KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

FINAL YEAR PROJECT REPORT ON

"STUDY OF HYDROELECTRIC POTENTIAL OF CHEPE RIVER"

A final year project report submitted in partial fulfilment of the requirements for the degree of Bachelor of Engineering in Civil Engineering (Specialization in Hydropower Engineering)

PROJECT SUPERVISOR:

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MAY, 2023

DEDICATED TO OUR
PARENTS AND TEACHERS

DECLARATION

We hereby declare that the project work entitled **"STUDY OF HYDROELECTRIC POTENTIAL OF CHEPE RIVER"** is an authentic record of our work, submitted in partial fulfillment of the requirements for the degree of Bachelor of Engineering in Civil Engineering with Specialization in Hydropower to **Department of Civil Engineering, Kathmandu University during the academic year 2023**, is a genuine work done originally by us under the supervision of **Er. Sujan Karki**. Any help from other people has been mentioned in the acknowledgement.

The report or any part of it has not been published or submitted for the academic award or any other Universities or Institutions. Any literature data or work done by others and cited within this report has been given due acknowledgment and listed in the reference section.

This report is prepared as purely academic work for the fulfillment of a Bachelor's degree and does not necessarily mean that the output and results can be implemented in any real-life construction.

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CERTIFICATION

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First and foremost, we extend our heartfelt appreciation to our supervisor **Er. Sujan Karki** & consultant **Er. Shiva Timalsina** Sir for their invaluable guidance, constructive feedback, and constant encouragement throughout the duration of the project. We are grateful to our external supervisor **Er. Subash Thapa Magar** sir for evaluating and providing good amount of knowledge in the respective project works. We are equally grateful to our final year project coordinator **Asst. Prof. Santosh Chaudhary** and the whole faculty members of the Department of Civil Engineering for their knowledge and support.

We are also obliged to all the people involved directly and indirectly who have consistently and continuously helped, supported and motivated us for the accomplishment of this project report.

EXECUTIVE SUMMARY

Super Chepe Hydropower Project (SCHP) is a run-of-river type project proposed in Ajirkot Gaupalika, Kharibot (Gorkha), and Dudhpokhari Gaupalika (Lamjung) with an installed capacity of 13.086 MW that will generate 73.86 GWh energy annually.

The project is proposed along the Chepe Khola in Gorkha and Lamjung districts of the Gandaki Province of Nepal. The proposed project lies between 28º 13' 00" N to 28º 15' 00" N and 84º 37' 55" E to 84º 39' 08" E.

The headworks of the project lies on the left bank of the Chepe Khola just below the confluence with Jumlyaha Khola at Sapru and the powerhouse lies 40 m upstream of the confluence of Thado Khola and Chepe Khola at Olang, Ajirkot Gaupalika, Gorkha.

The catchment area of the project at the proposed intake and powerhouse site is found to be 51.6 km^2 and 91.61 km^2 respectively. The project utilizes a design discharge of 2.91 m^3/s from Chepe Khola and the elevation difference between the proposed intake and powerhouse at Chepe Khola. All the components of the project lie within Ajirkot Gaupalika, Kharibot (Gorkha) and Dudhpokhari Gaupalika (Lamjung). The width of the river at the headworks site is sufficient to accommodate river diversion facilities during construction. The project consists of a broad crested weir with under sluice, side intake, gravel trap, approach canal, settling basin, headrace pipe, surge tank, penstock, anchor blocks, saddle supports, and surface powerhouse.

As Chepe Khola is a gauged river. The processed long-term streamflow data are available from a gauging station established by the Department of Hydrology and Meteorology (DHM) at Grambesi (Station No. 440) of Chepe Khola River 33km downstream from the proposed intake area. A reference station was selected for hydrological analysis and based on which the long-term flow estimated by Catchment Area Ratio method correlated to Chepe Khola, DHM Gauging Station No. 440 was adopted in the design process. The best frequency distribution is chosen from the existing statistical distributions such as Gumbel's Distribution, and Log-Pearson Type III.

Project capacity was optimized and the optimal capacity of the project corresponds to Q45% in the flow duration curve at a rated net head of 545.1 m (gross head 558m). Two Horizontal axis Pelton turbines of 6.847 MW capacity are designed with two nozzles.

The project comprises a broad crested weir across Chepe Khola Khola of 3.7m height, designed to divert the water to the intake. The crest level of the weir is at 1851.1 m which is assumed as the normal water level at design discharge. Two side intakes each of size 2.1 m x 2.1 m are provided to divert the designed discharge into the system. An undersluice of size 2m x 2 m (B x H) is designed to remove the bed load from the intake front. The gravel trap is designed to trap sediments larger than 15 mm with width and length of 4.2 m and 6 m respectively. An approach canal of length & width of 10 m

and 2.0 m respectively is constructed to convey the water to the settling basin of depth 3.5m and length of 40 m. Clear water from the settling basin flows in the headpond from where the water from the headpond is conveyed by the headrace pipe of length 3428.5m from the headrace to the surge tank. A surge shaft is provided at the end of the headrace pipe which consists of a total height of 18.5m with 2m freeboard. The flow from the surge tank is further conveyed to the powerhouse through 1006 m long penstock pipe with an internal diameter of 1m. Thus, the thickness of the penstock pipe used are 10 mm, 20 mm and 32 mm and the penstock requires 15 anchor blocks to withstand the horizontal and vertical thrust exerted in the penstock. The surface powerhouse is located towards the left bank of Chepe Khola which contains two horizontal axis Pelton turbines.

The study of the Super Chepe Hydropower Project concludes that with a payback period of 9 years, it is a technically feasible and financially viable project with a positive Net Present Value of NRs. 7.7 billion and an Internal Rate of Return (IRR) of 12.71 % is estimated for 33 years project period. The B-C ratio of the project is obtained to be 2.13. The total cost of the project is estimated to be NRs. 3.35 billion with a construction period of 2 years and an economic life of the project to be 33 years.

कार्यकारी सारांश

सुपर चेपे जलविद्युत परियोजना एक रन-अफ-रिभर प्रकारको परियोजना हो जुन अजिरकोट गाउँपालिका, खरिबोट, गोरखा र दूधपोखरी गाउँपालिका, लमजुङमा 13.086 मेगावाटको स्थापित क्षमताको प्रस्ताव गरिएको छ जसले वार्षिक 73.86 GWh ऊर्जा उत्पादन गर्नेछ।

यो आयोजना नेपालको गण्डकी प्रदेशको गोरखा र लमजुङ जिल्लाको चेपेखोला किनारमा प्रस्तावित छ । प्रस्तावित आयोजना २८° 13′ 00″ N देखि 28° 15′ 00″ N र 83° 37′ 55″ E देखि 83° 39′ 08″ E बीचको छ।

आयोजनाको हेडवर्क सप्रुको जुम्ल्याहा खोला संगमको ठीक मुनि चेपे खोलाको बायाँ किनारमा र पावरहाउस गोरखाको अजिरकोट गाउँपालिकाको ओलाङमा थाडो खोला र चेपे खोलाको संगमको ४० मिटर माथिल्लो भागमा अवस्थित छ।

प्रस्तावित इन्टेक र पावर हाउस साइटमा आयोजनाको क्याचमेन्ट एरिया क्रमशः ५१.६ किमी २ र ९१.६१ किमी २ रहेको छ।

परियोजनाले चेपे खोलाबाट २.९१ m^3/s को डिजाईन डिस्चार्ज र प्रस्तावित इन्टेक र चेपे खोलाको पावरहाउस बीचको उचाइको भिन्नता प्रयोग गर्दछ। आयोजनाका सबै अंगहरु अजिरकोट गाउँपालिका, खरिबोट, गोरखा र दूधपोखरी गाउँपालिका, लमजुङमा पर्दछन् । हेडवर्क साइटमा नदीको चौडाइ निर्माणको क्रममा नदी डाइभर्सन सुविधाहरू समायोजन गर्न पर्याप्त छ। परियोजनामा अन्डर स्लुइस, साइड इनटेक, ग्राभेल ट्रयाप, अप्रोच नहर, सेटलिङ बेसिन, हेडरेस पाइप, सर्ज ट्याङ्की, पेनस्टक, एन्कर ब्लक, सेडल सपोर्ट र सतह पावरहाउससहितको फराकिलो क्रेस्टेड वाइयर समावेश छ।

जसरी चेपे खोला नापिएको नदी हो । प्रशोधित दीर्घकालीन स्ट्रिम प्रवाह डाटा प्रस्तावित इनटेक क्षेत्रबाट ३३ किलोमिटर तल चेपे खोला नदीको ग्रामबेसी (स्टेशन नम्बर ४४०) मा जल तथा मौसम विज्ञान विभाग (DHM) द्वारा स्थापित गेजिङ स्टेशनबाट उपलब्ध छ। हाइड्रोलोजिकल विश्लेषणको लागि सन्दर्भ स्टेशन छनोट गरिएको थियो र जसको आधारमा क्याचमेन्ट एरिया रेसियो विधिद्वारा अनुमानित दीर्घकालीन प्रवाह चेपे खोला, DHM गेजिङ स्टेशन नम्बर 440 सँग सम्बन्धित डिजाइन प्रक्रियामा अपनाइयो। गुम्बेलको वितरण, र लग-पियरसन प्रकार जस्ता सांख्यिकीय वितरणहरूबाट उत्तम फ्रिक्वेन्सी वितरण छनौट गरिन्छ।

परियोजना क्षमता अनुकूलित गरिएको थियो र परियोजनाको इष्टतम क्षमता 545.1 मिटर (ग्रस हेड 558m) को रेट गरिएको नेट हेडमा प्रवाह अवधि वक्रमा Q45% सँग मेल खान्छ। ६.८४७ मेगावाट क्षमताको दुई तेर्सो अक्ष पेल्टन टर्बाइन २ नम्बर नोजलका लागि डिजाइन गरिएको छ।

आयोजनामा ३.७ मिटर उचाइको चेपेखोलामा फराकिलो आकारको वीर समावेश गरिएको छ जसलाई पानी बहाउन डिजाइन गरिएको छ। वीरको क्रेस्ट लेभल १८५१.१ मिटर छ जसलाई डिजाइन डिस्चार्जमा सामान्य पानीको स्तर मानिन्छ। डिजाइन गरिएको डिस्चार्जलाई प्रणालीमा डाइभर्ट गर्नका लागि २.१ मिटर x २.१ मिटर आकारको प्रत्येक दुई साइड इनटेकहरू प्रदान गरिन्छ। 2m x 2 m (B x H) आकारको अन्डरस्लुइसलाई इनटेक अगाडिबाट ओछ्यानको भार हटाउन डिजाइन गरिएको हो। ग्रेभल ट्रयाप १५ मि.मि. भन्दा ठुलो तलछटलाई फसाउन डिजाइन गरिएको हो जसको चौडाई र लम्बाइ क्रमशः ४.२ मिटर र ६ मिटर हुन्छ। ३.५ मिटर गहिराई र ४० मिटर लम्बाइको सेटलिंग बेसिनमा पानी पुऱ्याउन क्रमशः १० मिटर र २.० मिटर लम्बाइ र चौडाइको दृष्टिकोण नहर निर्माण गरिएको छ। सेटलिङ बेसिनबाट सफा पानी हेड पोखरीमा बग्छ जहाँबाट हेड पोखरीको पानी ३४२८.५ मिटर लम्बाइको हेड्रेस पाइपद्वारा सर्ज ट्याङ्कीमा पुऱ्याइएको छ। हेडरेस पाइपको अन्त्यमा सर्ज शाफ्ट प्रदान गरिएको छ जसमा २ मिटर फ्री बोर्डको कुल उचाइ १८.५ मिटर हुन्छ। सर्ज ट्याङ्कीको प्रवाहलाई थप १ मिटर भित्री व्यास भएको १००६ मिटर लामो पेनस्टक पाइपमार्फत पावरहाउसमा पुऱ्याइएको छ। यसरी,

पेनस्टक पाइपको मोटाई 10, 20, 32 एमएम हुन्छ र पेनस्टकमा लगाएको तेर्सो र ठाडो जोरलाई सामना गर्न पेनस्टकलाई 15 एंकर ब्लक चाहिन्छ। सतह पावरहाउस चेपे खोलाको बायाँ किनारमा अवस्थित छ जसमा दुई तेर्सो अक्ष पेल्टन टर्बाइनहरू छन्।

सुपर चेपे जलविद्युत आयोजनाको अध्ययनले ९ वर्षमा पेब्याक अवधिसहित यो प्राविधिक रूपमा सम्भाव्य र आर्थिक रूपमा सक्षम आयोजना भएको निष्कर्ष निकालेको छ । ३३ वर्षको परियोजना अवधिको लागि ७.७ बिलियन र १२.७१% को आन्तरिक दर (IRR) अनुमान गरिएको छ। आयोजनाको बी–सी अनुपात २.१३ प्राप्त भएको छ । आयोजनाको कुल लागत रु. ३ अर्ब ३५ करोडको निर्माण अवधि २ वर्ष र आयोजनाको आर्थिक आयु ३३ वर्ष रहनेछ ।

LIST OF SYMBOLS AND ABBREVIATIONS

amsl	Above Mean Sea Level
B/C	Benefit to Cost
CBS	Central Bureau of Statistics
cm	Centimeter
cm^2	Square Centimeter
cumecs	Cubic Meter Per Second
d/s	Downstream
DHM	Department Of Hydrology And Meteorology
E	Easting
etc.	Et Cetera
FDC	Flow Duration Curve
GoN	Government Of Nepal
GWhr	Gigawatts Hour
H.G	Hydraulic Gradient
HP	Horse Power
IRR	Internal Rate Of Return
IS	Indian Standard
Km	Kilometer
km^2	Square Kilometer
kN	Kilo Newton
kV	Kilovolt
kWhr	Kilowatts Hour
M	Mete
M	Magnitude
m/s	Meter Per Second
m^3	Cubic Meters
MFT	Main Frontal Thrust
Mm	Millimeter
MPa	Mega Pascal
MW	Megawatt
N	Northing
NEA	Nepal Electricity Authority
NPV	Net Present Value
NRs	Nepali Rupees
O&M	Operation And Maintenance
PH	Powerhouse
Q	Discharge
rpm	Revolution Per Minute
sq.	km Square Kilometer
USBR	United States Bureau Of Reclamation
VDC	Village Development Committee
Yrs.	Years

SALIENT FEATURES

Table 1. Project Location

Project Location	
Region/Province	Western/Gandaki Province
District	Gorkha and Lamjung
Rural Municipality	Ajirkot (Gorkha) & Dudhpokhari Rural Municipality
Nearest Town	Abukhaireni
Intake Site	Olang, Kharibot
Powerhouse Site	Olang, Kharibot
Geographical Coordinates	
Latitude	28 13’0’’N to 28 15’0’’N
Longitude	84 37’55”E to 84 39’08’’E

Table 2. General Information

General Information	
Name of River	Chepe Khola
Type of Scheme	ROR type Hydropower Project
Gross Head	558 m
Net Rated Head	545.1m
Installed Capacity	13.086 MW

Table 3. Project Hydrology

Project Hydrology	
Catchment Area	51.59 km^2
Mean Annual Discharge	3.95m^3/sec
Design Discharge at(45% POE)	2.91 m^3/sec
Riparian Release	0.072m^3/sec
Design Flow Discharge (100 years)	205 m^3/sec
Average Annual Precipitation	2500mm

Table 4. Diversion Weir

Diversion Weir	
Type of Weir	Broad crested weir
Length of Weir	18 m
Crest Elevation	1851.1 amsl
Undersluice Opening (W X H)	2 x 2 m

Table 5. Intake Structure and Gravel Trap

Intake Structure and Gravel Trap	
Type of Intake	Side Intake
Nos. of Opening	2
Size of Intake (W x H)	2.1 m x 1 m each
Intake Sill Level	1850.60 amsl
Length of Gravel Trap	6 m
Width of Gravel Trap (Avg.)	4.2 m
Overall depth	2.5 m

Table 6. Settling Basin

Settling Basin	
Type	Conventional Hopper type with intermittent flushing
Nos of bay	2
Dimension (L x B x H)	40 m x 4 m x 5 m each
Inlet Transition Length (Horizontal)	12 m
Inlet Transition Length (Inclined)	12.6 m
Trapping Efficiency	85.37% (Vetter's Equation)

Table 7. Head Pond

Head Pond	
Length	11.6 m
Width	6.6 m
Depth	3.6 m
Submerged Head	1.9 m

Table 8. Headrace Pipe

Head Race Pipe	
Type	Mild Steel
Internal Diameter	1.4 m
Length	3428.5 m
Steel Thickness	4 mm
Nos. of Anchor Blocks	55

Table 9. Surge Tank

Surge Tank	
Type	Simple Surge-Concrete, Surface
Height	18.5 m with 2 m freeboard
Diameter	5 m
Static water level	1849.5 amsl
Normal water level	1844.1 amsl
Upsurge Level	1851.91 amsl
Down surge Level	1840.81 amsl

Table 10. Penstock

Penstock	
Type	High Strength Steel
Internal Diameter	1 m
Length	1006 m
Steel Thickness	10mm, 20mm, 32 mm
Nos. of Anchor Blocks	15

Table 11. Powerhouse

Powerhouse	
Type	Surface
Size (L x W)	40 m x 15 m
Height	18 m
Turbine Axis Level	1290 amsl

Table 12. Turbine

Turbine	
Type	Pelton
Number	2
Rated Output Capacity per unit	6,847 kW
Turbine Axis Level	1290 amsl
Discharge per Unit	1.45 m^3/sec

Table 13. Tailrace

Tailrace	
Type	Rectangular section
Tailrace Length	40 m
Size (W x D)	1.5 m x 1.7 m
Tailrace Water Level	1288.5 amsl

Table 14. Project Cost Estimate

Project Cost Estimate	
The total cost of the Project	Rs. 3.35 billion
Construction Period	2 years