

Employer's Requirement (ERQ)

TECHNICAL REQUIREMENTS

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TECHNICAL REQUIREMENTS

1. INTRODUCTION

.....Project Specific Information

Example :

"This Project covers the rehabilitation of road and the construction of a new tunnel and a pedestrian rockshed on the Siddhababa stretch along the Siddhartha Highway, between Chainage 28+200 Km to 30+600 Km.

The Siddhababa Road Section is a very hazardous road section, due to the highly fractured rockfall site at the hillside of the road, characterized by an unfavourably discontinuity orientation with respect to the road alignment, and to high and steep slopes easily split by monsoon precipitation.

Since a relevant number of rockfall events has been registered during the time, a detailed design of permanent structures for rockfall protections has been developed to minimize the hazard of rock slope instability and debris flow.

Despite complementary to the main scope of the work, which is related to the permanent protection measures against rockfall, some additional issues have been considered since relevant to provide a complete and effective project design, such as:

- Road alignment improvement;
- Standardizing cross-section and durable pavement;
- Water collection systems design;
- Hydraulic management and flooding protections on crossing streams;
- Permanent protections against debris flow.

This Project aims at avoiding any risk related to rockfall and slope instability in the high hazard sections for car traffic and, at the same time, finding an attractive solution also for pedestrians and cycles.

The project foresees an existing track diversion in a new two lanes tunnel for motor vehicles only (one lane for each direction), along the whole high hazard sections, departing from the existing road near the Siddha Baba Mandir and reconnects to it near the hydropower plant, for a total length of about 1126 m.

Bicycles and pedestrian keep on following the existing road alignment, protected, along the whole high hazard section, by a rockshed with reduced internal dimensions of **5.0mx3.5m**, suitable to house only pedestrians and ambulance (or emergency car), in case of emergency situations.

In detail, the road design foresees both the rehabilitation of the existing road, from chainage 28+200.00 to 29+100.00 (called Main Road 1 - MT1) and from chainage 30+050.00 to 30+600.00, (called Main Road 2 - MT)) and the variation of the existing road alignment to connect the new tunnel road, approximately 1126 m long, by deviating from the old alignment towards East around chainage 29+100.00 and towards West around chainage 30+050.

The rehabilitation of the existing road has been developed and design to limit rock excavation along the mountain side and rock stabilization/earth retaining structures along the valley side, to reduce costs and time of construction.

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The new tunnel extends between chainages 0+908.46 (south portal) and 2+034.52 (north portal) and the position of the tunnel portals has been chosen considering a suitable site to minimize necessary excavation, hence entering the mountain almost perpendicularly to the slope, as well as to avoid the whole high hazard stretch. The U-shape of the tunnel horizontal alignment has been chosen in order to reach as soon as possible a sufficient depth (tunnel overburden) to minimize the tunnel excavation in low overburden areas, where weaker and altered rock can be foreseen, as well as larger water income. In order to improve visibility and traffic management, LED "cat's eye" devices will be installed above the kerb on both walkways.

Due to the new tunnel, the pre-existing alignment between around chainage 29+100 and 30+050 has been converted into a pedestrian-only road (called Pedestrian Road (PE)), comprehensive of two emergency aprons for reversal of traffic direction in case of tunnel closure during emergency. Moreover, each apron could be used as heliport in case of emergency. On the pedestrian road, the construction of a covered path with a rockshed has been foreseen from chainage around 29+215 to 29+995.

The pedestrian rockshed structure is connected to the emergency escape routes of the tunnel. According to tunnel safety measures (SIA 197-2), three pedestrian by-passes have been foreseen along the tunnel at chainages 1+145.00, 1+445.00 and ch. 1+745.00, with a spacing of 300m, so that, in case of emergency, the tunnel users can evacuate in the shortest possible time from the danger zone, leading directly to a safe space within the bypass tunnel itself and, from there, to the pedestrian rockshed along the existing road. No emergency escape route for vehicular access is foreseen due to the length of the tunnel (< 1.2 km).

This solution provides a minimal residual risk with regards to rock fall, as the car traffic diverted in tunnel is completely independent from rockfall events along the high hazard stretch and pedestrian are protected by the rockshed structure. The tunnel allows to mitigate the risk of a car traffic block not only in case of rockfall events, but also for unexpected debris flow or flooding due to high level of rainfall. Moreover, the tunnel car only provides maximum safety for pedestrian, as their route is separated from the car traffic.

Local wiremesh and rocknet are placed on adjacent medium and low hazard sections, in addition to local shotcreting for rock wall stabilization and local barring of instable rock mass.

During construction, no diversion routes are necessary for cars as the construction of the tunnel can be carried on keeping in service the current route, while the rockshed for pedestrian can be built once tunnel is in service.

Please note that the general absolute chainage referred to the existing Siddhartha Highways has to be abandoned for this project due to the new alignment of the Siddhartha stretch and the new tunnel road.

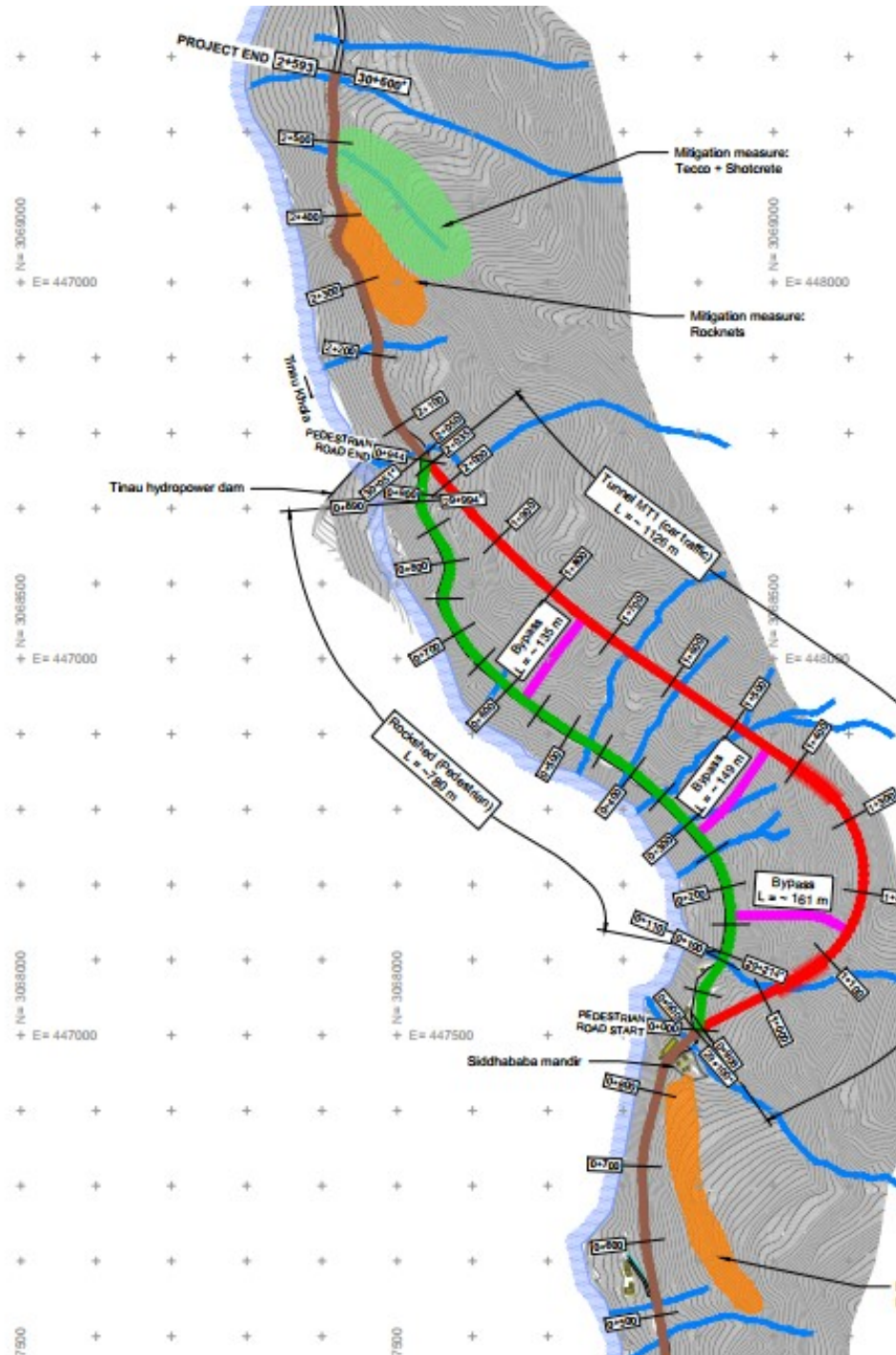


Figure 1: General Plan View of the Project Area

The main features of the projects can be summarized as:

Road Improvements:

including all works needed to guarantee expected improvements of existing road as by design criteria, such as works related to local widened of the existing road, pavement package replacement and construction of a carriageway drainage system. According to geometry requirement discussed during the feasibility stage and in line with the existing road dimensions, the design roadway total

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width is 8.50 m, including the 7.50 m width of carriageway, composed of two lanes 3.75 m wide and 0.50 m of shoulder on either side, and excluding the side drains.

Environmental protection measures: Hydraulic regimentation measures

including all works related to the hydraulic regimentation of crossing streams, especially during monsoon period, by means of concrete culverts of different dimensions and geometry, which also allow the mitigation of risks related to unexpected debris flow or flooding.

Concrete culverts of different dimensions and geometry have been foreseen along the road alignment: embedded concrete pipes (internal dimension: from 900mm to 1200mm) and rectangular section culverts (from 1500x1500mm to 2000x2000mm) are provided along the main road, while open channel with inner section 1500mmx1500mm have been placed on the top of the pedestrian rockshed. Two double channel rectangular culverts have been required in the most critical area near the north and the south tunnel portal.

Environmental protection measures: Mitigation measures for rockfall medium and low risk areas

including all works related to the three different types of measures here foreseen:

- Rocknet with Design Energy between 3000 KJ and 5000 KJ
- Local installation of adherence wiremesh (Tecco type) with bolts on stable outcrops upon the road, where only superficial debris and small blocks are expected, and local stabilisation systems by shotcrete with additional rock bolts, in more fractured areas.
- Local removal of single unstable blocks that cannot be withstood by the rocknet or to protect thick clay layers within an outcrop, that could otherwise get unstable because of gradual washout of clay during monsoon season.

Road diversion and Road Tunnel for rockfall high risk areas

including all works related to the construction of the rock tunnel and the three emergency escape routes foreseen along its alignment with a maximum distance lower than required 300 m. The tunnel cross-section has been studied in accordance to European and Swiss tunnel guidelines, in order to house: a carriageway width of 7.5 m, sideways on both side with minimum width of 1 m and all necessary hydraulic systems and operational and safety equipment. The operational traffic space considered for design includes not only the necessary space for passing cars and trucks (height up to 4.5 m), but also standard space for signalling, upon the carriageway and on both sides, and for standard safety margins. Thanks to the almost circular section, upon the operation traffic space there is space to house air fans for the longitudinal ventilation system.

Tunnel design also includes all the equipment and systems needed for the structure to be operational, such as:

- No. 2 technologic Buildings, at northern and southern portal.
- Energy supply
- Lighting
- Ventilation
- Signage

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- Surveillance system
- Control system and communication network
- Cabling system
- Auxiliary systems
- Control room

Pedestrian Rockshed for rockfall high risk areas

including all works related to the construction of the cast-in-situ concrete structure characterized by a reinforced concrete slab covered with a cushion layer. Main characteristics of the rockshed are:

- Inner dimensions, to comply with pedestrian walkaway (B x H = **3.5mx5.0m**), with a length of about L = 800m;
- Cushion material, made of Leca 0-30 (or similar) with a medium height of 2m on the top slab of the shed, to protect the structure from falling rocks;
- Roof grade, to be at least 5% to provide drainage of the cushion material and possibly allow falling rock rolling over the rockshed roof."

2. BASIC PREREQUISITES FOR TUNNEL OPERATION

.....Project Specific Information

Example :

- 1) In this project the use of Swiss and European standards and directives has been assumed concerning the characteristics of the tunnel facilities in relation to safety and operation.
- 2) For electrical installations of buildings, as for low voltage electrical distribution, a generic solution has been defined; in the executive phase (design-built), the Contractor will have to consider the application of the Nepalese regulations, where present, in this specific field.
- 3) The project presented in Volume 5 of these Tender Documents contains the description of the technical solution to be implemented regarding the operating and safety systems; the detail-degree of the description has been harmonized with the project phase and with the procedural situation (choice of a general contractor), therefore no executive details are provided where it is not considered essential for the outcome of the works. It was therefore assumed that the executive details will be defined within the scope of work of this tender.
- 4) The installations are designed to be serviced at least once a year by specialized personnel (of the client, of the future manager of the tunnel or of the general contractor). The correct maintenance frequency however depends on the characteristics of the individual plant and shall be defined by the supplier (general contractor).
- 5) The operation of the installations is strictly related to a correct and exhaustive periodic maintenance; the lack of adequate maintenance affects the operation of the plants and, ultimately, the safety of tunnel users.
- 6) The project assumes that tunnel users comply with traffic regulations, such as compliance with speed limits and signage and in particular compliance with the overtaking and stop prohibitions in tunnel. Likewise, the systems have not been designed to withstand shock or impact forces caused by loads projecting beyond the permitted vehicle-shape in tunnel.
- 7) The systems designed ensure automatic routines to guarantee the safety of the tunnel users. Nevertheless, the project assumes that the gallery is monitored and managed continuously (7 days a week, 24 hours a day) by at least two operators in the control room in the technical building at the south portal of the tunnel. In fact, in case of an event such as a fire in tunnel, only operators present on site and trained, can ensure adequate treatment of emergencies. It has been assumed that these operators will interface with the rescue services, such as the police, firefighters and rescuers, for the operational management of the events.
- 8) The project assumes that a regulation will be created by the tunnel manager that specifies the minimum operating conditions of the plants under which the tunnel can remain open and therefore, consequently, in correspondence with which plant faults the tunnel must be closed. Operation of the tunnel in the absence of adequate operating conditions of the plants (eg lack of ventilation, lack of fire detection, lack of electricity supply, and similar) exposes users to risk, can facilitate the occurrence of accidents and prevents the possibility of saving users.
- 9) The project for the signage system (arrangement of traffic signs, their images, distances, etc.) must be submitted by the client to the competent Nepalese authorities (ministries, police, etc.) for examination and approval before the tunnel is put into operation. In order to avoid late

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modifications, it would be desirable to obtain this approval before the procurement phase or, at the latest, before the start of the manufacture of the signals and their installation. Without the approval of the signage by the competent authorities, the tunnel shall not be put into service.

- 10) In the rest of the document indications will be provided on the constitution of the individual elements of the exploitation and safety systems and their housing. However, a general principle is given here, which also applies where details are not provided in this document: all the elements forming the exploitation and safety systems must be installed in cabinets or enclosures that allow protection against rain, dust, humidity, solar radiation, aggressive atmosphere, etc. Exceptions to this principle are the elements which, due to the function they perform, must be in direct contact with the field (traffic signs, sensors, cables, lamps, etc.).

- 11) As for the tunnel ventilation, the project contains a mere dimensioning of jet-fans and sensors. It is task of the Contractor to define the functioning (algorithms) of the ventilation in the normal case (sanitary ventilation) and in the event of a fire (operation of the system in the various fire scenarios in the tunnel). The definition of these algorithms is essential for the safety of tunnel users in the event of a fire.

Once the ventilation system has been defined and installed, the Customer (or the Contractor) must provide for real operational tests, even simulating the event of a fire, involving the emergency services such as fire brigades, police, rescuers, etc.

- 12) Since it is not possible to have redundant medium voltage power supply, that is coming from two different networks, the loss of this power entails the immediate inability of the tunnel due to the lack of ventilation in case of fire. For this reason, uninterruptable power supplies with batteries have been foreseen to guarantee one hour of operation of the systems (excluding ventilation). This time lapse serves to close the tunnel, which cannot remain open in case of lack of ventilation.

- 13) Due to the high-power requirement, no reserves were included in the calculation. In the execution phase, and in the phase of agreements with the electricity supplier, the client must evaluate, and have included in the project, the largest possible reserve power margin (desired 30%) compatible with the conditions of the network and the supply.

- 14) The cellular telephone system is not part of the installations covered by this project. It is in fact to be considered as an extension of the systems of the mobile telephony signal provider, and must be designed, supplied, installed and maintained by him. Nevertheless, in view of the importance of such a system both for the users of the tunnel and for the rescue forces, a separate room is provided for the installation of the necessary equipment. The external antennas for the collection of the external signal and the internal antennas for the broadcasting of the signal in tunnel and buildings will be installed by the provider of the mobile telephony.

This equipment will be powered by the low voltage distribution of the tunnel in the technical rooms, through a connection to reserve switches. Electricity consumption, as well as the space used, should be the subject of a specific agreement between the tunnel owner and the mobile phone provider.

The mobile phone signal broadcasting system is of great importance for the safety of tunnel users. However, it is also very important during the excavation and construction phases of the tunnel; therefore, it is recommended to start early with the stipulation of agreements with the mobile telephony provider, to ensure good coverage already from the early stages of work.

- 15) The closure of the tunnel in case of danger (accident, fire) is a critical event and must be well understood by road users.

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In Nepal Road Standard 2070, no indication was found of the transition times for traffic lights (changeover to red, stop of the traffic-flow). Therefore, two transition tables corresponding to Swiss regulations were suggested. It is imperative for the implementation phase that the general-contractor checks again with the competent authorities what the image transitions (switching from off/green to red and vice versa) of the traffic lights should be in order for the tunnel closure event to be clearly and unmistakably understood by road users.

- 16) A **60-month** maintenance and warranty period provided by the plant supplier must be included in the Tender Price. In fact, experience shows that, given the complexity of the systems, a similar duration allows to eliminate defects left hidden at the time of testing. “

3. DESIGN BASIS

For the Technical Requirements of the projects please refer to the document included in the **Annexes of this section**

ANNEXES

ANNEX A: CIVIL WORKS - DESIGN BASIS

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