
بسم الله الرحمن الرحيم

SUKKUR BARRAGE

The Sukkur Barrage: A Century-Old Engineering Marvel

- **Built in 1932:** Originally designed for an impressive discharge capacity of 1.5 million cusecs, it stood as a monumental achievement in hydraulic engineering.
- **Backbone of Sindh's Irrigation:** This iconic structure feeds 7 major canals, irrigating millions of acres and sustaining the agricultural heartland of Sindh.
- **Vital for Regional Life:** It remains crucial for both agriculture and urban water supply across Sindh and extending into parts of Balochistan, impacting millions of lives.

SBIP/S1 Work Program Year 3 (2025–2026)

27 Main Weir Barrage Gates & Hoists Replacement

SBIP | S1-Contract

The Project

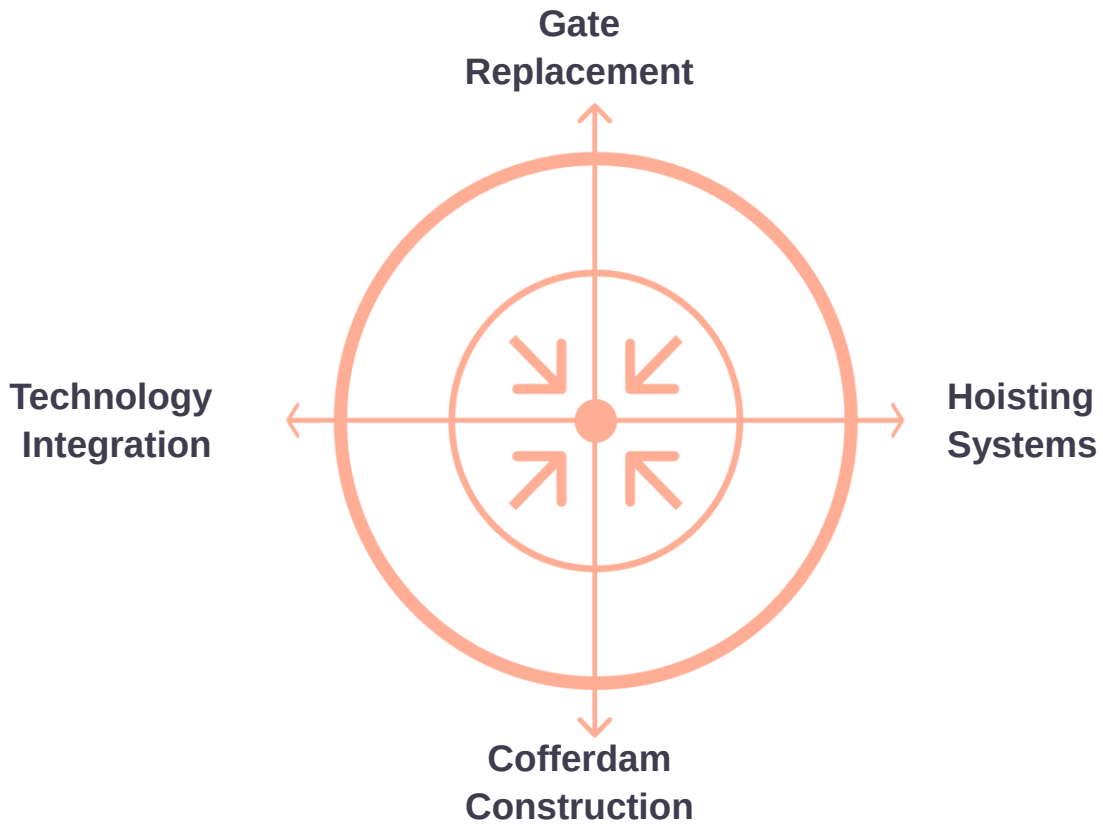
Sindh Barrages Improvement Project – SBIP

SBIP	Component A: Rehabilitation of Sukkur and Guddu Barrage Component B: Improved Barrage Operation Component C: Technical Studies Component D: River Basin and Riverine Area Management Component E: Project Management, Monitoring & Evaluation
Funding	World Bank, Government of Pakistan, and Government of Sindh
Component A	SBIP/G2: Rehabilitation of Guddu Barrage – Ongoing SBIP/G3: River training works at Guddu Barrage – Completed SBIP/G3A: Construction of TJ Spur – Contractor mobilised SBIP/S0: Emergency replacement of 6 gates Sukkur Barrage – Completed SBIP/S1: Rehabilitation and Modernisation of Sukkur Barrage – Ongoing SBIP/S2: Dredging at upstream of Sukkur Barrage – Ongoing (via S1 VO-6) SBIP/S3: Procurement of Dredgers – Bidding documents prepared SBIP/S4: Desilting of Rice Canal – Completed

Scope of the SBIP/SI Contract

This comprehensive contract addresses the critical need to restore and upgrade the Sukkur Barrage, blending historical engineering with advanced solutions.

- **Gate Replacement:** 56 out of 66 original barrage gates are being replaced with modern, lighter, and more efficient mechanized units.
- **Advanced Hoisting Systems:** Installation of wire rope winch hoisting mechanisms and automation through ADAS System for precise and reliable gate operation.
- **Cofferdam Construction:** Strategic construction of temporary cofferdams to create dry working conditions, ensuring safety and efficiency during critical structural repairs and offering flood protection.
- **Technology Integration:** Seamless integration of cutting-edge technology with the existing historic engineering marvel for enhanced functionality.



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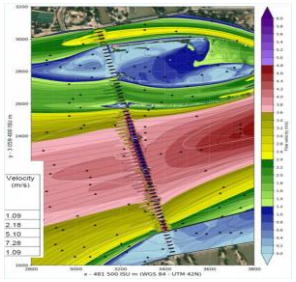
Technical Innovations and Engineering Feats

Enhanced Gate Height

•Raising gate height from 21 ft to 23 ft for 44 weir gates.
•Raising gate height from 23 ft to 24.5 ft for 12 scour gates.
•Achieving the NWL of 199.5 RL.
•Ensuring adequate water supply to the seven feeder canals
Refer:
Design Calculations



Advanced Hydraulic Testing

Utilization hydraulic modelling at **Artelia Laboratory, Grenoble, France**, for optimal design verification.
• Sediment exclusion testing
• Discharge capacity testing
• Riprap stability testing
Attachment:
Final Report

Automated Operation Systems ADAS

Implementation of automated gate operation systems to ensure precise and efficient water management, minimizing human error. Operationalize in the final year working season [2026-2027]
Inshallahtallah

First-Ever Floor Exposure

Cofferdam construction has enabled the first full floor exposure for inspection since 1932, allowing unprecedented structural assessment.

Rehabilitation Works – Sukkur Barrage

A comprehensive overview of the crucial components involved in the rehabilitation project.

Electro-Mechanical Works

- Replacement of 56 barrage gates and hoisting system.
- Replacement of 55 canal head regulator gates and hoisting system
- Electrical system modernization
- Control & automation system installation ADAS
- New Standby power system rehabilitation

Civil Works

- Structural strengthening of piers & deck
- Overlay concreting at apron
- Settled U/S apron at bays 15 to 17 repaired
- Overlay concreting Baffle Wall D/S tail Channel
- Rip-rap (stone dumping) D/S as per Artelia Model Study
- Bay 23 & 24 – Construction of new low height wall
- Construction of New Buildings.

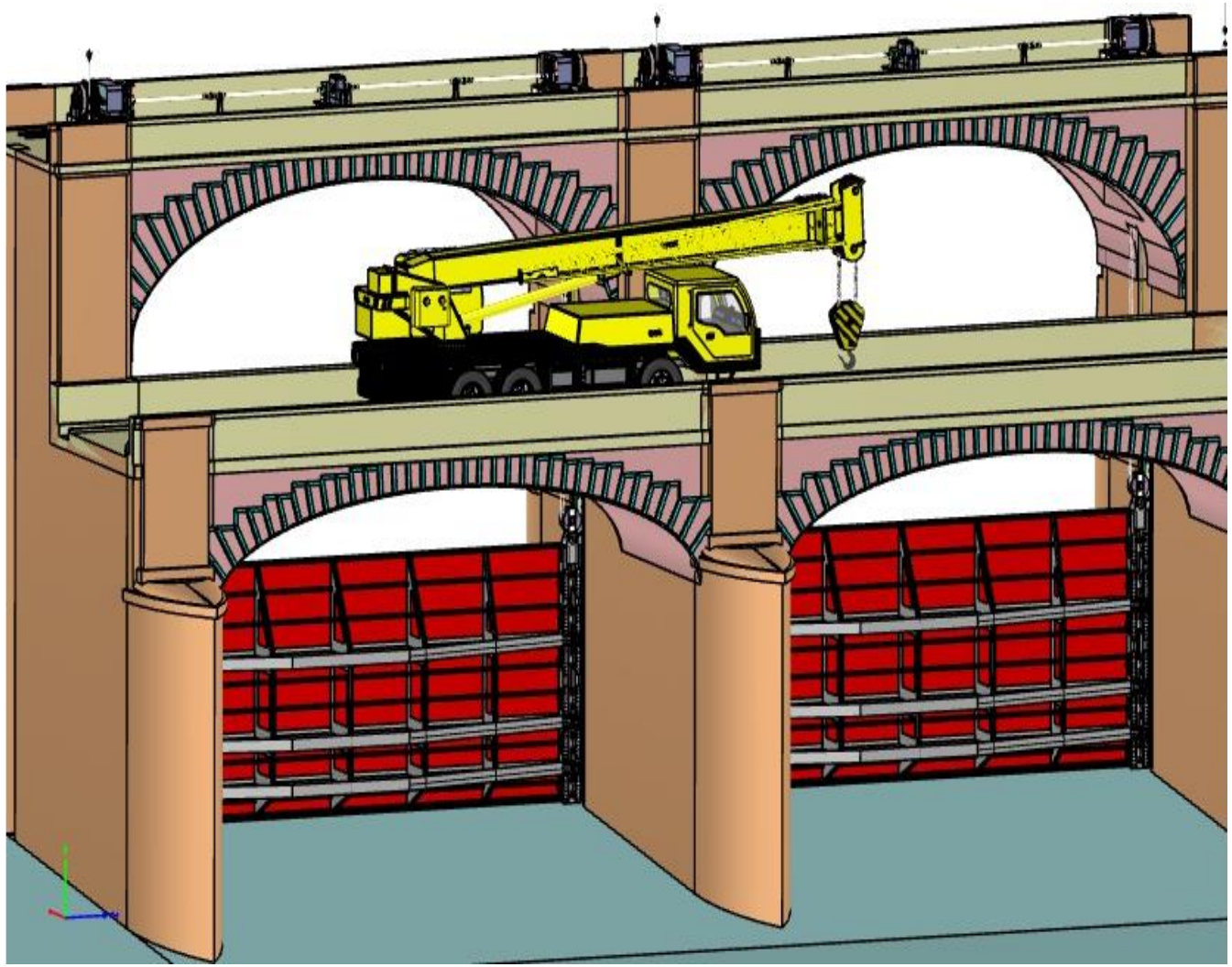
Environmental Works

- Environmental & Social Management Plan ESMP implementation.
- Social & Health Plans HSPs Implementations
- Solid waste & pollution control measures
- Water, air & noise monitoring
- Plantation & ecological measures

Electro-Mechanical Works

Electro-Mechanical Works – Overview

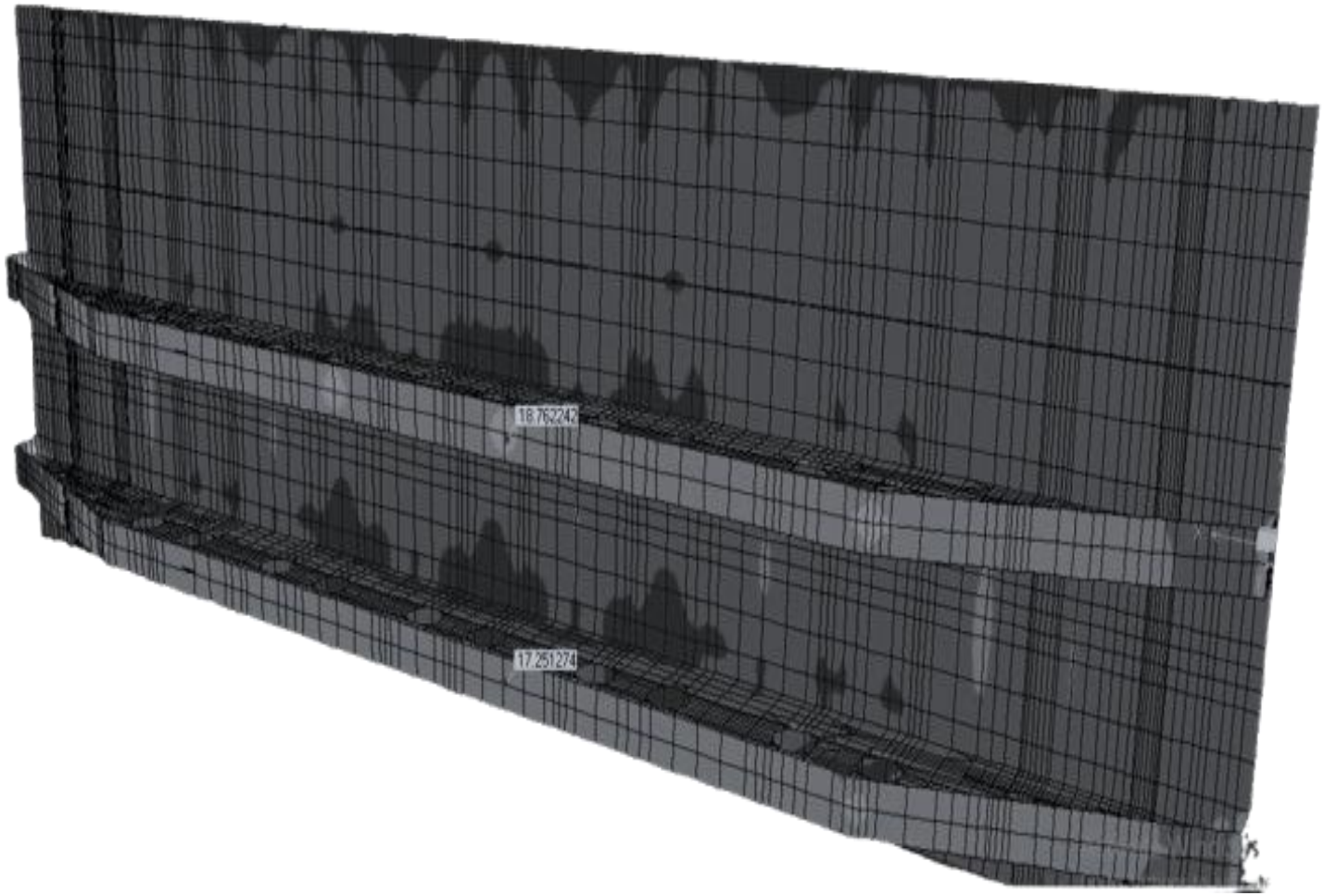
Delivering advanced electro-mechanical solutions for critical infrastructure of Sukkur barrage, ensuring precision, reliability, and safety.



Old Gate System at Sukkur Barrage

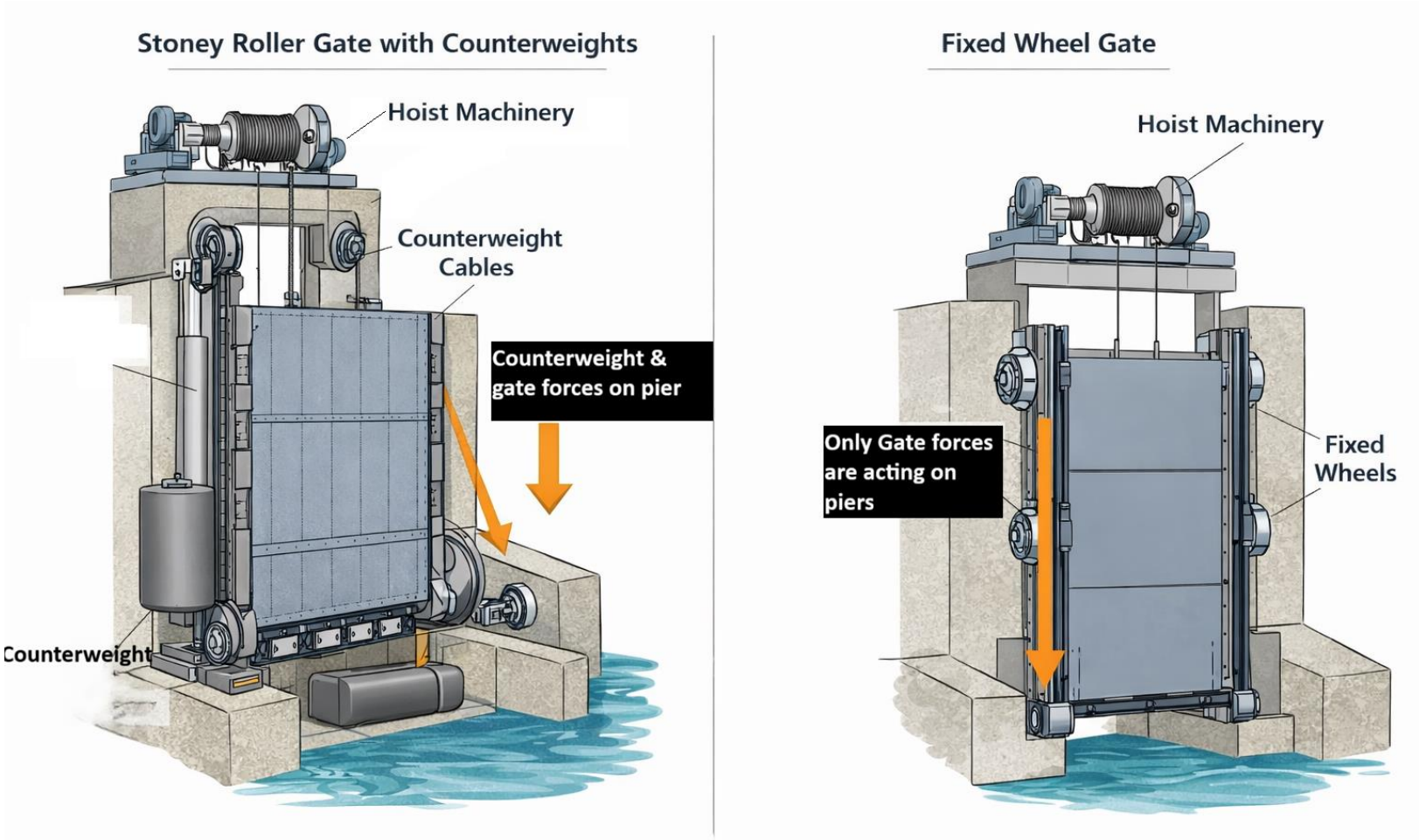
Existing Infrastructure
The barrage was utilized "Stony roller type" gates, which operate with a counterweight system to achieve partial load balancing.

Proposed Modification
The current scope of the S1 project mandates Fixed Wheel counterweight less system, converting the gate operation to a direct-drive, motor-powered configuration.



Comparison of Old and New Design Philosophy

- Traditional Stoney roller gates rely on counterweights to partially balance gate loads, reducing the effort required from hoisting machinery.
- Though effective, such systems introduce additional loadings of 80 tons per bay on civil structures.
- Alternatively, the counter-weightless solution reduces the balancing load of 80 tons per bay from the civil structure, hence enhancing the structure life of the barrage.



"Schematic Comparison: Stoney Roller Gate with Counterweight vs. Fixed Wheel Gate without Counterweight"

MATERIAL TESTING AND FABRICATION
GATES TESTING THROUGH IN-HOUSE AND THIRD PARTY LAB

Ensuring Quality, Reliability and Compliance at Every Stage

OBJECTIVE

To verify that all materials and fabricated gate components conform to the specified standards and performance requirements through comprehensive testing conducted in-house and by accredited third party laboratories.

SCOPE

- Raw material testing
- Welding and fabrication quality control
- Dimensional and visual inspection
- Mechanical and chemical testing
- NDT (Non-Destructive Testing)
- Performance / load testing of gates

APPLICABLE STANDARDS

- ASTM / ASME / AISI
- IS / ISO Standards
- BS EN Standards
- Project Specifications
- Irrigation Department, Govt. of Sindh Requirements

TESTING PROCESS FLOW

01 RAW MATERIAL INSPECTION AND TESTING
Chemical, Mechanical and Dimensional Tests

→

02 FABRICATION AND WELDING
Welding Procedure Qualification (WPQ) and Welder Qualification (WQT)

→

03 IN-PROCESS INSPECTION
Dimensional Check, Visual Inspection and NDT

→

04 FINAL TESTING
Mechanical, Chemical and NDT as per Applicable Standards

→

05 THIRD PARTY INSPECTION & TESTING
Testing by Accredited Third Party Laboratory and Certification

→

06 APPROVAL & RELEASE
Review of Test Reports, Compliance Check and Release for Dispatch / Erection

TESTING FACILITIES

IN-HOUSE LAB

- UTM, Hardness Tester
- Impact Tester
- Spectrometer
- NDT Equipment
- Dimensional Inspection Tools

THIRD PARTY LAB

- Accredited & Certified Laboratories
- Advanced Testing Equipment
- Independent Verification
- Compliance Certification

TYPES OF TESTS

- Chemical Composition Test
- Tensile Test
- Yield & Elongation Test
- Impact Test
- Hardness Test
- Bend Test
- Macro & Micro Examination
- Non-Destructive Testing (UT, MT, PT, RT)
- Dimensional Inspection
- Load / Functional Testing of Gates
- Coating Thickness Test
- Welder Performance Test

DOCUMENTATION & TRACEABILITY

- Material Test Certificates (MTC)
- Welder & WPS Records
- Inspection & Test Reports
- NDT Reports
- Third Party Test Certificates
- Traceability of Materials and Components

GATES TESTING (PERFORMANCE)

STATIC LOAD TEST
To verify strength and deformation within permissible limits

DYNAMIC / FUNCTIONAL TEST
To verify smooth operation of lifting, lowering and components

WATER TIGHTNESS TEST
To ensure gate seals and joints are free from leakage

LOAD TESTING

OPERATIONAL TESTING

WATER TIGHTNESS TEST

BENEFITS

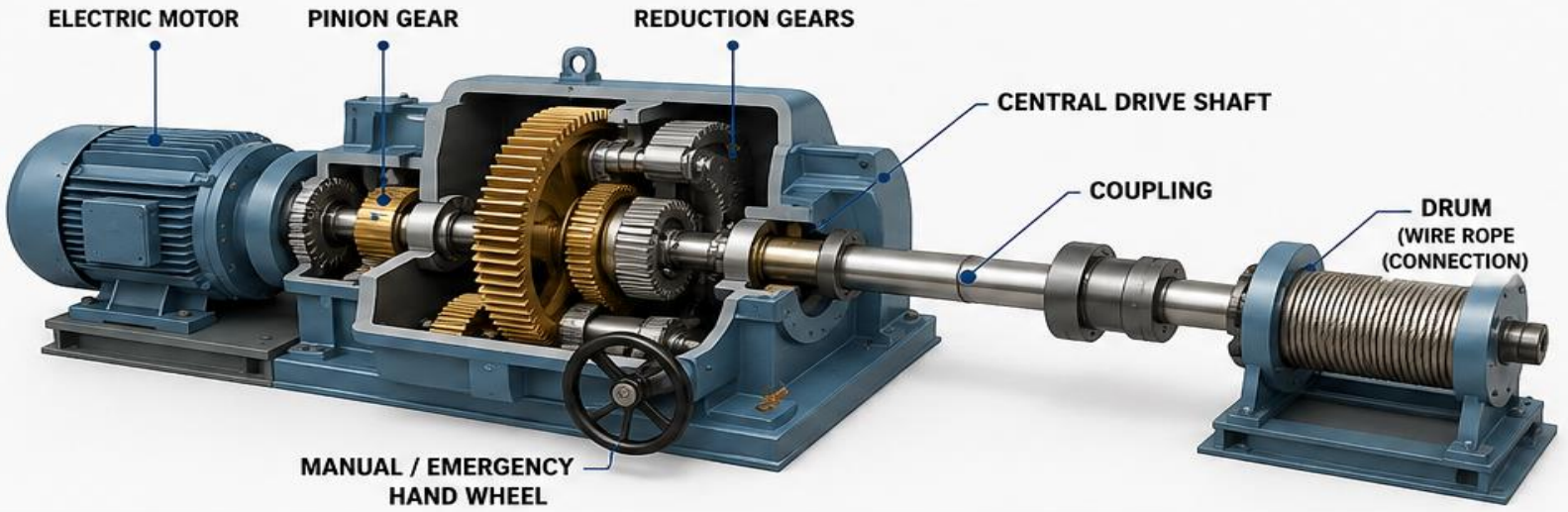
- Ensures quality and reliability of gates
- Compliance with international standards
- Reduced risk of failure in service
- Enhanced safety and performance
- Complete documentation and traceability

QUALITY TESTED. RELIABILITY ASSURED. PERFORMANCE DELIVERED.

SUKKUR BARRAGE HOISTING SYSTEM

CENTRAL / REDUCTION GEAR SYSTEM

Power Transmission for Safe, Smooth and Synchronized Gate Operation



KEY FEATURES

- **High Torque Transmission**
  Provides sufficient torque to lift and lower heavy barrage gates.
- **Speed Reduction**
  Reduces high motor speed to low output speed for controlled operation.
- **Synchronized Operation**
  Central shaft ensures uniform movement of both sides of the gate.
- **Heavy Duty & Reliable**
  Robust design for continuous operation in demanding hydraulic environment.
- **Safety & Protection**
  Equipped with brakes, overload protection and anti-reverse locking.
- **Easy Maintenance**
  Designed for easy inspection, lubrication and long service life.

WORKING PRINCIPLE

Motor (High Speed) → **Reduction Gear** (Speed Reduction & Torque Increase) → **Central Shaft** (Power Transmission) → **Drum** (Gate Hoisting)

The motor drives the pinion which meshes with the reduction gears. The gear train reduces speed and increases torque, which is transmitted through the central shaft to the drum for lifting or lowering the gates.

TYPICAL SPECIFICATIONS (EXAMPLE)

Item	Specification (Typical)
Type of Gear	Helical / Spur Gear
Reduction Ratio	Approx. 1:25 to 1:40
Input Speed (Motor)	~ 970 RPM
Output Speed (Shaft)	~ 25 – 40 RPM
Rated Output Torque	As per gate load requirement
Material of Gears	Forged Steel
Lubrication	Oil Bath / Splash Lubrication
Mounting	Base Mounted
Application	Hoisting of Barrage Gates

SAFETY & MAINTENANCE

- **Braking System**
  Ensures safe stopping and holding of gates.
- **Overload Protection**
  Prevents damage due to excessive load.
- **Anti-Reverse Locking**
  Prevents reverse rotation and accidental back driving.
- **Regular Lubrication**
  Maintains efficiency and reduces wear.
- **Inspection & Monitoring**
  Periodic checks of gears, bearings, couplings and oil levels.

The reduction gear assembly is the core mechanical unit that converts motor power into controlled gate movement for safe and reliable barrage operation.

Comprehensive Scope of Work

Design & Fabrication

Barrage gates Fabrication in Sukkur workshop

Testing & Commissioning

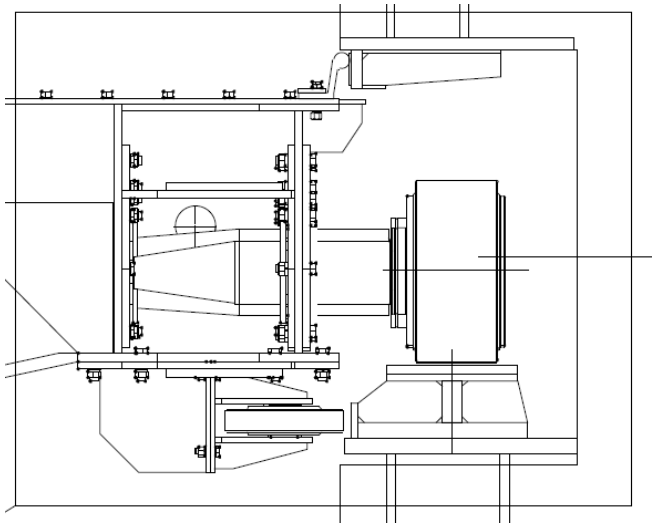
27 Hoist machines FAT carried out at Hubei Workshop China.

Supply & Installation

Lowering and installation of gate leaf

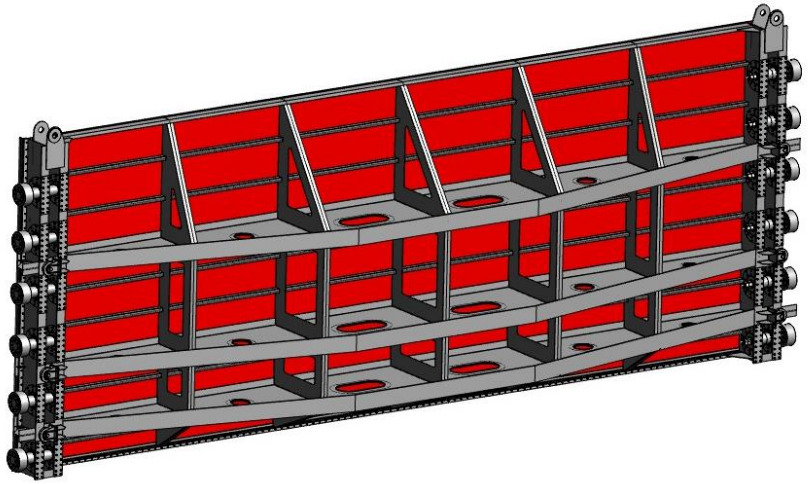
Key Components

Our electro-mechanical solutions integrate several critical components; each meticulously designed for optimal performance and durability in demanding environments.



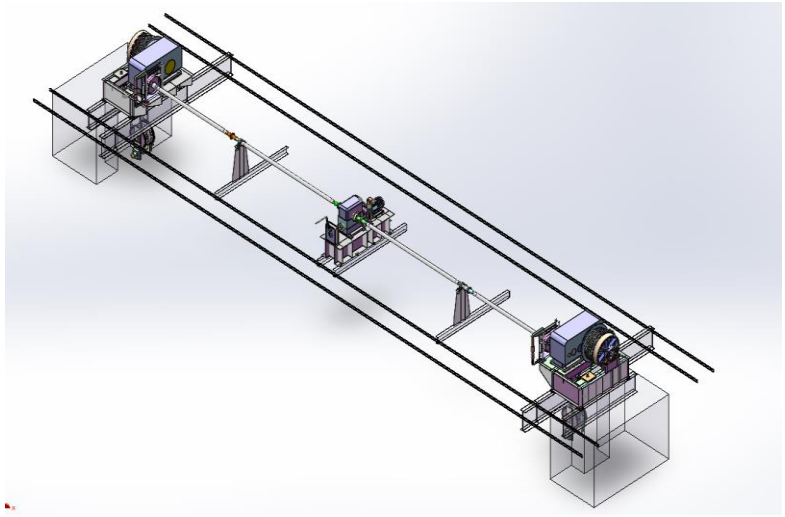
Embedded Parts

These foundational elements are crucial for structural integrity, providing secure anchoring for all electro-mechanical assemblies within the infrastructure.



Gate Leaf

Designed for precise water control or barrier operations, the robust gate leaf ensures efficient regulation and withstands significant environmental pressures.

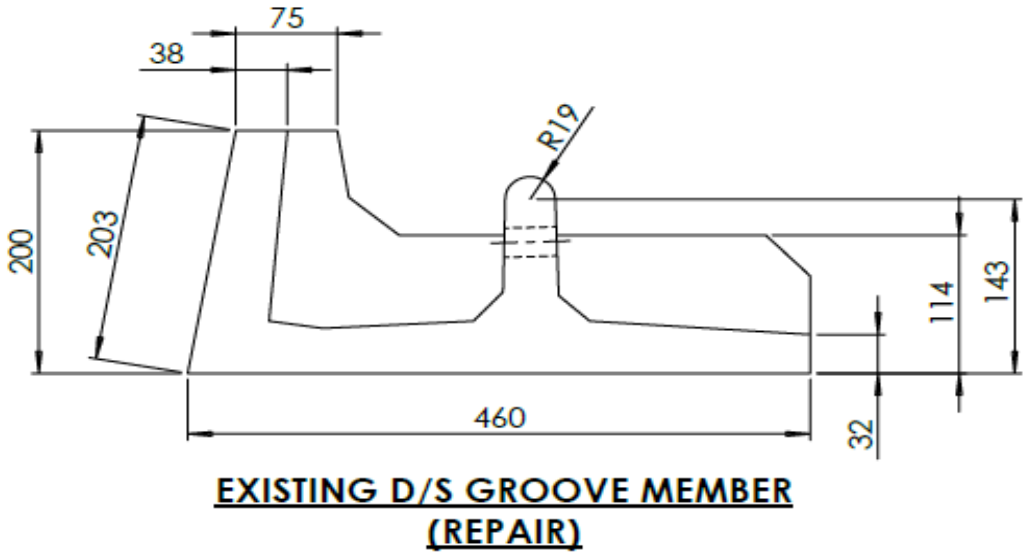


Hoisting System

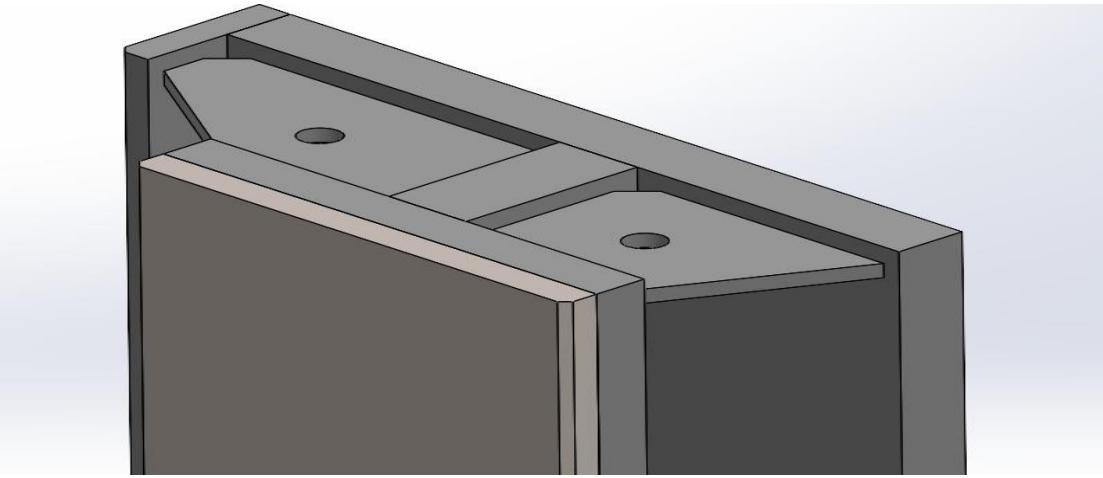
A powerful and reliable system comprising motors, gearboxes, and cables, engineered for smooth and controlled operation of the gate leaf.

Embedded Parts

Embedded Parts
Old Vs New



EXISTING D/S GROOVE MEMBER
(REPAIR)



Old Embedded Parts

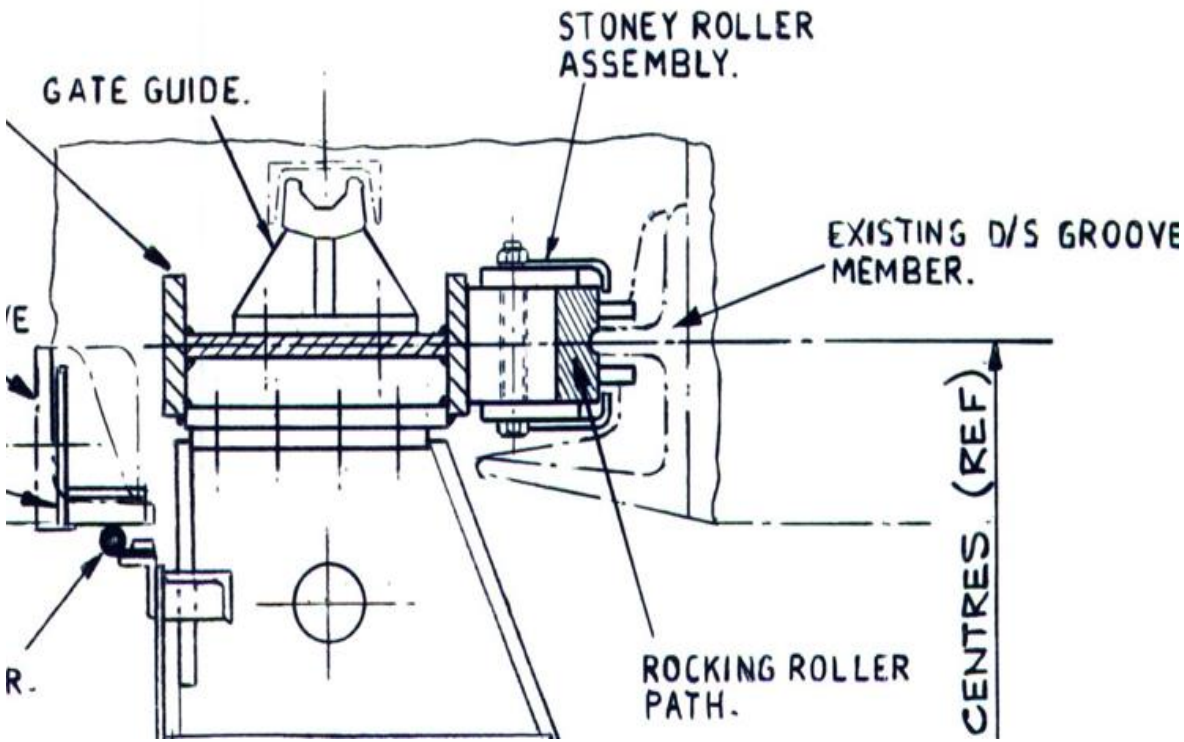
Comprise of F-Shaped casted member which used to provide a rocking track for stony rollers and an extended flap for protection against incoming floating debris or bio-mass

New Embedded Parts

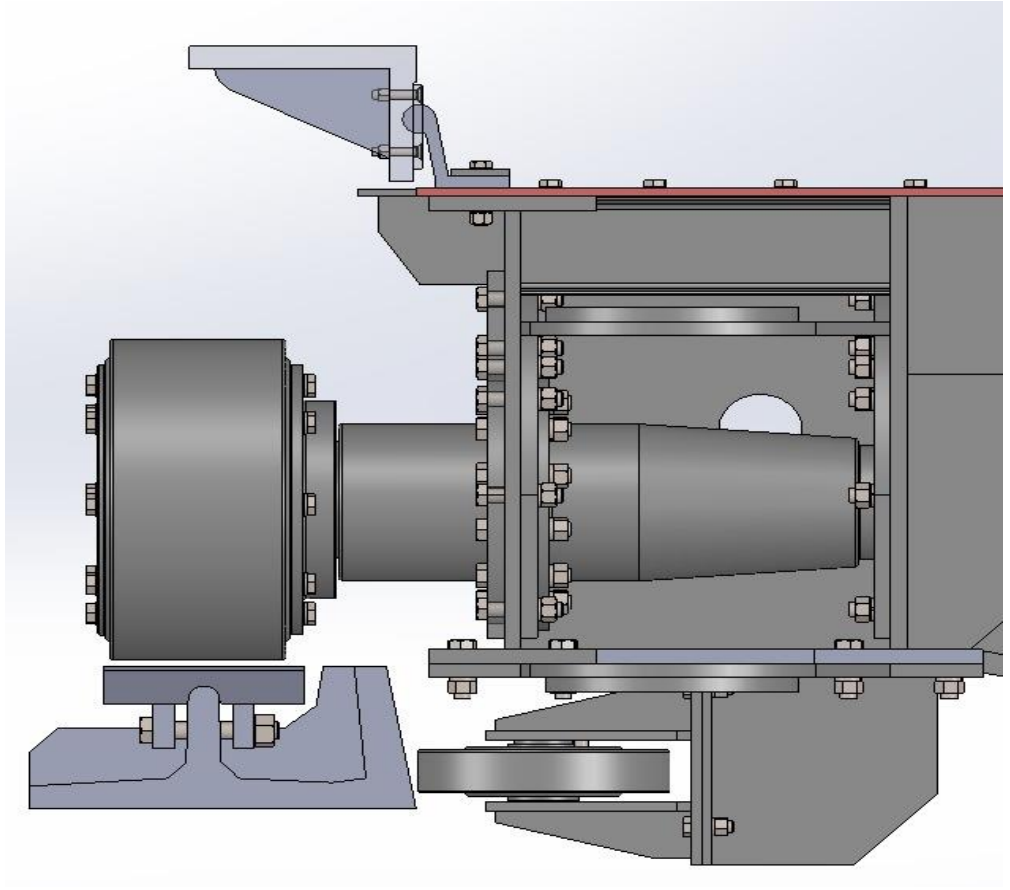
Comprise of a fabricated single unit with base plate directly attached to the D/S side of the groove and a track plate (track path) for Fixed wheels

Typical Arrangement of Existing and New Embedded Parts

Stony Roller Vertical Gates

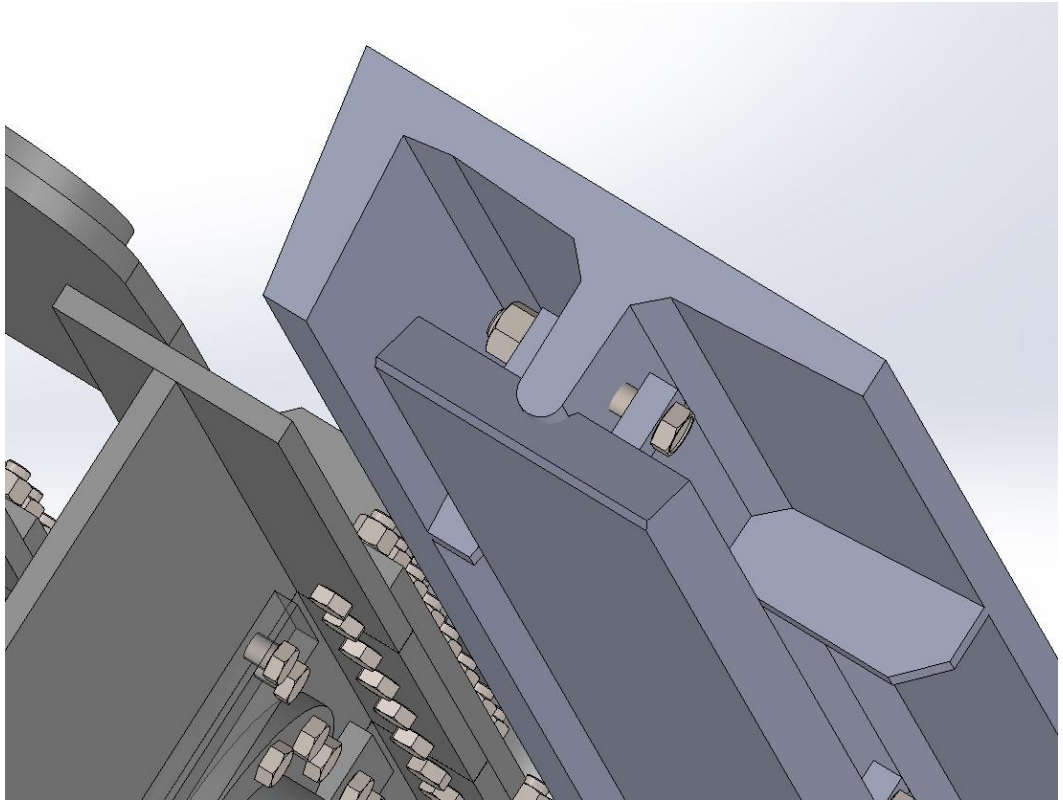


Fixed Wheel Vertical Gates

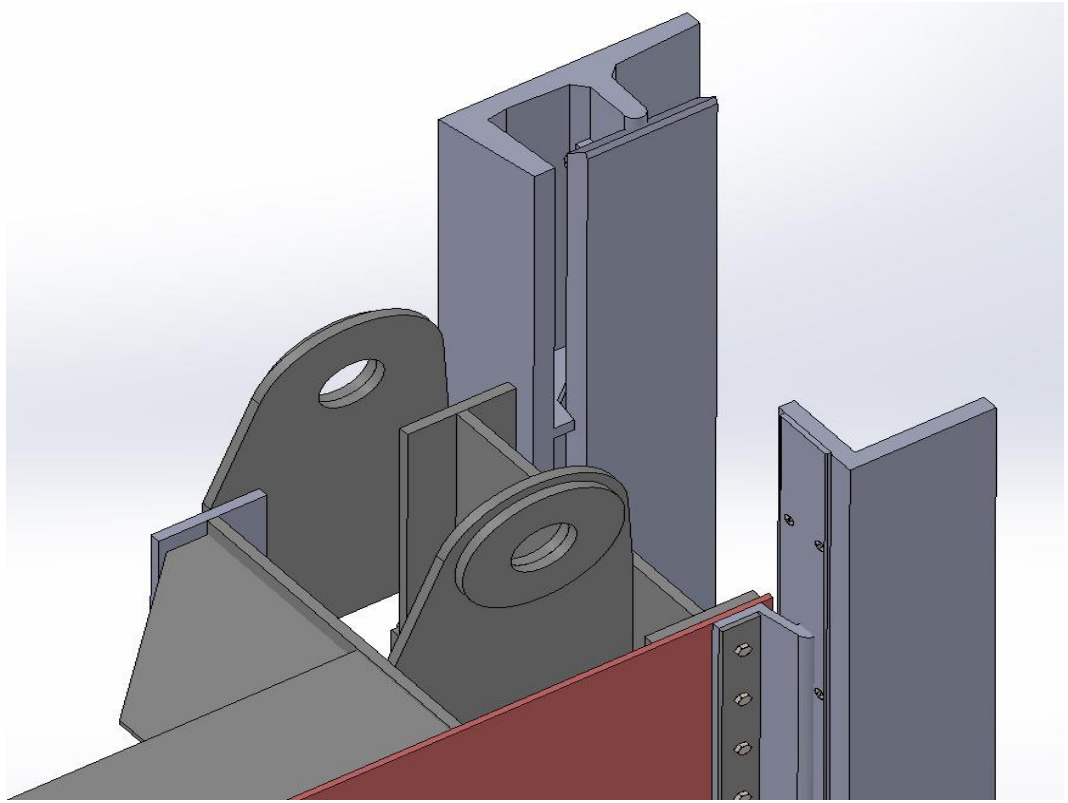


MAIN BARRAGE EMBEDDED PARTS

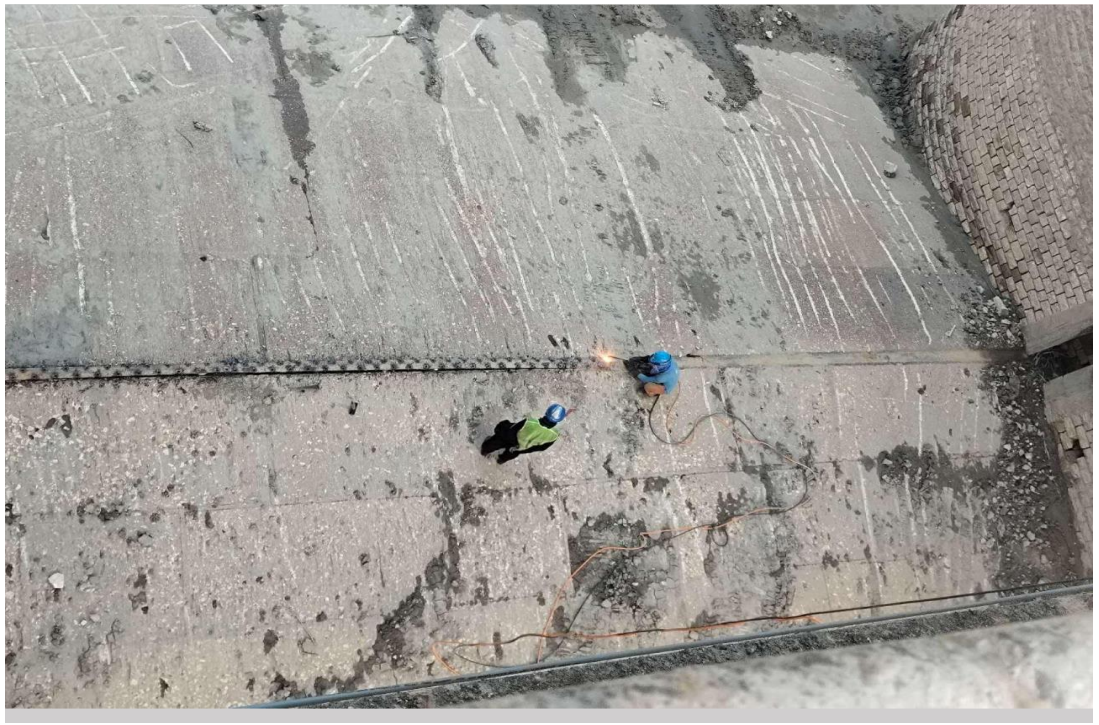
Existing Main Wheel Track For Fixed Wheel Vertical Gate [DS]



Existing Lateral Seal For Fixed Wheel Vertical Gate [US]



Installation of New Sill Beam on 27 Main Weir Barrage Gates



Grade material:

MS PLATE OVER SILL BEAM: A-572 GR.50

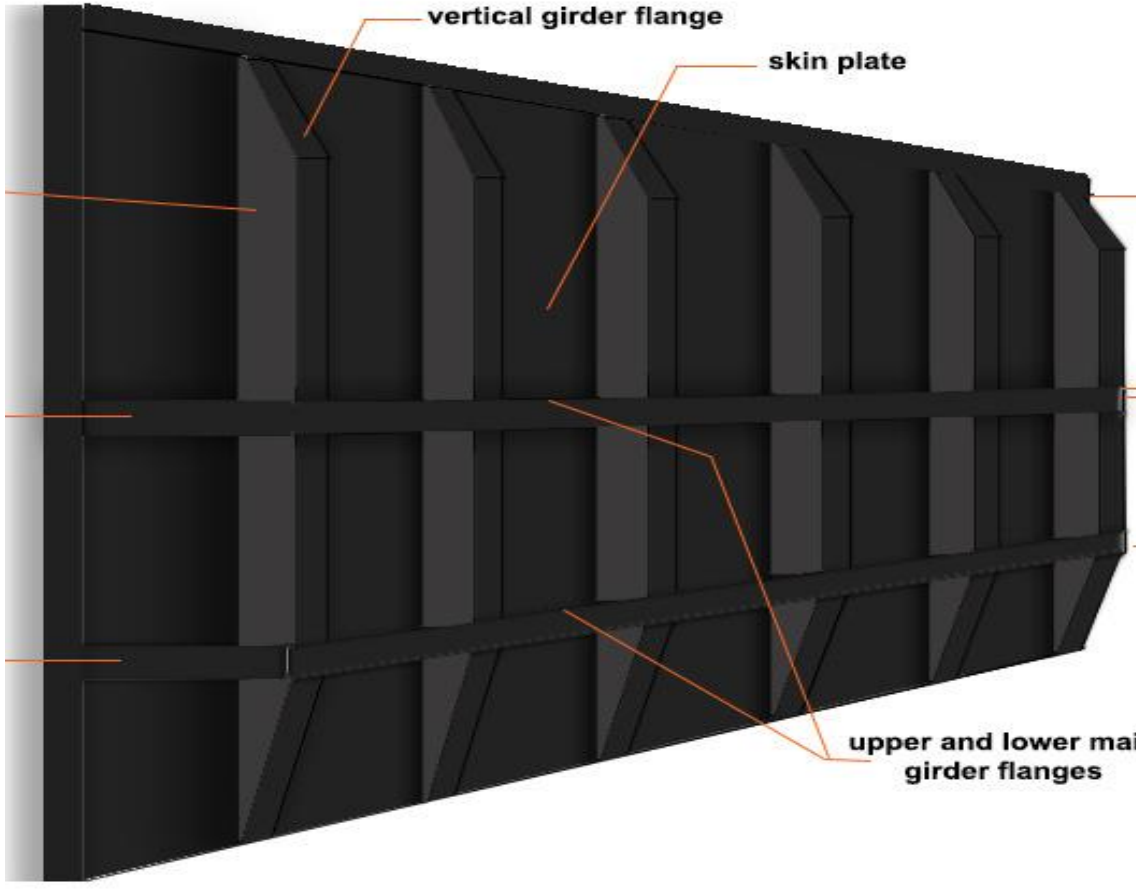
Grade material:

SS TOP PLATE: SS 304

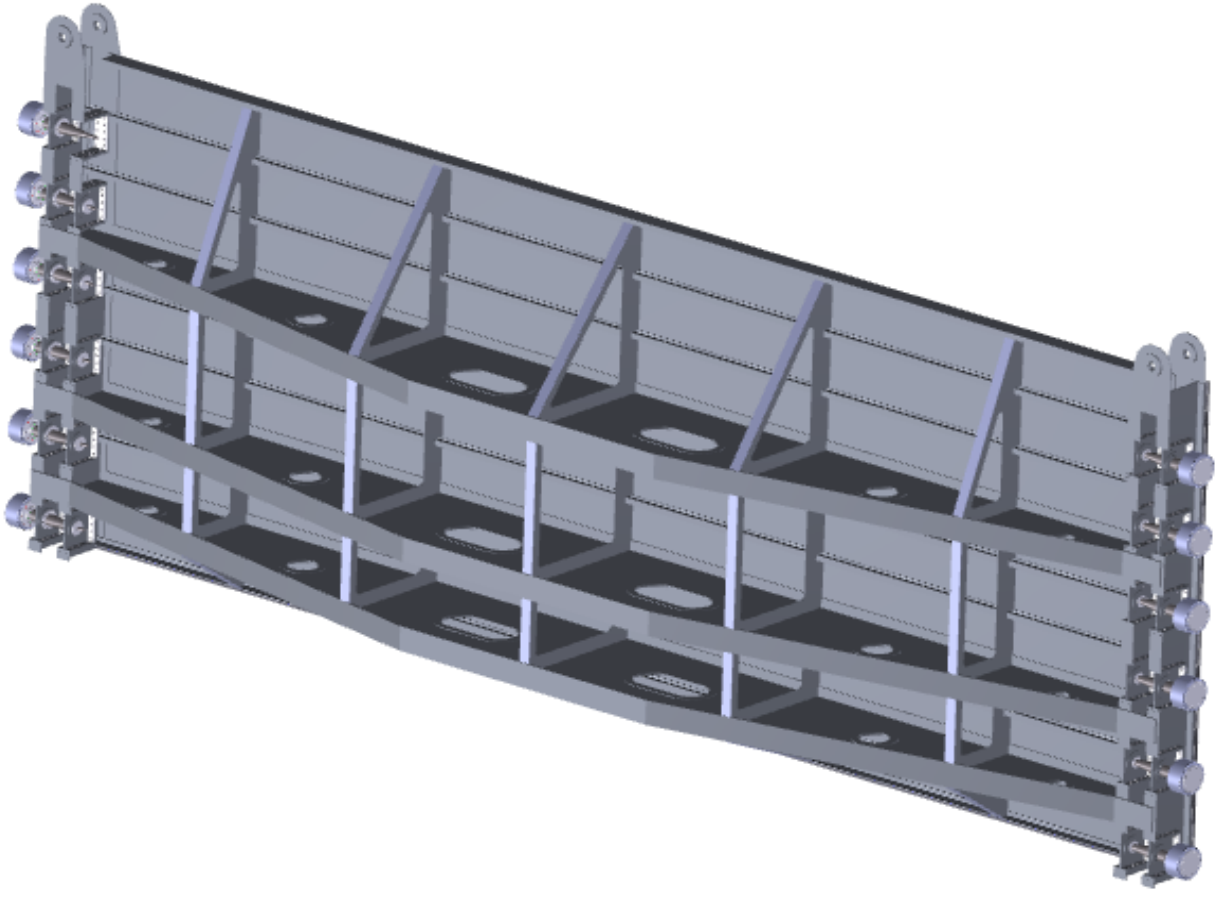
Gate Leaf

GATE LEAF—STEEL HYDRAULIC STRUCTURE
CHANGE OF DESIGN PHILOSOPHY

ROLLER STONEY GATE



FIXED WHEEL GATE

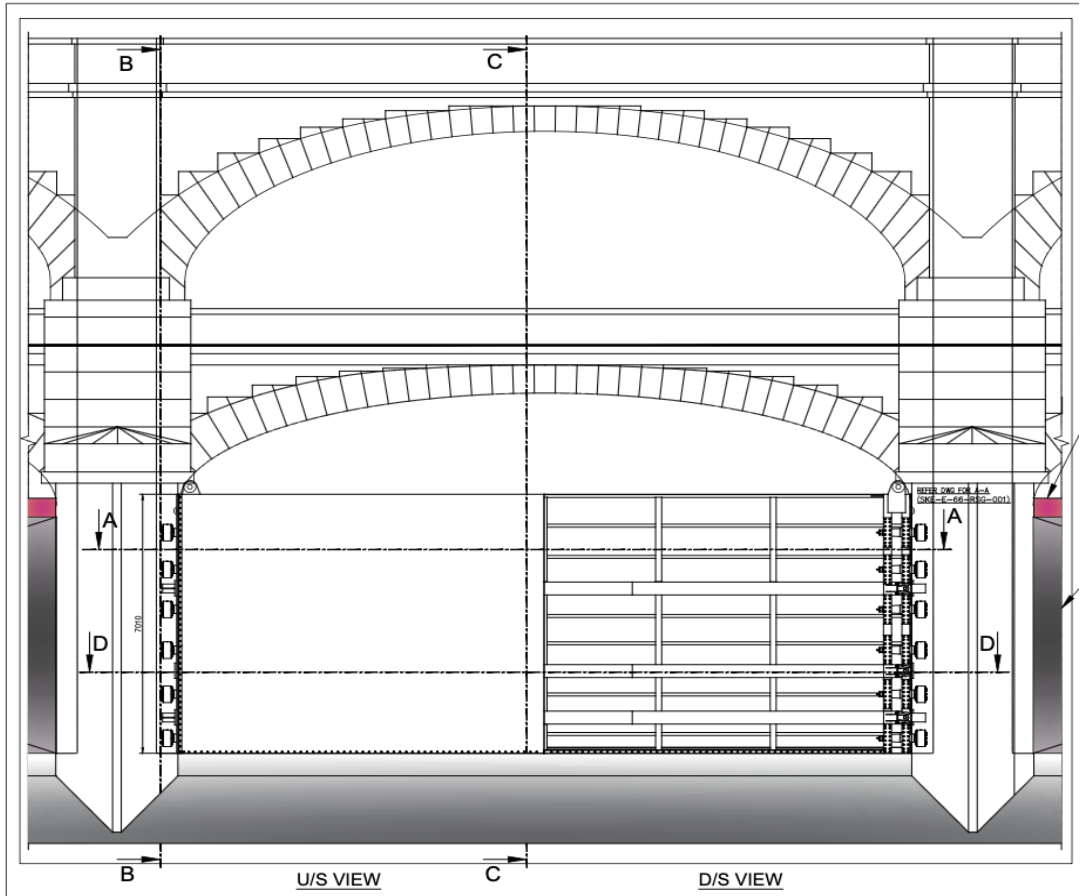


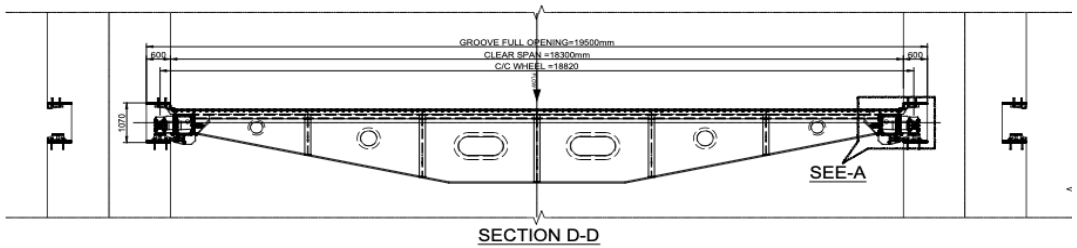
Design Calculation of River Sluice Fixed Wheel Gate

1 Basic Parameters and Allowable Stresses				
1.1 Related Standards				
STANDARDS				
DIN 19704 Standard				
Design Specification for Steel Gates of Water and Hydropower Projects - SL74 - 2019				
REFERENCE BOOK FOR DESIGN GUIDELINE				
Design of Hydraulic Gates - ERBISTI				
1.2 Basic Parameters				
Basic Parameters for New Gates are as the following:				
Description		**Fixed Wheel Gate**		
Number of Opening	No.	1		
Number of Gates	Set	1		
Units System	**Metric**		**FPS**	
Clear Width of Opening	m	18.2	ft	59.7
Clear Height of Opening	m	9.450	ft	31.0
Design Head	m	6.860	ft	22.5
Sealing Width of Gate (L_h)	m	18.30	ft	60.0
Sealing Height of Gate (h_s) (Section 4,Sub	m	7.010	ft	23.0
Elevation of Sill (Section 4,Sub Section	m	53.96	ft	177.0
Normal Water Level	m	60.8	ft	199.5
Max. Pond Water Level	m	61.11	ft	200.5
Max. Pond Water Level (During Extreme	m	62.17	ft.	204
Groove Width	m	1.07	ft	3.51
Groove Depth	m	0.6	ft	1.97
OBE	0.08	g		
MCE	0.22	g		
Lifting	Under Full Flow Conditions			
Closing	Under Full Flow Conditions			
Operation	Electrically/Manually			

The adopted Allowable & Yield Stresses-(Page No.65 Section 4.4.9.11 Sub Section II)						
2. Stresses: BS EN 10025-3 Grade A572 G50						
						Unit : MPa
Type of Stress	**Load Cases**					
	Normal		**Exceptional**		**Extreme**	
For Structural Members						
Bending	$0.6F_y$	207	$0.8F_y$	276	$0.95F_y$	328
Shear	$0.4F_y$	138	$0.5F_y$	173	$0.6F_y$	207
Tension	$0.45F_y$	155	$0.5F_y$	173	$0.6F_y$	207
Bearing Pressure (Machined Surfaces)	$0.8F_y$	276	$0.85F_y$	293	$0.9F_y$	320
Combined stresses	$0.75F_y$	259	$0.95F_y$	328	NR	N/A
Buckling	$1F_a$	207	$1.3F_a$	269	$1.4F_a$	290
	F_a=Allowable Stress			F_y=Yield Stress= 345 MPa		

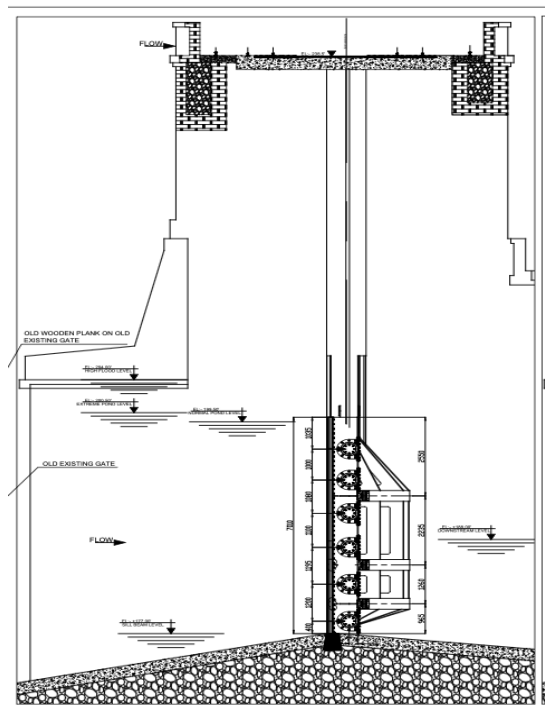
2.1 Minimum Material Thickness (mm)		
Plate Thickness on any structural member except webs of Rolled shape	12	mm
Webs of rolled Shape	8	mm
Structural plates / gate Skin plate	12	mm
Embedded metal with exposed surfaces	12	mm
Completely embedded metal	10	mm
Corrosion resistant steel cladding, after final machining	3	mm
Fillet weld, leg length	6	mm



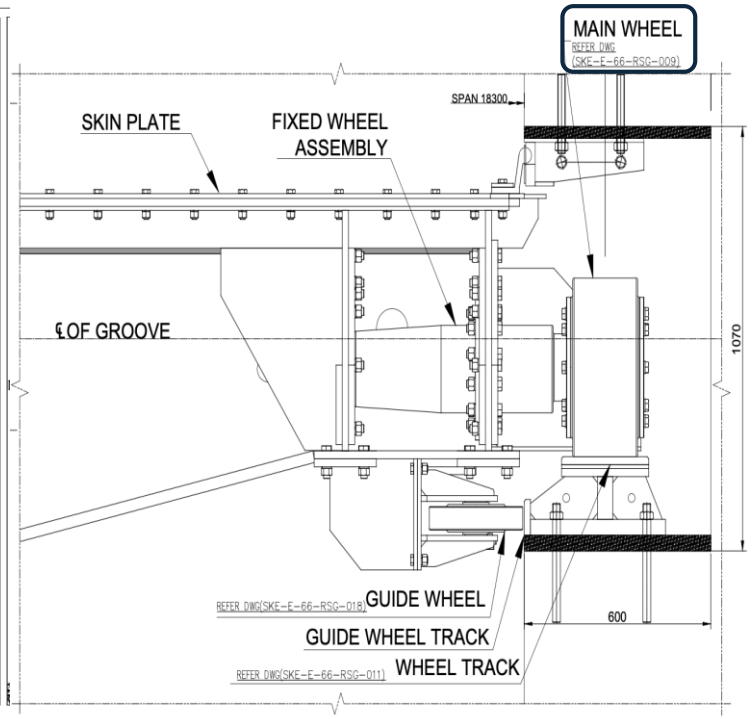


SECTION D-D

Main Data of Gate and Hoist	
Groove Span	18.3m
Type of Gate	Fixed Wheel Gate
Type of Operation	Hoisting System without CW
Type of Hoist	Winch Type
Rated Capacity	2x560kN
Stroke of Hoist	10m



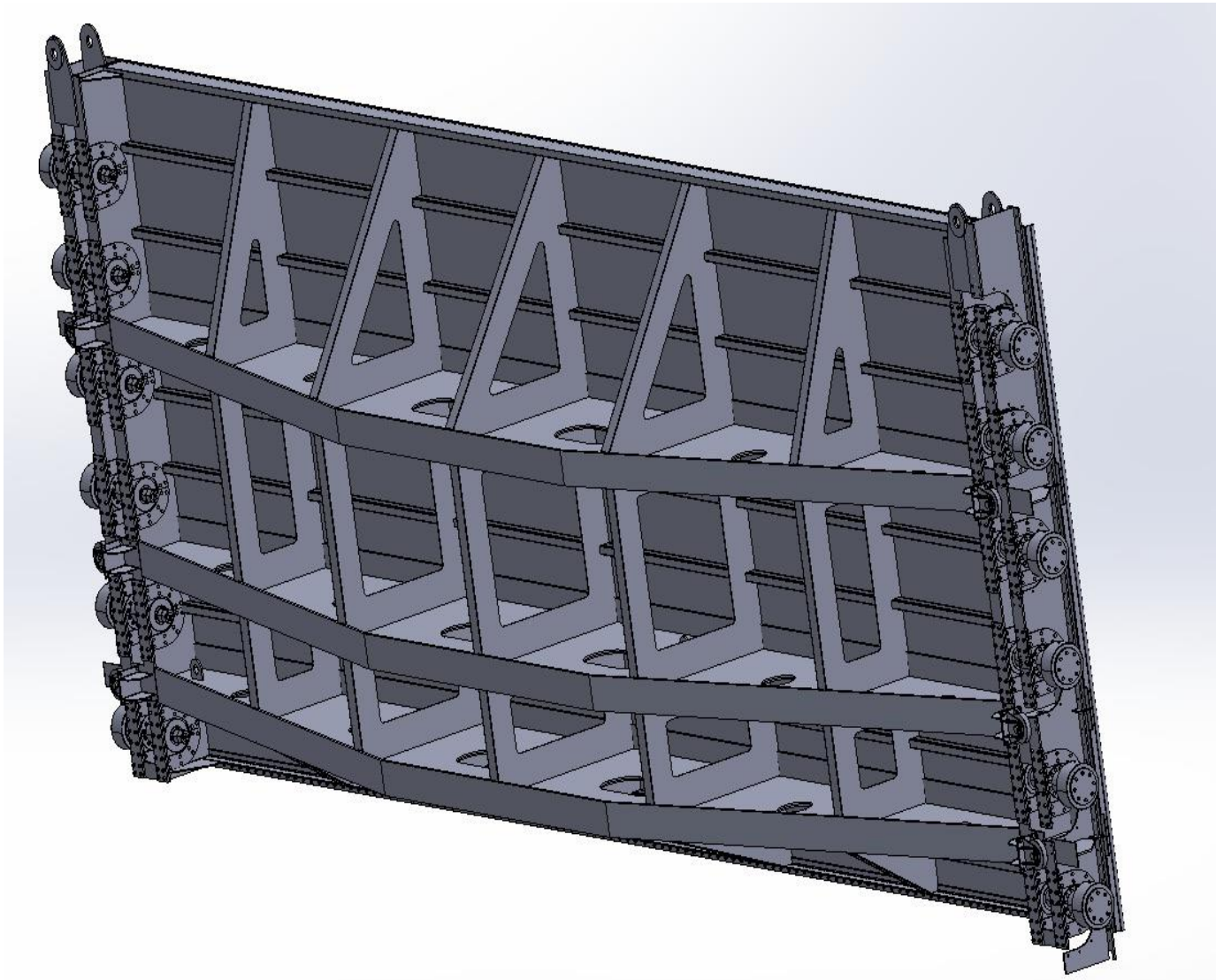
SECTION B-B



Fixed Wheel Gate Leaf (Skin Plate)

The gate leaf for the River Sluice Gate [RSG] is the main steel plate surface that retains water. It resists hydrostatic pressure and transfers loads to the internal stiffeners and structural frame which ultimately pass on the loading forces to the groove through fixed wheels.

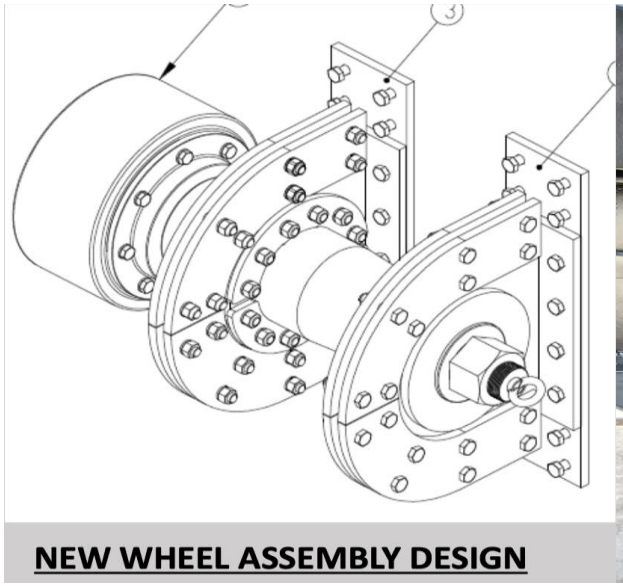
Grade material: ASTM A570 G50
Gross Weight: 50-ton approx.



Fixed Wheel Assemblies

Total of 12 heavy duty fixed wheels per gate have been provided which are mounted along the vertical sides of the gate.

They run on guide tracks installed in the pier grooves and support the weight of the gate during opening and closing operations.

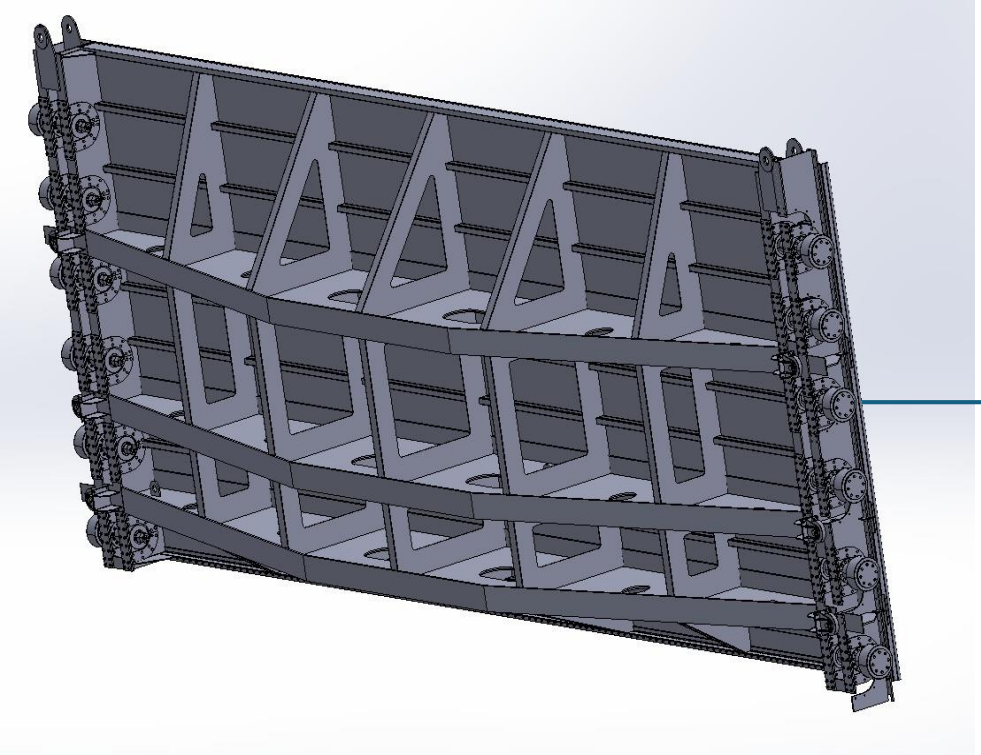


Grade material:
Wheel: 35CrMo
Shaft: 40 Cr

Side Seal Arrangement

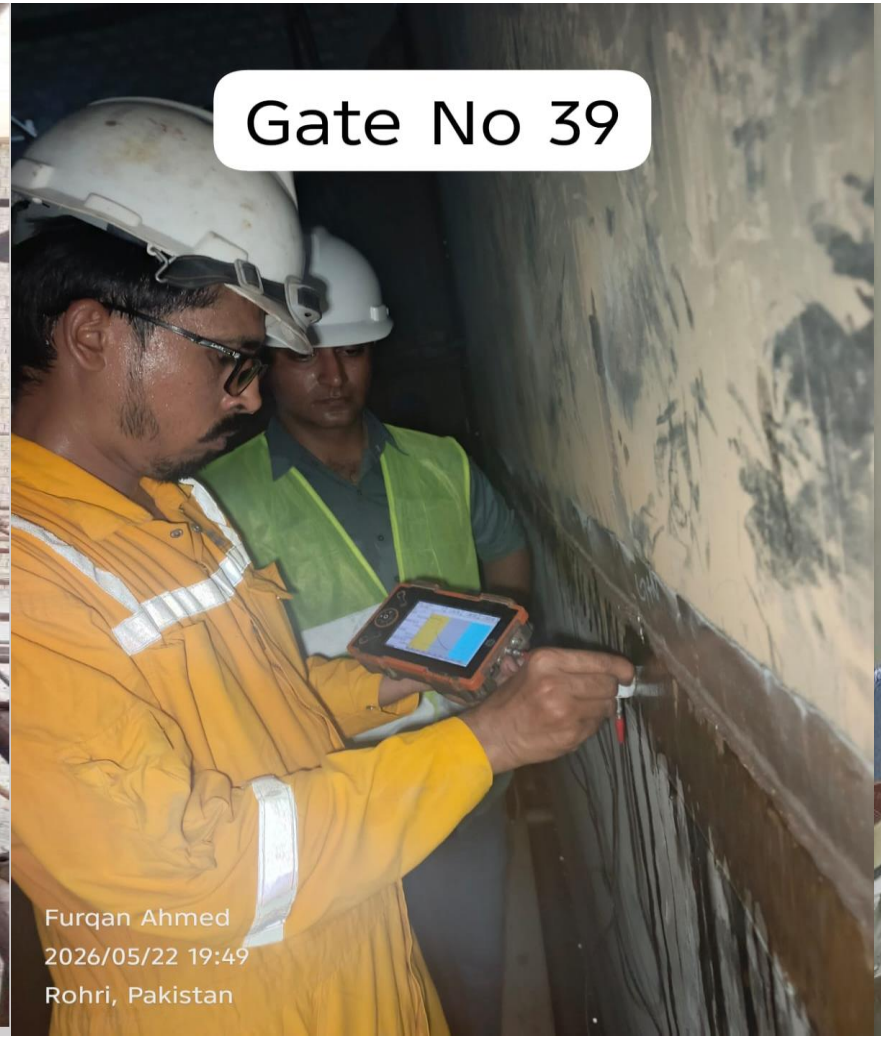
Side seals are installed along the vertical edges of the gate to minimize leakage between the gate and the concrete pier grooves.

Grade material:
Rubber



Side Seals

Gate Fabrication Quality Assurance: Inspection, NDT, TPI & Material Testing



Hoisting System

Hoisting Arrangement

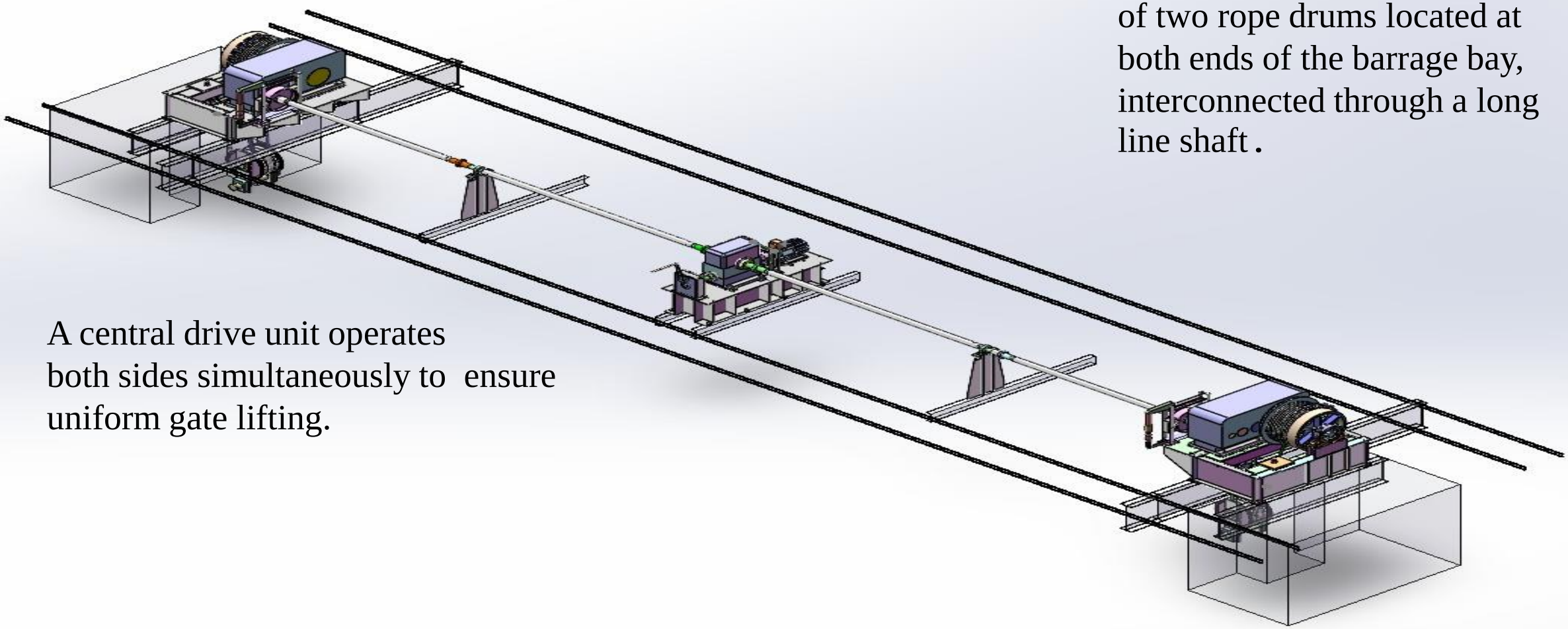
Designer: Huadian Zhengzhou Mechanical Design and Research Institute

Hoist Type: Winch Type Wire Rope

Rated Capacity: 2X560KN-10m

Lifting speed: (0.3 m/min)

The hoisting system consists of two rope drums located at both ends of the barrage bay, interconnected through a long line shaft .

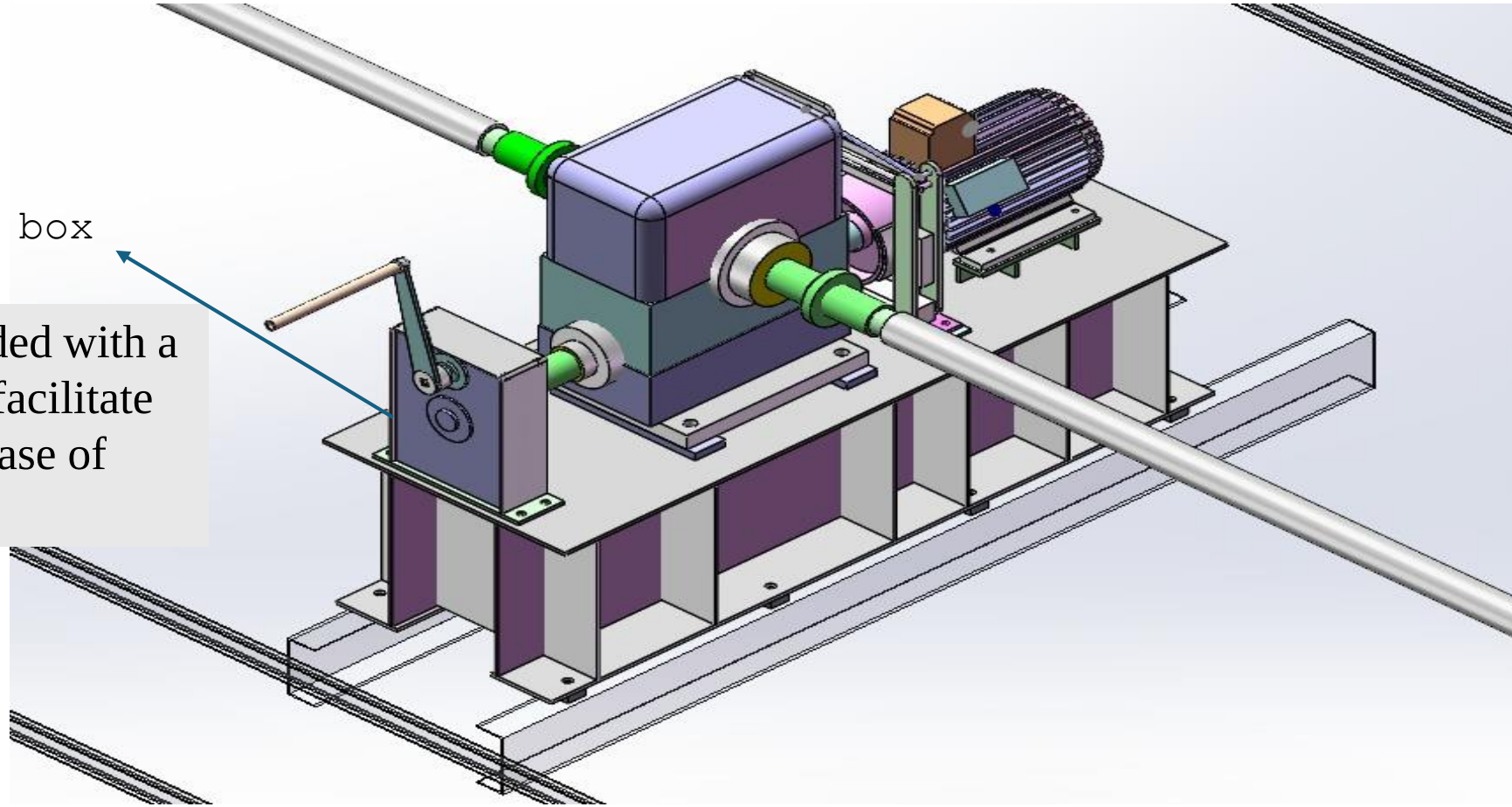


A central drive unit operates both sides simultaneously to ensure uniform gate lifting.

Electric Motor

Make: ABB
Model: M2QA200LB6
Rated Power: 22KW
Speed: 978 r/min

The electric motor provides the primary driving power for gate operation. It is coupled to the reduction gearbox and is designed to deliver sufficient torque for lifting the gate under full load.

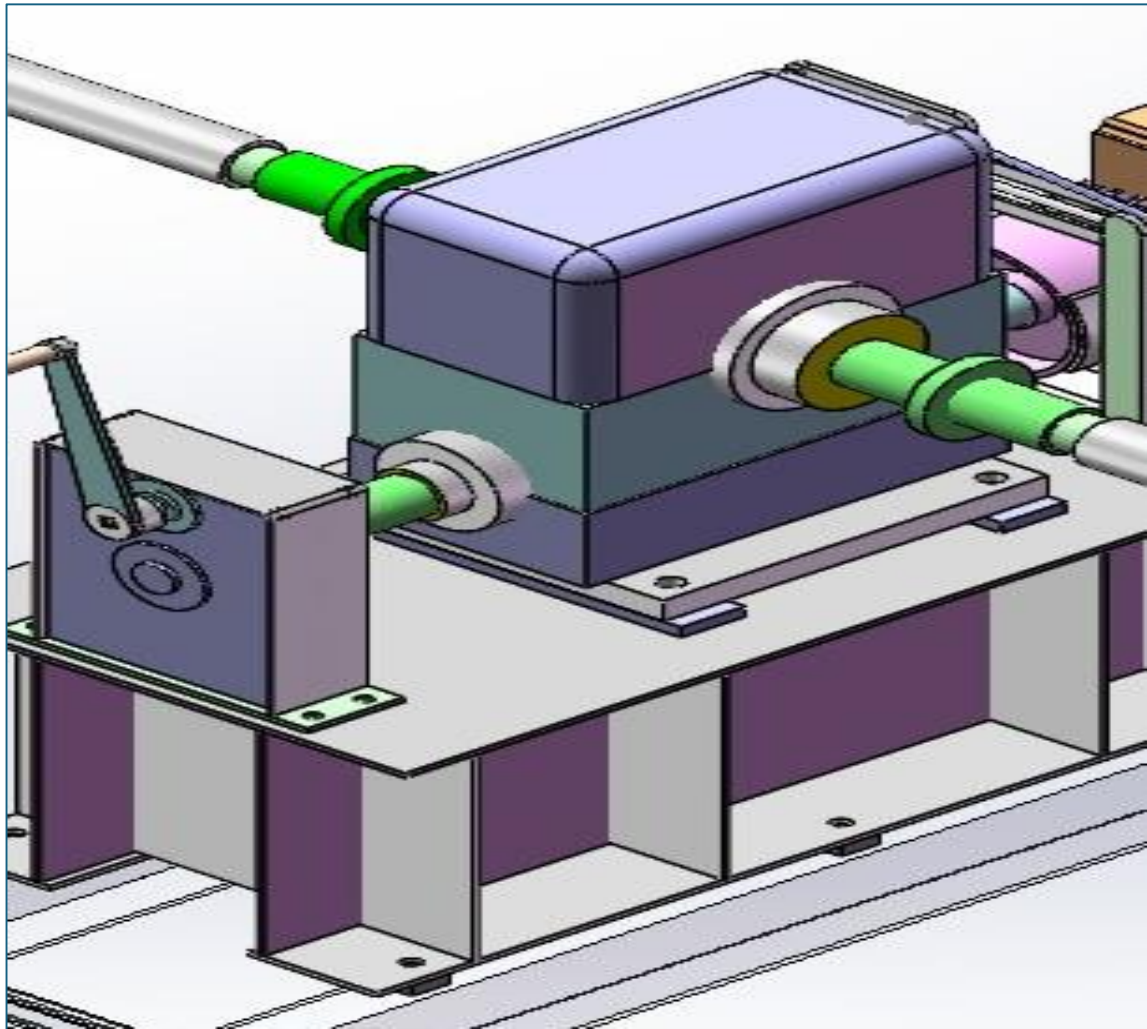


A crank handle provided with a manual gear box can facilitate manual operation in case of power blackout

Worm Gearbox Reducer

Manufacture: Tianjin Jugang Reducer Manufacturing Co., Ltd.
Model: PWUF250-57
Type: Worm Gear Reducer
Reduction ratio: 57:1

The reduction gearbox reduces the motor speed and increases torque before transmitting power to the line shaft. It ensures smooth and controlled operation of the hoisting system.



Side Gear Reducer
Manufacturer: Jiangsu Guomao Reducer Co., Ltd.
Model: H314SH-40.
Type: Helical reducer
Gear ratio: i=40:1

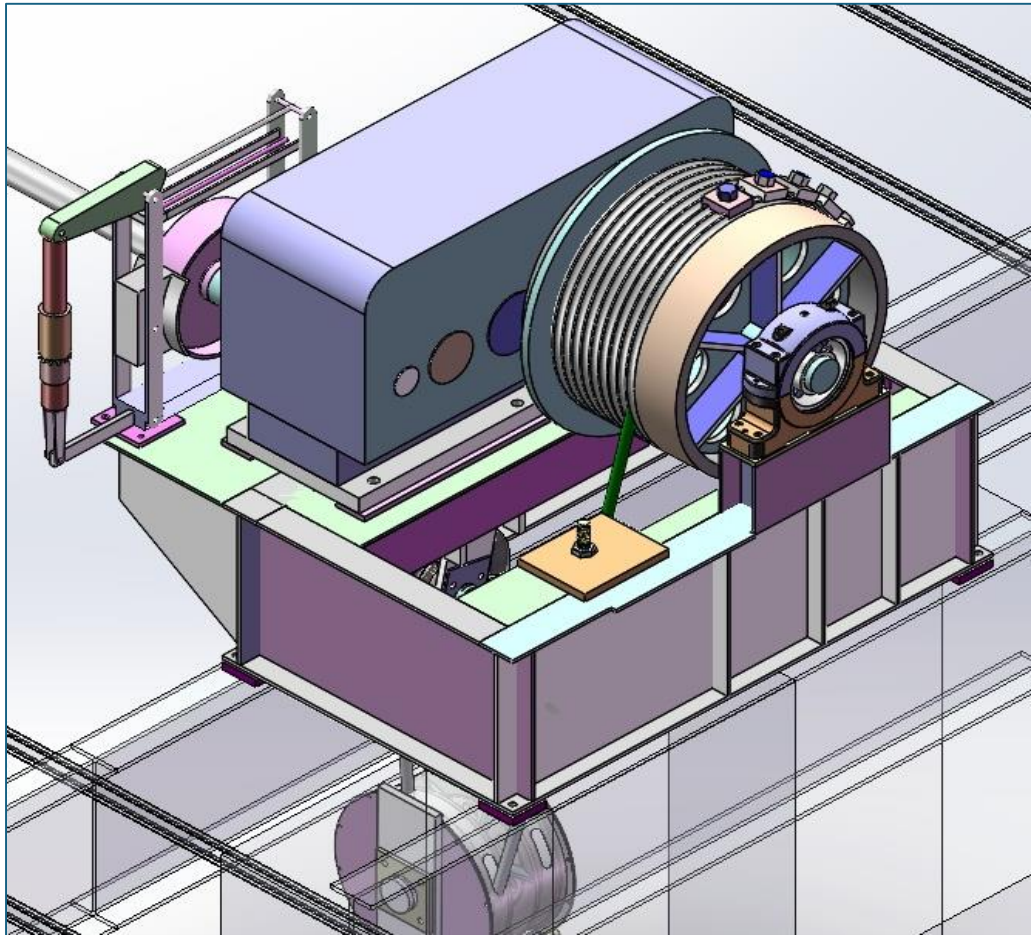
Rope Drum: Dia: 900 mm.
Brakes: Jiaozuo Hongqiao Brakes. **Model**: YWZ5-315/E30 **BT** 400 N.m
Galvanized Steel Wire Rope: Mfr: Xiangtan Steel Group, **Dia:** 36mm, **MBL** 904KN
Spec: 36ZAB6×36WS-IWRC1960ZS

Precision-Grooved Rope Drum: Optimized for uniform wire rope winding; mitigates wear and prevents overlapping under high-load conditions.

High-Torque Integrated Gearbox: Enables direct-drive gate operation by translating motor input into the required torque, eliminating the need for counterweights.

Industrial Bearing Support: Heavy-duty pillow block bearings ensure precise drum alignment and load distribution on the main chassis.

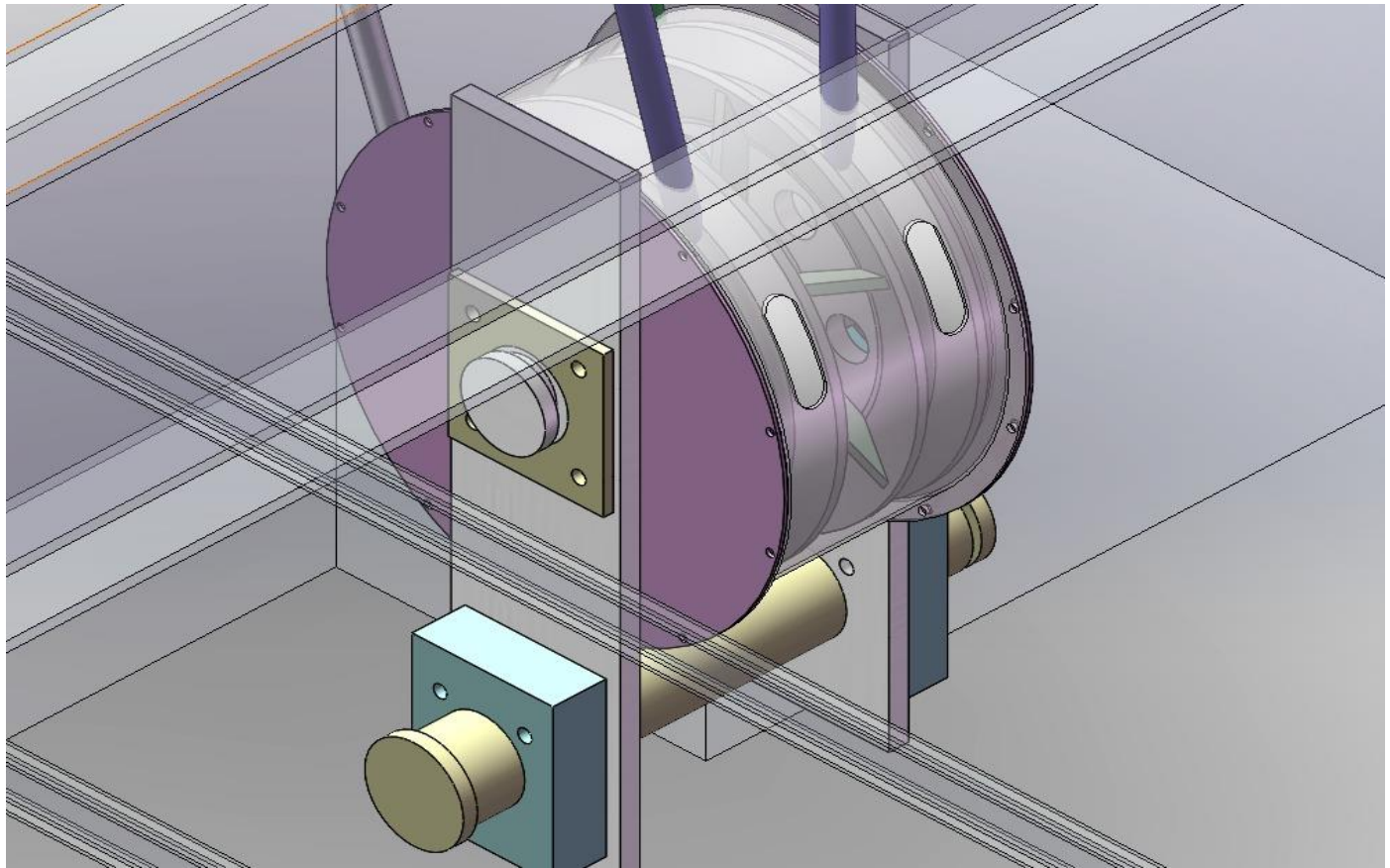
Fail-Safe Braking System: Includes a high-precision side-mounted brake for emergency stops and accurate gate positioning.



Movable / Balancing Pulley

Pulley block: 4-fold ratio

The movable pulley with load reduction factor of 2x2 reduces the potential Fatigue factor on the hoisting system by 4 times, hence making the design safer and more sustainable



Hoisting System of Sukkur Barrage

Hoists Factory in China

Rope Drum Winch Hoist @ Site

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Civil Works

Civil Works - 2025-2026

Grouting

Repointing

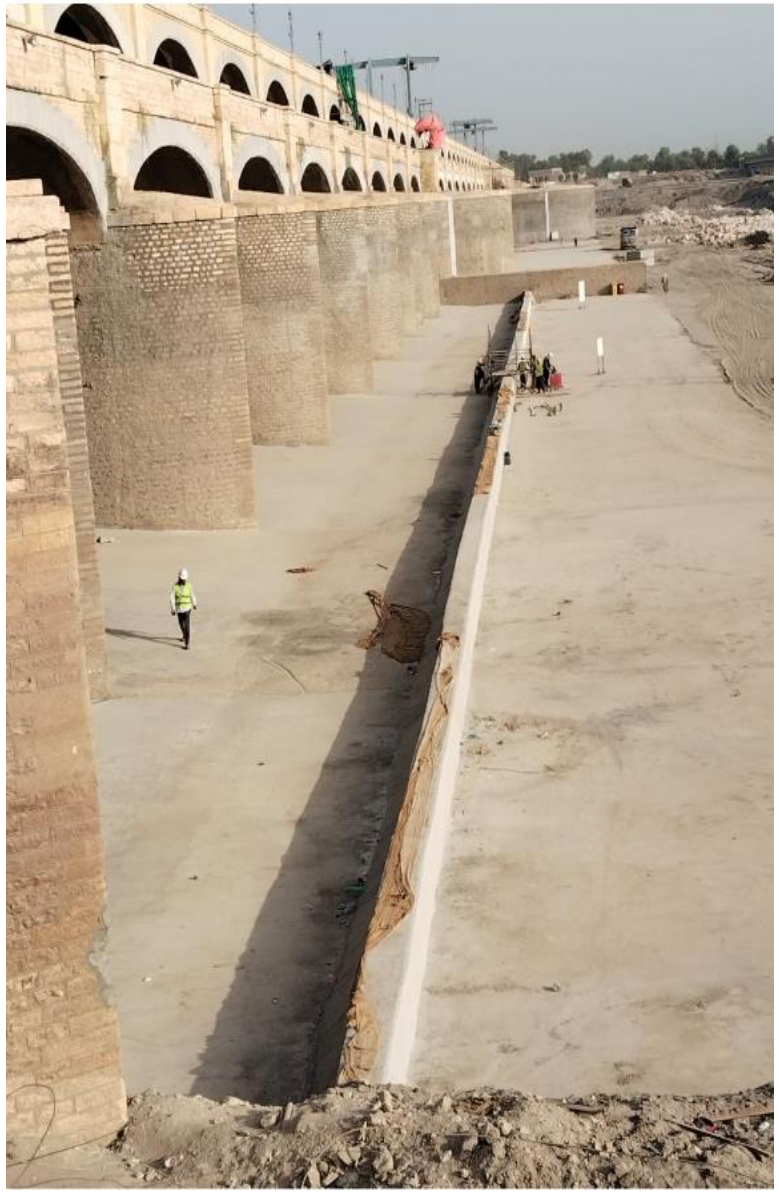
Civil repair for damaged areas

Overlay concreting at apron

Settled U/S apron at bays 15 to 17

Finished bay D/S view

Civil Works - 2025-2026



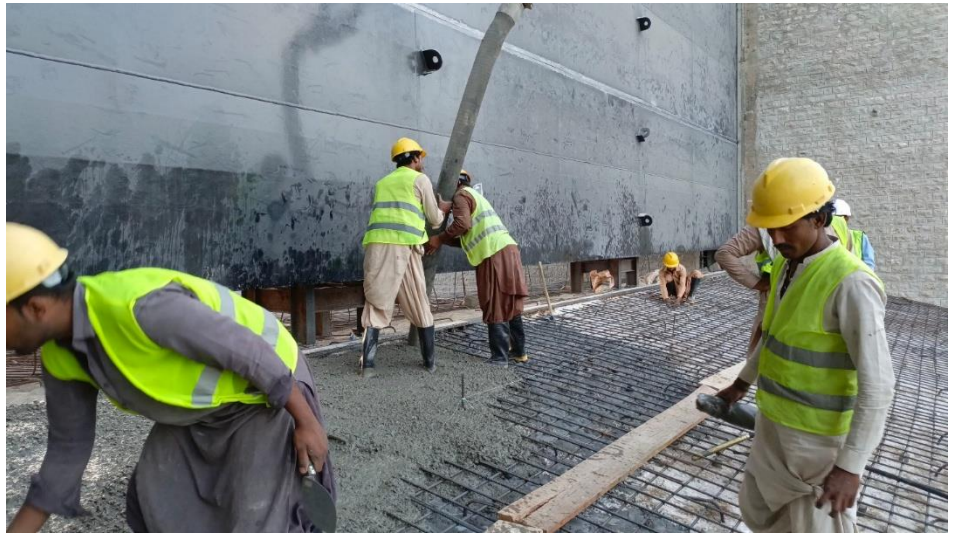
Overlay concreting Baffle Wall D/S tail Channel

Rip-rap (stone dumping) D/S as per Artelia Model Study

Bay 23 & 24 – Construction of new low height wall

Civil Works 2025-2026

Civil Works - 2025-2026



Buildings

- Engineer Compound, Contractors various Camps, and Gate Fabrication workshop in Sukkur– Completed
- Employer Office and Residence – Completed
- B4 Building for Irrigation Department – Completed
- B2 Building for Irrigation Department – Finishing works remain, to be recommenced during upcoming flood season

Employer Residence and Office

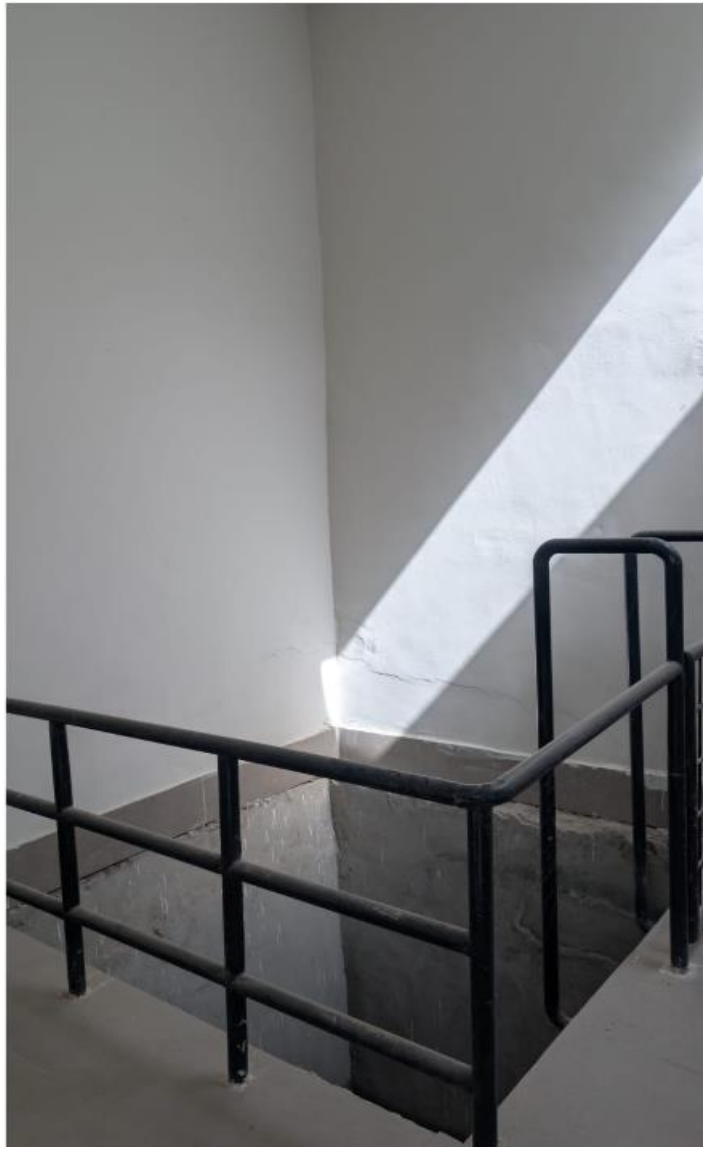
B2 building for Irrigation

B4 building for Irrigation– finishing works

Gauge Wells

- 3 Right Bank Canals – Completed
- 3 Left Bank Canals – Completed
- 1 at Left bank Nara Canal to be completed in 2027 Closure period

Dredging Works – Dredger at Left Pocket



Guage Well interior view

Staff Guage within Guage well

Coffer Dam

Geomembrane Cofferdam

UPSTREAM

DOWNSTREAM

Sukkur Barrage 2025-2026

Cofferdam (covering 30 bays D/S side)

U/S Cofferdam

Settled apron at U/S of bays 15 to 17 repaired

Cofferdam Breach

- The main barrage cofferdam breached on 4th March 2026. No persons were harmed. Canal supplies were disrupted.
- The root cause analysis review is underway by the Contractor’s designer.
- The cofferdam breaches were plugged by 12th March 2026 and accordingly the pond level was increased incrementally from 13th March 2026 to 17th March 2026
- The Contractor re-entered the cofferdam on 24th March 2026 following a safety review by their designer.
- Enhanced monitoring of the cofferdam is being implemented by the Contractor and witnessed by PIC

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Dredging

Dredging upstream of Sukkur Barrage

Background

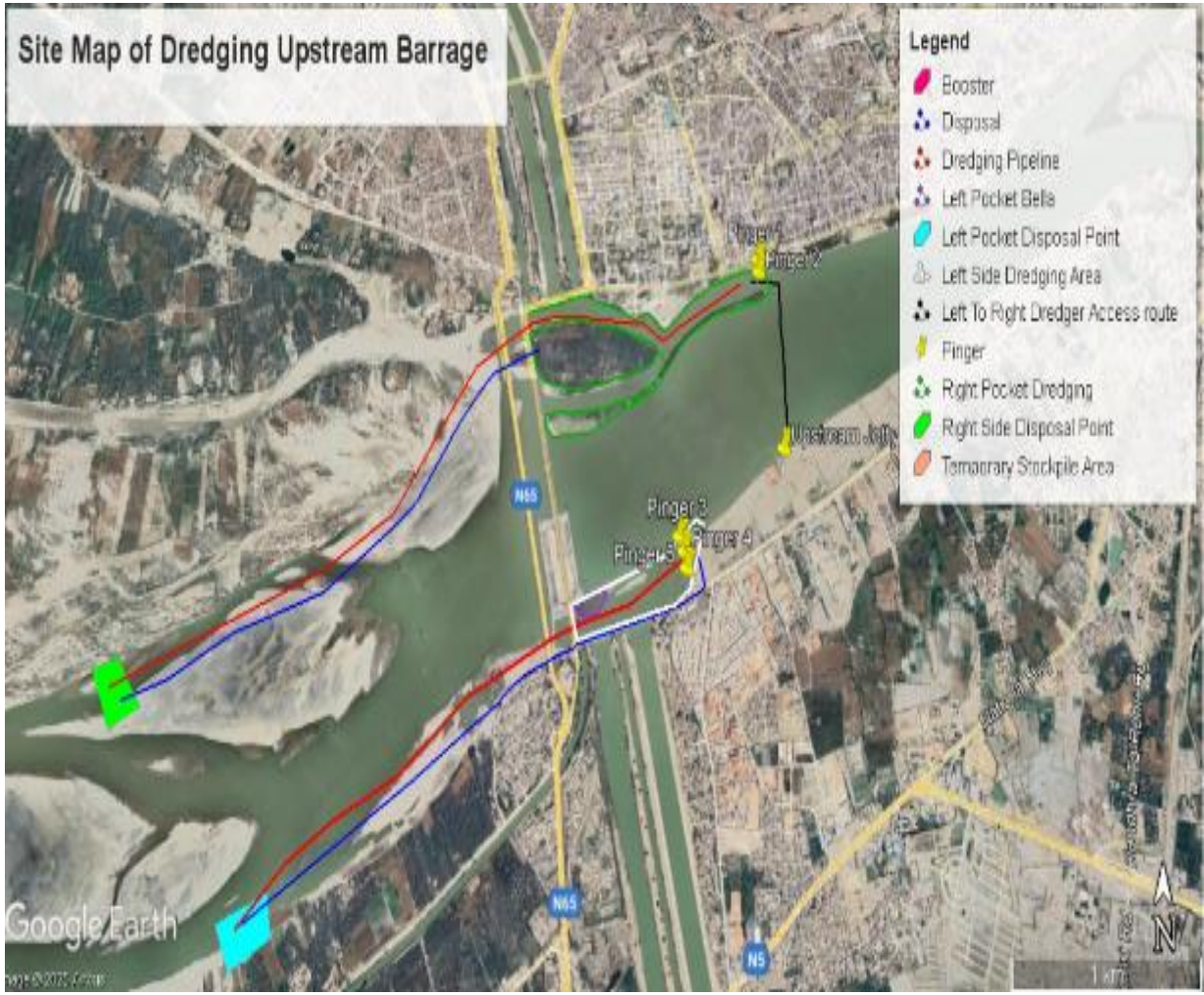
A Variation Order (VO-6) has been signed for the S2 scope of works to be undertaken by the S1 Contractor.

Dredging and excavation of various areas upstream of Sukkur Barrage and disposal of corresponding silt material.

The Contractor has developed a Method Statement and updated CESMP & HSP for the works, based on the VO-06 Specification and the requirements of the ESA 2017.

Map has been produced and joint survey of working areas undertaken for any changes since 2017.

Joint meeting held on 30th September 2025 with Barrage Authorities, PMO, PIC where Contractor briefed on the works and ESHS mitigation measures. PMO and PIC ESHS teams provided comments.



Cutter Suction Dredger

MODEL: HID- CSD4518YCIPT (3000 M3/H)

CUTTER SUCTION DREDGER SPECIFICATIONS

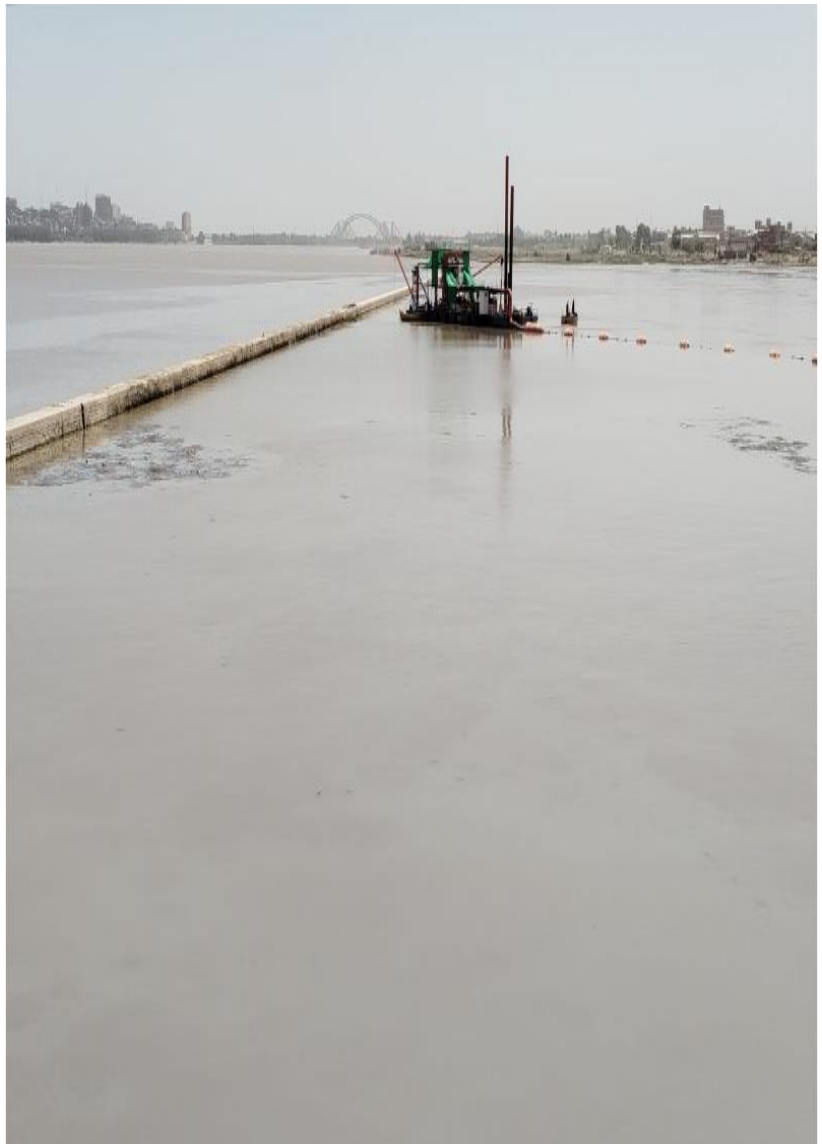
No.	Parameter	Value
1	Overall Length	42.80 m
2	Dredger Length	31.65 m
3	Engine Room Length	16.50 m
4	Overall Width	7.10 m
5	Molded Depth	2.0 m
6	Average Draft	1.3 m
7	Dredging Depth	13 m
8	Max Discharge Distance	≥3000m
9	Dredge Pump Water Flow	3000 m^3/h
10	Dredge Pump Sediment Output	400-400 m^3/h
11	Suction Pipe Diameter of Ladder	500 mm

S1 – Dredger

S1 – Disposal pipeline in containment bund

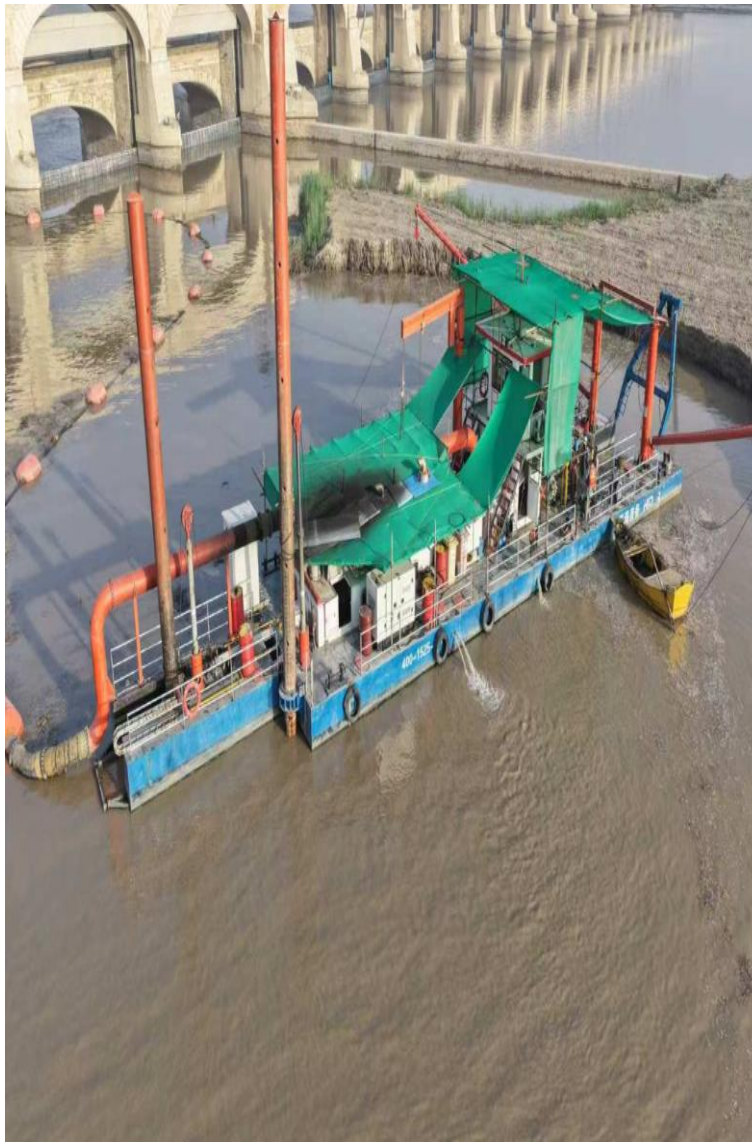
Dredging Works VO-6 (previously SBIP/S2)

- Right Pocket (U/S and D/S) and stabilization of Divide Wall – Completed
- Approach Channel – Completed
- Left Pocket – to be completed by 20th June 2026
- Tail Channel – Next working season (last remaining dredging task)



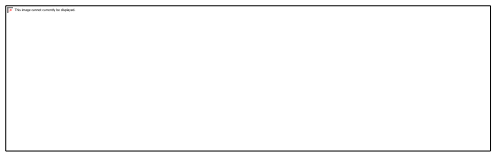
Dredging at Left Pocket Continues (bella

Dredging Pipeline disposal site at



Dredger at Left Pocket

Environmental & Social compliance background



Safeguards

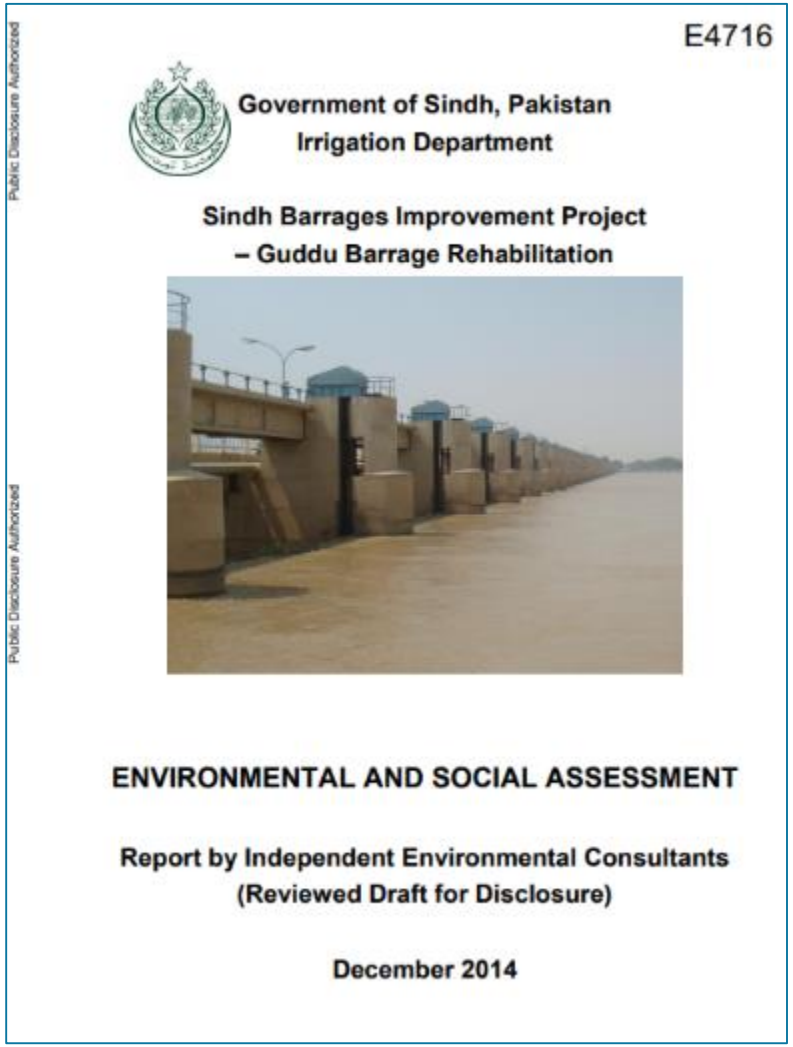
Environmental, Social, Health & Safety and Security

A comprehensive Environmental and Social Assessment (ESA) has been carried out for the Sukkur Barrage Rehabilitation and Modernization Project in 2017, which was approved and cleared by the World Bank and Sindh Environmental Protection Agency. This included an Environmental and Social Management Plan (ESMP).

An Addendum has been produced in 2022 to include changes since the original report in 2017 (namely use of temporary cofferdams).

For the Guddu Barrage works, the ESA was developed in 2014 following the feasibility study and design phases.

There Contractors develop Contractor's Environmental Social Management Plan (CESMPs) and Health & Safety Plans (HSPs) accordingly.



CESMP and Roles

The Contractors shall ensure that the CESMP is compliant with the Environmental Codes of Practice and the Environmental and Social Management Plan both as defined in 'Environmental and Social Assessment (ESA)'

As per the contract: '*The Contractor shall review the C-ESMP, periodically (but not less than every six (6) months), and update it as required to ensure that it contains measures appropriate to the Works.'*

Requirements detailed in the specification.

PIC's role is to monitor the Contractors against the compliance with these documents.

PMO ESHS team undertakes a critical role in monitoring the various parties in the field, stakeholder liaison, facilitating security requirements, ensuring ESAs are followed and overseeing the wider SBIP ESHS requirements.

shall include the following:

- Organisational Framework
- Construction Camp Management Plan
- Traffic Management Plan
- Erosion, Sediment and Drainage Control Plan
- Pollution Prevention and Control Plan
- Waste Disposal and Effluent Management Plan
- Borrow Area Management and Restoration Plan
- Protection of Gas Pipeline Plan
- Drinking Water Supply and Sanitation Plan
- Management Plan for Protection of Flora and Fauna
- Fuel and Hazardous Substances Management Plan
- Instream Construction Works Management Plan
- Emergency Plan
- Training Plan
- Monitoring Plan
- Communication and Local Recruitment Plan
- Security Plan

S1 – PMO building site visit

S1 – Medical emergency drill

S1 – Community consultations

Model Study

Hydraulic Model Study of Sukkur Barrage
FINAL REPORT
By ARTELIA

OBJECTIVES AND CONTENT OF THE MODEL STUDIES

Various configurations of the barrage and river training works have been studied:

- Configuration 0 was the present layout,
- Configuration 2 was “Option 8” recommended by Atkins/ACE/NDC in 2014,
- Configuration 3 consisted mainly in relocating the canal intakes with associated guide wall further into the main
- Channel with a divide wall similar to existing Left Pocket configuration, with river training works removed.
- Configuration 4 was a configuration of the river training works proposed by ARTELIA based on analysis of the
- Results obtained with Configurations 0, 2 and 3.
- A reinforcement of the downstream riprap protections of the barrage has been designed considering the
- 0.9 Mcusecs Design Flood and the 1.2 Mcusecs Safety Flood.

CONFIGURATIONS

Various operation rules and scenarios have been also studied:

- For all configurations of the river training works tested, the evolution of the riverbed during the morphologic period of the year has been simulated on the 2D sedimentological numerical model for the purpose of comparison between the configurations,
- Study of Configuration 0 was based on the present operation rules of Sukkur Barrage,
- In Configuration 1, it was assumed that the barrage in its present configuration was operated with target pond level 199 ft AMSL instead of 200 ft AMSL, and also with an increase of the discharge in the Tail Channel, aimed at improving sediment exclusion at the entrance to the Right Pocket.
- In river training works Configuration 0 and Configuration 4, flushing scenarios of the Right Pocket and Tail channel with discharges of 30,000 cfs and 60,000 cfs have been tested, the irrigation canals being closed.
- Additional operation and flushing scenarios of the Tail Channel with the head regulators of the canals open have been also studied.

Operational Challenges

Reduced Flood Capacity

Design conveyance decreased from 1.5 million cusecs to 0.9 million cusecs after modifications—raising overtopping and routing concerns during high flows.

Severe Sedimentation

Right-bank canals experience persistent deposition that reduces conveyance and affects crop water delivery efficiency.

Erosion & Riprap Risk

Local scour and riprap instability observed near piers and guide banks; requires quantification under altered tailwater scenarios.

Hydraulic Model Scope

01

1. Flood Performance Evaluation

2D/1D coupled modelling of gate operation, approach flow patterns, and conveyance capacity under multiple tailwater conditions.

02

2. Sediment Exclusion Assessment

Simulate intake hydraulics and particle trajectories to estimate bypassing and capture rates for canal intakes.

03

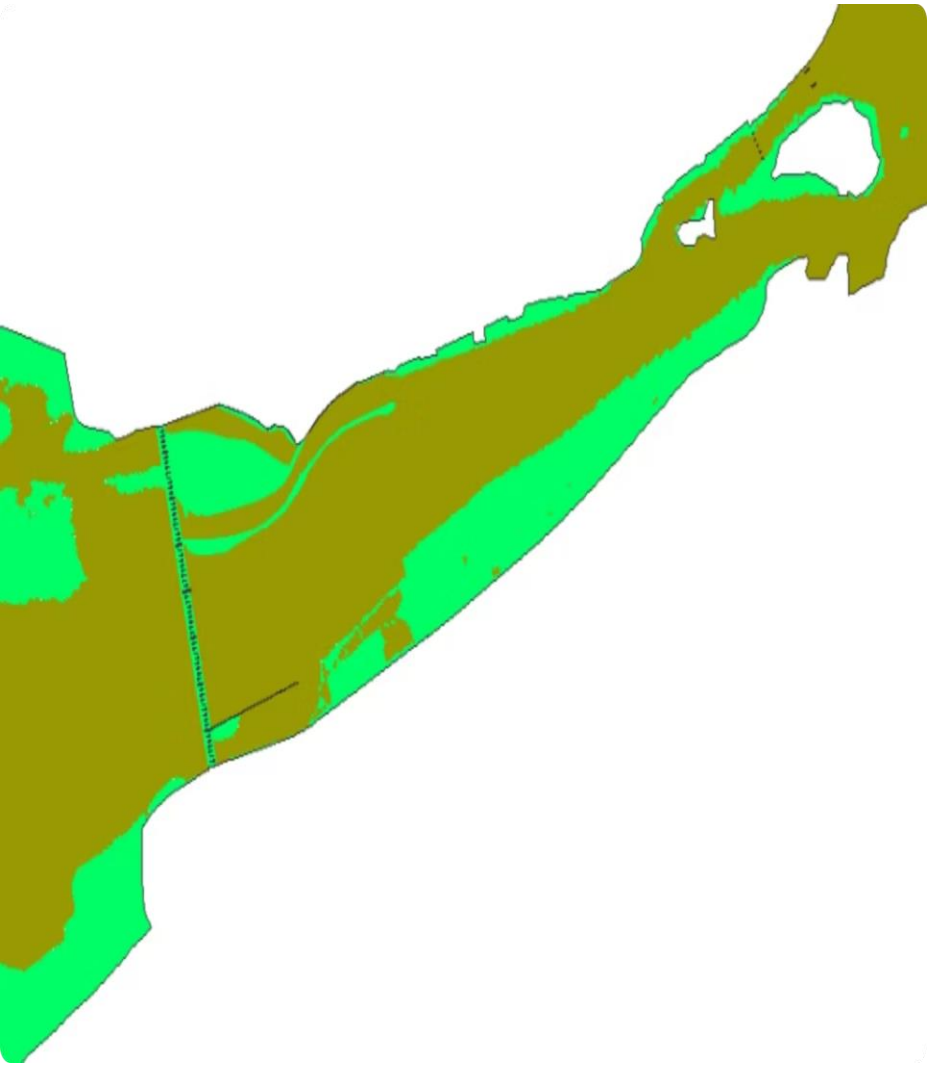
3. Sediment Flushing Effectiveness

Evaluate flushing scenarios (timing, gate sequences, and scour potential) to maximize sediment evacuation while protecting structures.

04

4. Riprap & Scour Stability

Assess local velocities and bed shear to estimate riprap stability and design countermeasures where thresholds are exceeded.



Numerical Model Setup & Sediment Transport

The study utilized TELEMAC-2D numerical modeling to accurately simulate hydraulic and sediment behavior within the Sukkur Barrage system.

Bed Load Transport

Modeled using the Soulsby–Van Rijn empirical formula.

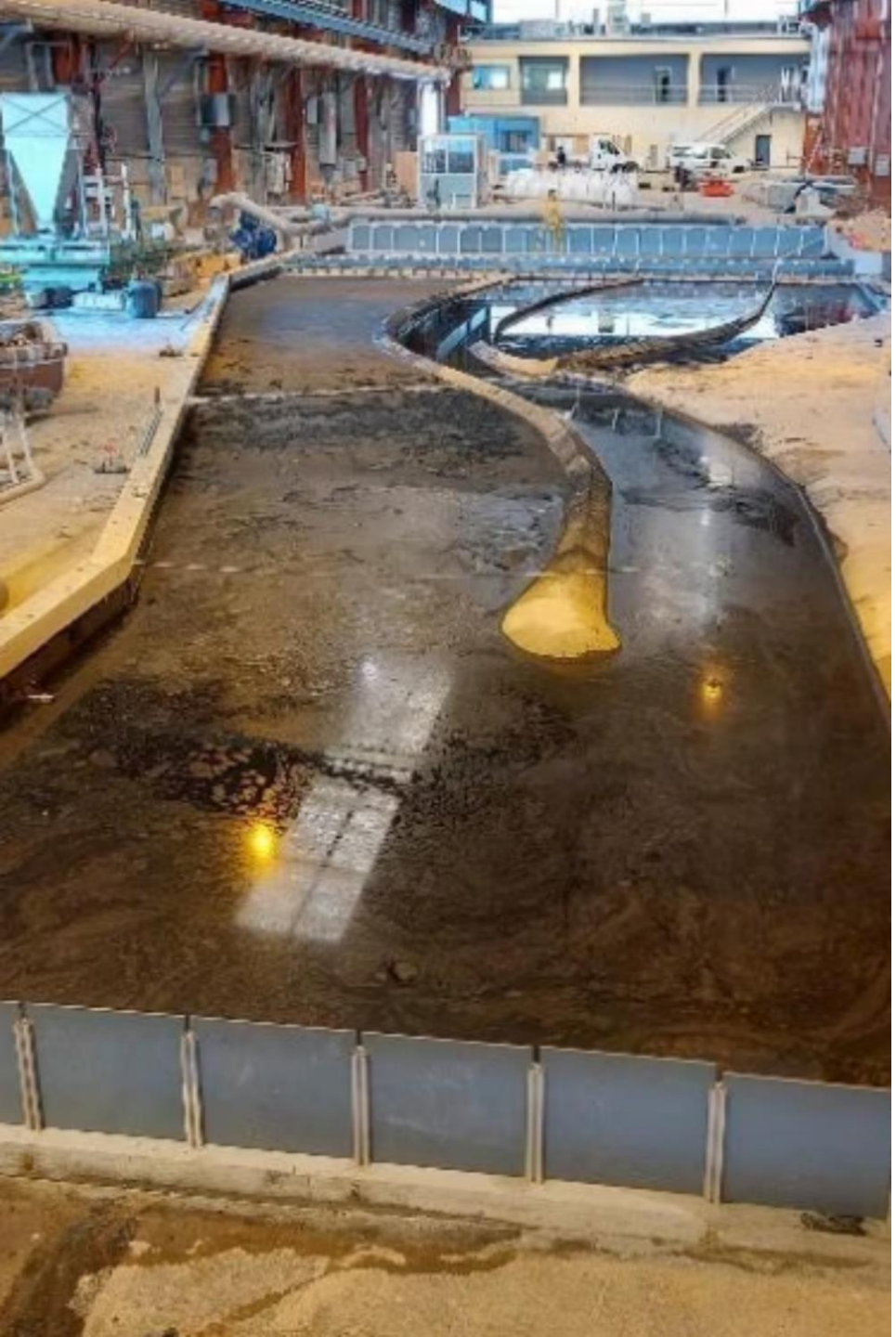
Suspended Sediment

Represented through a dynamic balance of erosion and deposition processes.

An alternative method (Zyserman & Fredsoe, 1994) was also tested to evaluate sensitivity of results to the chosen transport formulation.

Boundary Conditions Applied

- Upstream sediment load derived from a sediment rating curve (discharge and concentration).
- Initial sediment thickness assumed 10 m (excluding non-erodible zones).



Physical Model & Key Findings

A 1:75 scale physical model was constructed using Froude similitude to accurately replicate hydraulic behavior, utilizing lightweight polystyrene sediment material to simulate suspended sediment transport.

Key Findings

Sediment Representation

The model effectively represented fine suspended sediments in the 0.1–0.2 mm range, crucial for accurate transport analysis.

Performance Evaluation

It proved suitable for evaluating sediment exclusion efficiency at canal intakes and assessing overall hydraulic performance of the system.

Flushing Efficiency

While providing qualitative rather than quantitative flushing efficiency, the model was highly useful for comparing the effectiveness of different operational configurations.

Proposed Configuration 4 (Final Recommendation)

Improved Hydraulic & Sediment Control Design

Configuration 4 Proposal

Submerged Weirs

Introduces two submerged weirs at the Right Pocket entrance to enhance sediment exclusion and flow control.

Straightened Geometry

Straightened Right Pocket and Tail Channel geometry to minimize flow separation and sediment deposition.

Modified Outer Bank

Modified Outer Bank alignment to reduce shoal formation near barrage gates.

Sediment Flushing Strategy

A robust sediment flushing strategy is essential to maintain the long-term efficiency and operational integrity of the Sukkur Barrage system, preventing detrimental sediment accumulation.

The Sediment Challenge

Right Pocket Infill

Sediment gradually accumulates within the Right Pocket, progressively reducing its storage capacity and decreasing the exclusion efficiency of sediment from the canal intakes.

Re-entry Risk

Under conditions of higher canal diversion, previously deposited sediments can be re-suspended and transported back into the irrigation canals, compromising water quality and distribution.

Proposed Sediment Management Procedure

Flushing Operation

Annual flushing should be carried out in October, as the irrigation demand is limited and the Indus River discharge should be sufficiently high to enable such flushing operation. Whenever flushing is undertaken, the head regulators should be closed for the duration of the flushing, to avoid increased sediment concentration entering the Right Pocket then the irrigation canals. During the low flow season, any period during which the head regulators can be closed should be used as an opportunity to clean the Right Pocket and Approach Channel by flushing. **ARTELIA**

Periodic Flushing During Irrigation Season

Results of the tests indicate that the sediment exclusion could be significantly improved by combining:

- *(1) if and when the head regulators can be closed during few hours (October for example), annual flushing of the Right Pocket and Tail Channel and*
- *(2) when the head regulators shall be kept open, closing of the Tail Channel gates (or minimum opening of these gates) with periodical Tail Channel flushing sequences whenever necessary*

The Tail Channel gates would be widely open only during the Tail Channel flushing sequences and when passing the higher flood discharges requires so. This could be confirmed by testing a defined combination of annual and periodical flushing sequences over a full geomorphological season. Definition of the optimum combination may require a long iterative trial and error process.

Final Recommendations & Conclusion

Recommended Way Forward

Priority Recommendation

Strengthen riprap protection to ensure barrage safety during floods, especially near central barrage gates. Already done in Working Season-III [2025-26].Alhamdullilah

Preferred Engineering Solution

Implement Configuration 4, which includes:

- Two submerged weirs at the Right Pocket entrance.
- Straightened Right Pocket and Tail Channel geometry.
- Improved Outer Bank alignment.

Operational Recommendation

Adopt a comprehensive sediment flushing strategy:

- Conduct annual flushing in October.
- Periodic Flushing During Irrigation Season

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Attachment: **ARTELIA FINAL REPORT**

Progress Report

Progress Highlights as of May 2026

61%

Physical Progress

Overall physical progress achieved in the Sukkur Barrage rehabilitation project, demonstrating significant strides towards completion.

44

Gates Replaced

By 15 June 2026, 44 Main Weir Sluice Gates marking a major milestone in the replacement efforts.

15

Days Closure

Temporary closure of the barrage in January 2026 to facilitate essential major canal head regulator embedded parts works.

80

Tons Reduced

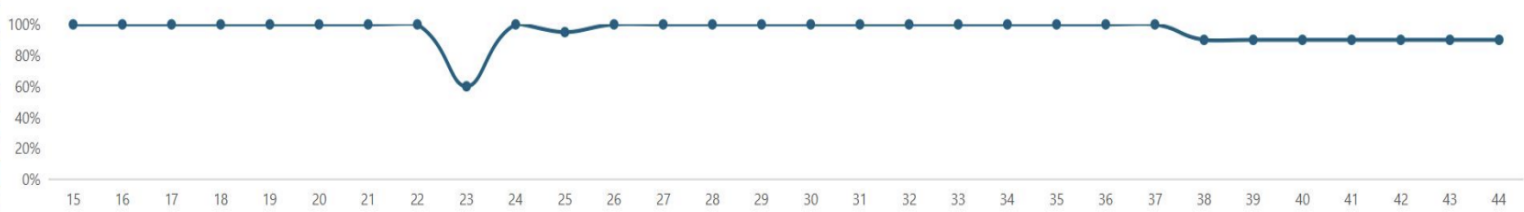
Significant reduction in weight per gate, vastly improving operational efficiency and longevity of the new gates.

These milestones reflect the dedicated efforts in modernizing the vital Sukkur Barrage infrastructure.

Daily Progress Report-Civil Works Working Season-III [2025-26]

Progress Report of SBIP | S-1 Project: Restoration and Upgradation of Sukkur Barrage Bays 15-44
Working Season-II (2025–2026), Period from 1st April to 31st May 2026

Activity started Date	28/5/2026
Bay Works Completed	21
In progress	9
Not Started	(1)



Legends
Complete √
In Progress √
Not Started ×

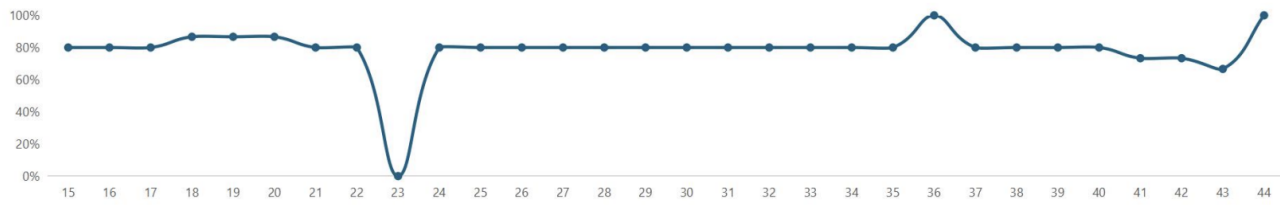
ACTIVITY/TASK NAME	ZONE 1									ZONE 2																				Total Work Completed
	Bay 15	Bay 16	Bay 17	Bay 18	Bay 19	Bay 20	Bay 21	Bay 22	Bay 23	Bay 24	Bay 25	Bay 26	Bay 27	Bay 28	Bay 29	Bay 30	Bay 31	Bay 32	Bay 33	Bay 34	Bay 35	Bay 36	Bay 37	Bay 38	Bay 39	Bay 40	Bay 41	Bay 42	Bay 43	Bay 44	
CIVIL WORKS																															
GPRS.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Non Shrinkage Grout in Gate Groove	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Re-pointing of Piers Upstream	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	28
Re-pointing of Piers downstream	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Re-pointing of Gate Groove L/S & R/S	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	28
Grouting Piers Up stream	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	28
Grouting Piers Down stream	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Grouting Glacis Upstream	√	√	√	√	√	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	28
Grouting Glacis Downstream	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Grouting Floor Upstream	√	√	√	√	√	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	28
Grouting Floor Downstream	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
6" RCC Layer on Floor & glacies U/S	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	28
6" RCC Layer on Floor & glacies D/S	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Replacement of Filter Blocks D/S	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	28
Recoupment of Stone Apron U/S	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Recoupment of Stone Apron D/S	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Pre-Cast Flooring Panel	√	√	√	√	√	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	28
Pre-cast Beams	√	√	√	√	√	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	28
Cladding of Arches lower deck U/S	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	23
Cladding of Arches lower deck D/S	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	×	×	×	23
Task completed	20	20	20	20	20	20	20	20	12	20	19	20	20	20	20	20	20	20	20	20	20	20	20	18	18	18	18	18	18	18	
% completed	100%	100%	100%	100%	100%	100%	100%	100%	60%	100%	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	90%	90%	90%	90%	90%	90%	90%	
ACTIVITY	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	

96% Progress of Civil Works

Daily Progress Report-Electromechanical Works Working Season-III [2025-26]

Progress Report of SBIP | S-1 Project: Restoration and Upgradation of Sukkur Barrage Bays 15-44
Working Season-II (2025–2026), Period from 1st April to 31st May 2026

Activity started Date	28/5/2026
Bay Works Completed	2
In progress	27
Not Started	-

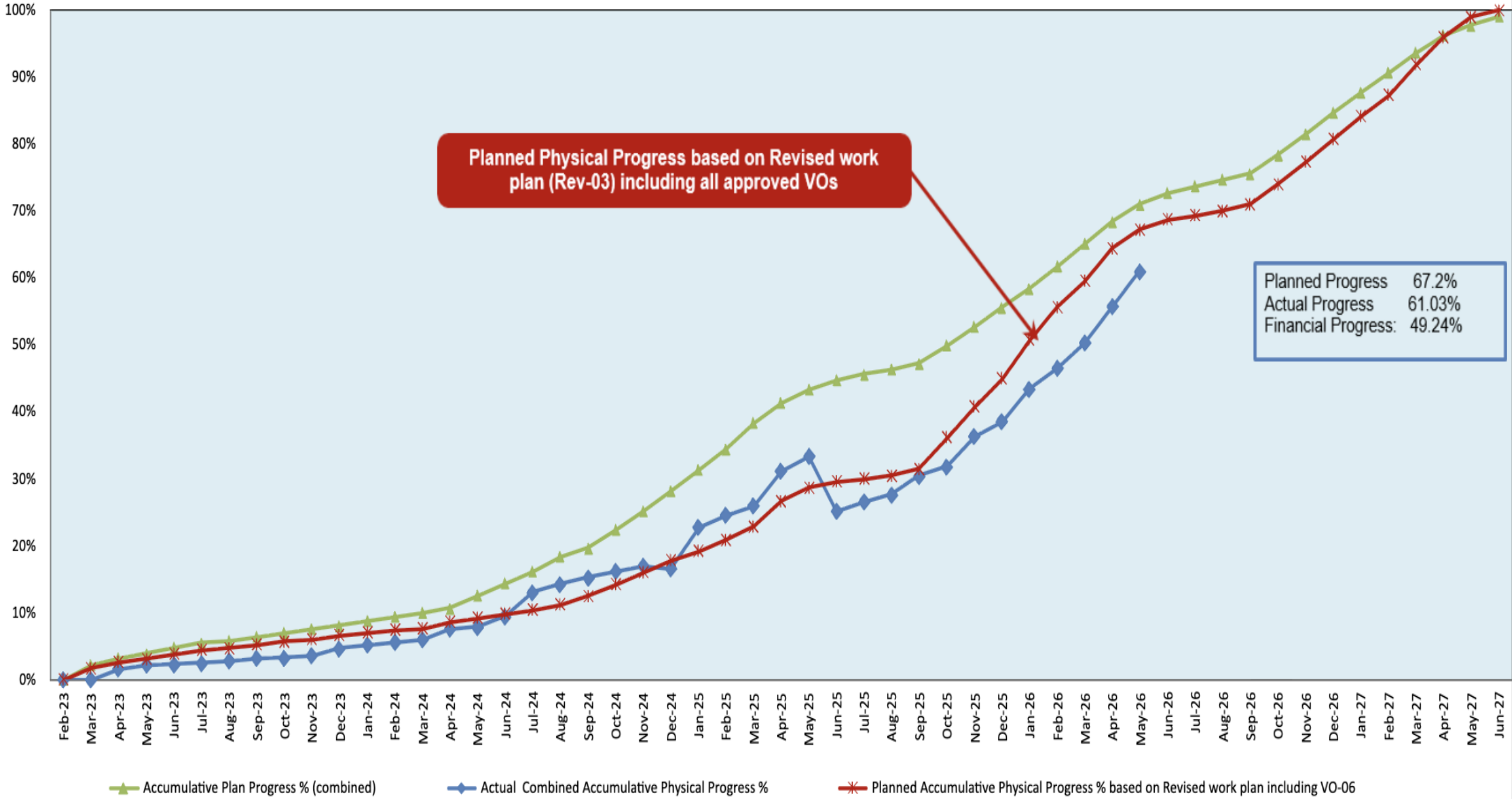


Legends
Complete √
In Progress √
Not Started ×

ACTIVITY/TASK NAME	ZONE 1									ZONE 2																				Total Work Completed
	Bay 15	Bay 16	Bay 17	Bay 18	Bay 19	Bay 20	Bay 21	Bay 22	Bay 23	Bay 24	Bay 25	Bay 26	Bay 27	Bay 28	Bay 29	Bay 30	Bay 31	Bay 32	Bay 33	Bay 34	Bay 35	Bay 36	Bay 37	Bay 38	Bay 39	Bay 40	Bay 41	Bay 42	Bay 43	Bay 44	
MECHANICAL WORKS																															
Dismantling																															
Hoisting system	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Gates leaves	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Embedded Parts	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Fabrication																															0
Gate leaves	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Sand Blasting & Painting of Gate Leaves	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Embedded Parts	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	28
Hoisting System	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Installation of Gates																															0
Fixing of embedded parts	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Fixing of gates	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
Fixing of wheel assembly	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√	28
Fixing of hoisting system	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×	×	×	√	26
Electric Works (LCP)	×	×	×	√	√	√	×	×		×	×	×	×	×	×	×	×	×	×	×	×	√	×	×	×	×	×	×	×	√	5
Testing and commissioning																															0
FAT for Embedded Parts	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
SAT for Embedded Parts	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	√	×	×	×	×	×	×	×	√	2
FAT for Gate Leaves	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	√	×	×	×	×	×	×	×	√	2
SAT for Gate Leaves	×	×	×	√	√	√	×	×		√	×	×	×	×	×	×	×	×	×	×	×	√	×	×	×	×	×	×	×	√	6
FAT for Hoisting System	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	29
SAT for Hoisting System	×	×	×	√	√	√	×	×		√	×	×	×	×	×	×	×	×	×	×	×	√	×	×	×	×	×	×	×	√	6
Rectification for Punch List items																															
Observe during the FAT/SAT																															0
Embedded Parts	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	√	×	×	×	×	×	×	×	√	2
Gate leaves	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	√	×	×	×	×	×	×	×	√	2
Hoisting System	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	√	×	×	×	×	×	×	×	√	2
Task completed	12	12	12	13	13	13	12	12	0	12	12	12	12	12	12	12	12	12	12	12	14	12	12	12	12	11	11	10	15		
% completed	80%	80%	80%	87%	87%	87%	80%	80%	0%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	100%	80%	80%	80%	80%	73%	73%	67%	100%		
ACTIVITY	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	

78% Progress of Mechanical Works

SBIP/S1 - Planned Physical Vs Actual Achieved Physical Progress - 31 May 2026



Conclusion: Securing Sindh’s Water Future

The rehabilitation of the Sukkur Barrage is not just an engineering project; it is a critical investment in the future of Pakistan’s agricultural backbone and a testament to collective commitment.

- **Critical Investment:** This project safeguards Pakistan's vital agricultural sector, ensuring food security and economic stability.
- **Climate Resilience:** Modernization fortifies the barrage against climate variability and future water shortages, ensuring long-term sustainability.
- **Livelihoods Secured:** The commitment to timely completion directly impacts millions of livelihoods, fostering prosperity across the region.
- **Sustainable Future:** Together, we are building a stronger, more sustainable irrigation future for generations to come, ensuring vital resources for all.

POST-REHABILITATION OPERATIONAL & SUSTAINABILITY RECOMMENDATIONS

Following the successful installation and commissioning of all **27 barrage gates**, the following actions are recommended to ensure sustainable operation, safety, and long-term Mega Structure preservation:

1. Strengthening O&M Capacity

Recruit dedicated **Electro-Mechanical Engineers and Technicians** for operation, maintenance, and troubleshooting of the newly installed hoisting system, Local Control Panels (LCPs), and Automated Data Acquisition System (ADAS).

2. Periodic Asset Preservation

Establish a **long-term maintenance contract** for periodic painting, seal replacement, corrosion protection, and associated works, with inspections by an independent Third-Party Inspector (TPI).

3. Reservoir Level Management

Enforce the prescribed **Maximum Pond Level (MPL)** to safeguard gate integrity and structural safety.

4. Sediment Management & Flushing Operations

Implement flushing operations in accordance with the recommendations of the **Physical/Arterial Hydraulic Model Study** to maintain hydraulic efficiency and sediment control.

5. Capacity Building & Training

Conduct regular training programs for **Irrigation Officers and operational staff** to enhance awareness, operational readiness, emergency response capability, and effective utilization of the modernized barrage systems.


فَبِأَيِّ آلَاءِ رَبِّكُمَا تُكَذِّبَانِ