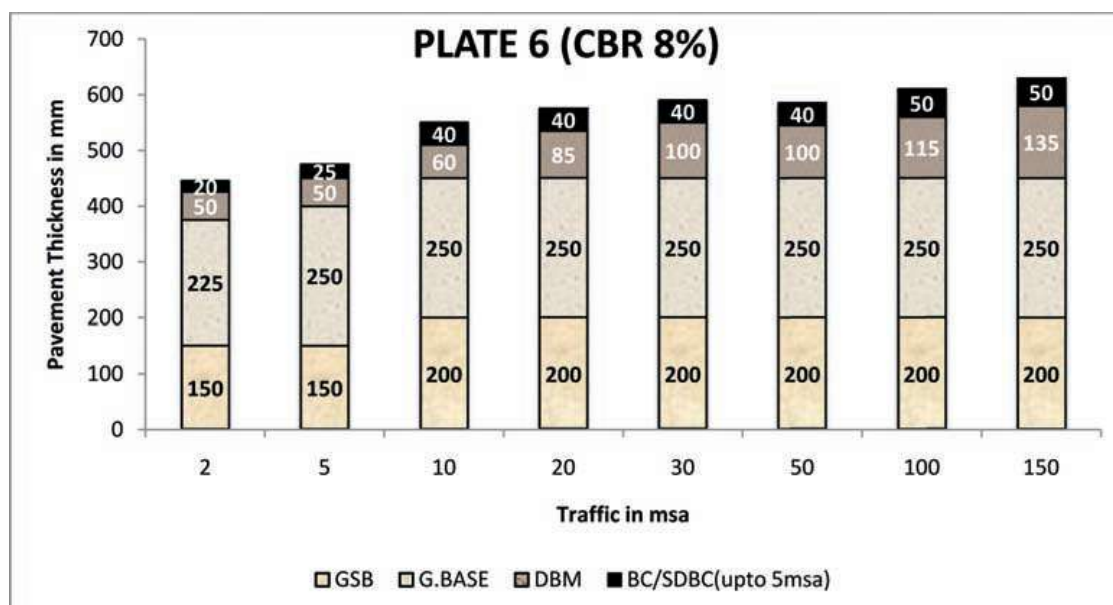
6.3 STRENGTH OF SUB GRADE

The strength of sub-grade in terms of California Bearing Ratio (CBR) is required for the design of new flexible pavement as per IRC: 37-2012. As new lanes will be constructed in Mountainous Hilly, half Cut & fill sections, the CBR of existing ground and imported borrow earth will govern the design. The existing ground and borrow material is combination of moorum, gravel, soft rock types. Visual study indicates that the CBR value for cut & fill materials will vary from 5 % to over 20%. For design purposes, CBR of 8% has been considered. Borrow areas containing materials with CBR less than 8 % may be used in embankments.

6.4 PAVEMENT DESIGN FOR NEW ROAD CONSTRUCTION

Design of new flexible pavement applies to the new lanes including paved shoulders and reconstruction of Existing Carriageway, which will be constructed to the same standard as the main carriageway and thus forms an integral part of the main carriageway.

The methodology recommended in IRC: 37-2012 is adopted for the design of flexible pavement structure. Catalogue of pavement design given at Plate 6 of IRC: 37-2012 for 30 msa traffic is adopted.



As per above chart, there is only difference in DBM layer thickness for 20msa & 30 msa. Other layers thicknesses are same.

The project area lies in the region where the lowest daily mean air temperature is more than - 15°C and the highest daily mean air temperature during summer is approximate 30°C. To counter this, harder grade of binder (VG-30) or modified bitumen of equivalent stiffness is recommended for DBM. For bituminous concrete (BC) wearing course, polymer modified binder (PMB-40) or crumb rubber modified binder (CRMB-60) is suggested.

The pavement thickness worked out for 15 years design period is given in Table 6.5.

Table 6.5 : Pavement Structure for 10 Year Design Life Considering Stage Construction

SI No.	Traffic Homogeneous Section		Length (km)	Design CBR (%)	Design Traffic (MSA)	Pavement composition				
	From	To				Layers Thickness (mm)				
						BC	DBM	WMM	GSB	Sub-grade#
1	Rezan (km69)	Sonamarg (km82)	6.9	8	30	40	100	250	200	500

Subgrade shall be provided for only Embankment/Fill sections. For CUT section : NIL.

6.5 PAVEMENT COMPOSITION FOR SERVICE/SLIP ROAD

Slip/ Service Roads are provided at merging and de-merging of the approach roads, grade separated structures for Solamarg Bypass & Solamarg town roads. Considering the importance of the slip roads for free movement of traffic, heavy machinery, multi-axle vehicles will flow on these slip/service roads. Hence same pavement composition as of main road is proposed as below:

Table 6.6 : Pavement composition slip/ service road (mm)

BC	DBM	WMM	GSB	Sub-grade
40	100	250	200	500

Table 0.1 : Classified Volume Count Survey Data July 2011 as per Technical Schedules

Station – 1 (Gagangir 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 Morh Zojila 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		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	

