PROJECT PROPOSAL

Construction of Research and Observatory Tunnel at the Kathmandu University

Kathmandu University
School of Engineering

Tentative Start Date	***Tentative End Date***	***Estimated Budget***
January 01, 2022	December 31, 2023	NRs. 45 million

Project Goal:
To construct a research and observatory tunnel in Kathmandu University with a cavern for specialized Rock Mechanics lab

Project Budget Breakdown (Nepalese Rupees):
Construction Cost (excluding equipment cost): 26 million
Equipment cost: 19 million (Contribution by Megatech)
Administrative cost: 0.5 million

Project Objectives:

- Construction of research and observatory tunnel for research and development in underground structures in the Nepal Himalaya.
- Collaboration among the construction industry and Government organizations with the University for knowledge sharing in the field of tunnel construction technology.
- To demonstrate the different types of the rock support that are used in the Nepal Himalaya along the proposed tunnel.
- Monitoring and recording of all the stages of construction of the KU tunnel.
- Capacity building of human resources in the field of tunnel and rock engineering for the construction of underground structures especially in the Himalaya.

Contents

Salient features of KU Research Tunnel

Length [m]	274
Tunnel excavation shape	Inverted D shaped
Dimensions [m^2]	
Inlet Tunnel	3.5*3
Outlet Tunnel	2*1.5
Cavern	20*6
Maximum Overburden [m]	35
Rock Quality number	0.5 (average)
Rock Type	Weathered meta-sandstone with presence of phyllite and schist
Total cost of construction	45 millions
Total cost of construction materials (excluding equipment)	22 millions
Construction Period (estimated)	2 years
Classification of Rock mass	**Designed Support**
Inlet Portal (Ch. 0-3)	Stone Masonry walls and Concrete arch and invert
Class I (Ch. 3-13)	S(fr) + ISMB + Pattern bolting + Concrete lining : 200 mm + Forpoling
Class II (Ch. 13-43)	S(fr) + ISMB + Pattern bolting + Concrete lining: 200 mm
Class III (Ch. 43-58)	S(fr) + ISMB + Pattern bolting + Concrete lining: 250 mm
Class IV (Ch. 58-73)	S(fr) + ISMB + Pattern bolting + Concrete lining: 250 mm
Slope Protection	S(fr): 100 mm
	Grouting – 3 m from ground surface
	Pattern rock bolting – 3 m length
	Pattern rock bolting – 7.5 m length

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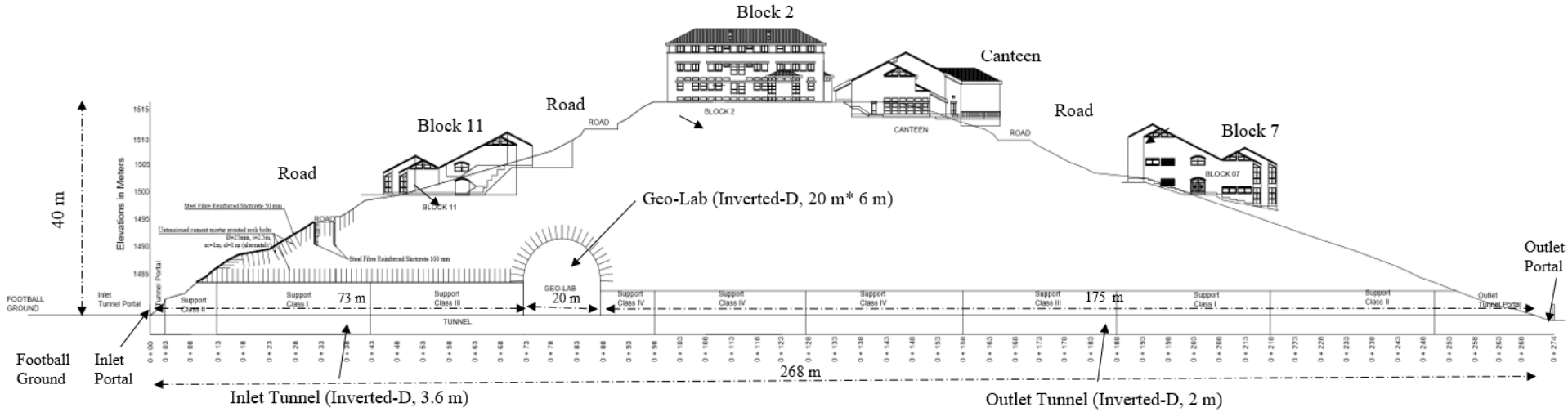

Figure 1 *Proposed profile of KU Research Tunnel*

Project Summary and Background

With the rapid development of underground structures in the country, it has become necessary for extensive field and laboratory research in the sector. Kathmandu University has continuously worked in R&D of underground structures. The major purpose of construction of KU tunnel is for research and advanced studies where regular monitoring of strength and stress of rock mass will be done which will provide detailed information on the behavior of rock mass during the construction.

The monitoring and investigation of the tunnel in the university will provide insights into the geological condition of the region and its results can be effectively used for the construction of the national projects. Although, the tunnel is short in length (around 275 m), the tunnel goes through weak geology of fractured rock mass and with low overburden and overlying structures. This tunnel will thus serve as a valuable experience and lesson obtained during its construction will aid future projects in the country. This shallow ground tunneling will prove to be relevant for the underground metro proposed to be constructed under the Kathmandu valley in soft rock condition.

The construction of the tunnel will not only initiate research and development in the field but will also initiate collaboration between academia and industry. Knowledge sharing is important for more advanced research in the field and the initiative by Kathmandu University will promote and attract other industries and universities in the matter. Nepalese industry Megatech Hydro & Infrastructure Pvt. Ltd. has collaborated with KU by agreeing to provide construction equipment and recent construction technology in tunnel construction while HTR provides necessary expert guidance and consulting service. The construction of the tunnel can also allow collaboration with others construction material manufacturers, by providing their product to develop the nation pride project, and government organizations, to allocate the research fund to enhance the research and development in the field of construction of tunnel.

The department has already initiated the construction of the tunnel portal. The department has been working for this project since 2013 and has generated human resources (PhD and master graduate) for the purpose. With the inauguration of groundbreaking ceremony by Dean of School of Engineering on Bhadra 07, 2078 (August 23, 2021), the school has aimed to complete the tunnel within two years. About 5 meters of the tunnel will also be constructed supported by the School of Engineering and Energize Nepal. Around 3 million has been allocated for construction of the tunnel which is to start by the mid of November. Although KU has already initiated construction of the tunnel through the support of Energize Nepal, the construction is a challenging task and requires support from various agencies for completion. By opening doors to academia – industry coordination, more research can be completed which will aid future construction projects in underground structure.

In addition, the department will also initiate human resource development through enrollment in graduate and doctorate students and the construction of the tunnel will allow hands on experience for future engineers. Since the current practice of tunnel and underground support is inadequate from economic and safety aspects, it is essential to perform detailed study to safely design such structures.

Project Objectives

Following are the major key project objectives

- Construction of research and observatory tunnel for research and development in underground structures in the Nepal Himalaya.
- Collaboration among the construction industry and Government organizations with the University for knowledge sharing in the field of tunnel construction technology.
- To demonstrate the different types of the rock support that are used in the Nepal Himalaya along the proposed tunnel.
- Monitoring and recording of all the stages of construction of the KU tunnel.
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Along the above mention objectives, the following are the long-term benefits of the project.

- A tunnel is proposed for education purposes with a cavern where the Geo-Technical Lab/Rock Mechanics Lab is supposed to be placed in underground.
- An underground geotechnical lab would be a good idea where research and education are combine for the undergraduate and graduate students of KU.
- Courses in Tunnel and Rock Engineering could be started in near future.
- The proposed tunnel and cavern would be used as the showcase for the different types rock support class used in the Nepal Himalaya.
- Expand and enhance the local knowledge on the stability problems of underground structure in Himalayan region where the geological regime is very different to other parts of world
- This study and the proposed lab would be used to develop further basis for rock stress parameter for the input the engineering rock mass classification in Himalayan region.
- Opportunities for PhD and MS by research students to conduct research work in the field of Tunnel engineering and Rock Engineering and simultaneously develop the human resources in the field.

Project Relevance

i. Nation priority for underground structures

Construction of underground structures has been rising in various fields highlighting its importance and relevance in the mountainous country like Nepal. As of 2019, more than 500 km of hydropower tunnels are under construction with around 200 km in Bagmati province of Nepal (*Source: Department of Electricity Development*). In addition, with the start of the fiscal year 2078/79, the Government of Nepal has planned to develop tunnels and underground structures for sustainable development of the country. With the allocation of more than 100 billion Nepalese Rupees for infrastructure development, priority has been given to tunnels for transportation, irrigation and hydropower development. With the construction of Nagdhunga-Sisnekhola tunnel, the country is said to have entered the tunnel era. In the Kathmandu valley, an underpass is planned to be constructed in the Tinkune Jadibuti area. Similarly, tunnels are also planned to be constructed in roadways between Tokha-Chhahare-Gurju Bhangyang, Betrawati-Syaphrubesi, Khurkot-Chiyabari, and Thankot-Chitlang.

ii. Economic and sustainable development of country

Several tunnels have been constructed in the country, especially for the purpose of hydropower. These tunnels allow to divert the water while maintaining the head required for power generation. Recently, the government has initiated to construct the structure for transportation realizing its importance. The Nagdhunga-Naubise tunnel, which is a 2.71 km tunnel with a carriageway width of 9.5 m, lays the foundation for construction of such structures in the country. The tunnel shortens the Thankot-Naubise hilly road section of 9 km to 5.7 km thus shortening the travel time from almost 30 minutes to less than 10 minutes. This project benefits the country in aspects of economy, natural hazards and environment protection. Apart from this, Nepal has also completed the Bheri-Babai water divergence tunnel of length 12.2 km and the Melamchi water supply tunnel of length 26 km.

iii. Human resource development

The department of civil engineering has been working on this goal through the integration of Tunnel and Underground structure course in undergraduate level. This has allowed human resource generation in the field and the students have also been involved in various underground construction projects. Apart from this, the construction of the KU tunnel will allow skilled human resource generation through graduate and PhD courses. The construction will also help in upscaling the current Rock Mechanics and Rock Engineering lab into a specialized laboratory which allows more advanced R&D in the field.

iv. Research and Development

The initiative by KU to build a tunnel within the university will aid in design and construction of future projects. Although short in length, KU tunnel passes through challenging ground condition of shallow depth and weak rock mass with overlying structures. The results of the project will provide a valuable lesson on design and construction aspect in the Himalayas. Data monitoring, acquisition and analysis from the KU tunnel will provide opportunity while also promoting advance R&D works in the field. Due to limited studies in context to Himalayan geology, the findings from the project will allow designers and engineers for safe and economic planning and construction of underground structures.

v. Observatory and exploratory tunnels

The KU tunnel will also serve as exploratory tunnels for future engineers and students. The tunnel will be constructed in a manner which showcase all the different types of supports used along with the rock mass encountered. Since tunnels after completion will be fully lined and not much information can be gained from a completed tunnel, KU tunnel will provide a reference to people in regards to the different support systems.

Partnership and Responsibilities

Applicant Institution: Kathmandu University

Key Responsibility - Lead project up to its goal
- Overall management and supervision of construction
- Reporting and updating project partners on project
- Train human resources
- Knowledge sharing and information dissemination

Resource Partner: Megatech Hydro & Infrastructure

Key Responsibility - Support in construction equipment
- Expert guidance and monitoring of construction works

Resource Partner: Hydro Tunnelling and Research Pvt. Ltd.

Key Responsibility - Consulting service for the construction of the tunnel
- Design review and guidance for construction
- Expert guidance and monitoring of construction works

KU has also been in coordination with Norwegian University of Science and Technology (NTNU) and Seoul National University (SNU). They have been providing expert opinions and reviews over the project activities and their contribution will continue during the duration of construction of the tunnel. Close coordination between all the involving bodies will lead to successful completion of the project.

Project Partnership Cooperation Strategy

- MOU between the partner organization, which will form a Project Consortium (PC) and a Project Steering Committee (PSC) with the representatives from each partner organization.
- PSC will plan the overall activities and negotiate in any issue to be raised before and after the project initialization period. PSC would also plan, execute and monitor the day to day project activities to meet the project objectives and milestones within the allocated time and budget.
- Project leader will be assigned to the project with responsibility to coordinate overall project activities, organize regular meetings between project partners and prepare project progress report in timely basis.
- Expert partners will support to develop the infrastructures and technical expertise at KU, where the major R&D activities required before establishing the turbine company in Nepal shall be conducted.

Project Steering Committee Members

The overall structure of the project management will comprise various bodies from admiration, advisory and technical teams. The structure of the project management body can be seen in the chart below:

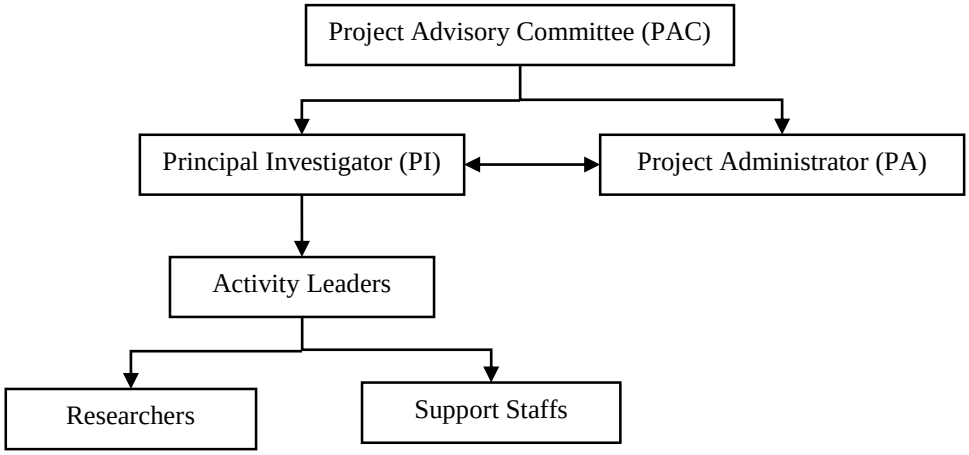

Figure 2 *Management Structure*

The Project advisory committee will consist of the following bodies:

i.	**Chairman**	-	Prof. Dr. Manish Pokheral Dean, School of Engineering
ii.	**Members**	-	Assoc. Prof. Brijesh Adhikari, Associate Dean, School of Engineering
		-	Er. Shri Ram Neupane, Executive Director, Megatech Hydro & Infrastructure
		-	Dr. Pawan Kumar Shrestha, Director, Hydro Tunnelling and Research Pvt. Ltd.
		-	Dr. Shyam Sundar Khadka, Head, Department of Civil Engineering
		-	President, Nepal Tunnelling Association
		-	Representatives from Government of Nepal (funding agency)
		-	Interested International Institutions (To be decided)

Project operation and management committee will comprise of the following bodies:

i.	**Chairman**	Assoc. Prof. Brijesh Adhikari, Associate Dean, School of Engineering
ii.	**Administrator**	Dr. Shyam Sundar Khadka, Head, Department of Civil Engineering
iii.	**Engineers**	Rock and Tunnel Engineer
		Geologist
		Civil Engineer
iv.	**Researchers**	
v.	**Lab Technicians**	

All the necessary resources (infrastructure, equipment and human resources) are either available within the partnering organizations or will be hired on a project-basis as per the requirement of the project.

Key Human Resources

Key human resources will be recruited based on two categories: 1) regular and 2) project basis. Regular human resources are those who are already available within the partner organizations and are willing to be involved in the project on a full-time or part-time modality. Project basis human resources are those who are not already available and will be acquired during the project duration on a part-time modality as per the requirement of the project. The roles and responsibilities of the key human resources are summarized in the table below. In addition, other necessary resource persons will also be hired if it is found necessary in the due course of time within the project period.

Table 1 *Details of technical human resources.*

S.N	Human resources	Designation	Responsibility
1	Er. Shri Ram Neupane	Advisor	Tunnel and Civil Engineering
2	Dr. Shyam Sundar Khadka	Project Leader	Tunnel /Structural Engineering
3	Dr. Pawan Kumar Shrestha	Expert	Rock and Tunnel Engineering
4	Er. Sujan Karki	Engineer	Tunnel/Civil Engineering
5	Er. Bimal Chhushyabaga	Engineer	Tunnel/Civil Engineering
6	Researcher 1*	Full time researcher	Civil Engineering
7	Researcher 2*	Full time researcher	Civil Engineering

** To be available*

Project Schedule

WP	Activity Detail / Time (years, months)	2021		2022												2023											
		11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1	Construction of tunnel portal																										
2	**Field Survey and Design Review**																										
2.1	Collection and testing of rock samples																										
2.2	Review of tunnel design																										
2.3	Consultation with experts																										
3	**Construction of tunnel (Phase I)***																										
3.1	Slope Protection works																										
3.2	Excavation and Support - Inlet Tunnel																										
3.3	Excavation and Support - Cavern																										
3.4	Data recording and monitoring																										
4	**Construction of tunnel (Phase II)***																										
4.1	Excavation and Support																										
4.2	Data recording and monitoring																										
5	**Design Review and expert consultation**																										
6	**Information Dissemination**																										
7	**Reporting and closing**																										

** Excavation is done at the rate of 2-3 m per week*

Budget

The overall budget of the project has mainly been divided into two parts:

i. Capacity development of human resources
ii. Construction and maintenance of tunnel

As mentioned earlier, the total cost of the construction has been subdivided into various sections and the project partners will also contribute in the process. The total fund generated through participation of various government and private organizations and industries will be managed by the university for its ease of the work. The financial support from various partners is listed below.

- Consulting and engineering design will be contributed and supported by HTR and NTA.
- Cost of equipment and other technical assistance will be supported by Megatech through the mutual understanding of KU and Megatech
- Major construction material (Cement and Steel) will be asked from different manufacturing companies
- Other funds will be collected from different government agencies and private industries involved in the infrastructure development

The summary of the overall budget plan is given below (for underground structure).

SN	Particulars	Unit	External Funding		Distribution	Remarks
			Quantity	Total		
A	**Construction Cost**					
A.1	Inlet Tunnel (Phase I)	meters	73	10,273,637.79	98.91%	
A.2	Slope Stability (Phase I)	meters	268	1,353,372.18		
A.3	Cavern (Phase I)	meters	20	4,900,100.99		
A.4	Outlet Tunnel (Phase II)	meters	175	5,707,576.55		
A.5	Machine and Equipment			**19,249,466.01**		***Contribution by Megatech***
A.6	Labor Cost			3,957,020.00		
	Subtotal			45,441,173.52		*Contribution by University*
B	**Office Costs**	LS	2	200,000.00	0.44%	
C	**Administrative Cost**	LS	1	300,000.00	0.65%	

Risks and Mitigations

Although an attempt has been made to identify all possible uncertainties during the proposal phase, there are chances of some risks creeping in during the project duration. The risks that are likely to occur are listed out as follows:

- *Construction Challenge*: The proposed research and observatory KU tunnel passes through shallow overburden in weak and fractured rock mass. There exist above-ground structures which pose additional risks to the construction. As such all necessary means will be employed to deliver a safe and economic construction. With regular coordination with project experts, the design and construction will be regularly reviewed. Additionally, researchers will be actively engaged in the project to observe and optimize the construction process. Development of human resources from the project will aid the nation in future projects in such geological settings.

- *Unavailability of data*: In Nepal, it is difficult to acquire data from some concerned authorities. Due to the unavailability of data, optimum design of the structures will be delayed. In such a case, every attempt will be made from the Principal Applicant and the Partner organizations to facilitate the data acquisition process. Similarly, regular monitoring and observation will be done during the construction of the KU tunnel and the design of the structures will be regularly modified as demanded by the geological condition encountered. The monitoring of the tunnel will also supplement future projects in the country.

- *Insufficiency of funds*: Although every attempt has been made in the budgeting to estimate a very realistic amount of funds for each project activity, in cases due to some unforeseen circumstances beyond the control of the Partnership, an insufficiency might arise in some project activities. In such a case, as a first attempt, the Partnership will jointly try to manage the deficit amount by contribution. However, if the insufficiency turns out to be excessively large, the project activities will be revised accordingly and again communicated with partner organizations and funding agencies. The project will be then continued as per the instruction which might also influence the project schedule and work plan.

Besides the ones mentioned above, other risks that might occur during the project duration will be managed by the Partnership tactfully and with the experience of the team members without hampering the project considerably. Whenever possible, risk mitigation will be done by maintaining a risk register.