CONSTRUCTION OF OFFSHORE BREAKWATER FOR ALL WEATHER LNG OPERATIONS AT KLL, DABHOL LNG TERMINAL

BRIEF HISTORY OF BREAK WATER PROJECT AT KONKAN LNG LIMITED

- Construction of the marine facilities for the Dabhol LNG terminal was commenced in 1999.

- Approximately 55% of the breakwater and 95% of the LNG jetty were completed when the works were abandoned in 2001.

- Later in 2013, the LNG terminal was commissioned but because of the partially completed breakwater, terminal was available for unloading LNG only during fair weather (Non-Monsoon season).

IMPORTANCE OF BREAKWATER CONSTRUCTION AT KONKAN LNG LIMITED

•The LNG Terminal at Dabhol, a key facility on the west coast, faced significant operational challenges due to maritime constraints resulted in limited LNG vessel berthing during monsoon.

•To overcome this and transform the LNG Terminal into an all-weather terminal, A breakwater was constructed (Length-2.3 KM) and approximately 2.2 KM from the seashore at a depth of around 18 meters +7 meters above Chart Datum (CD). (A chart datum is the baseline water level used to measure water depths and tide heights on a nautical chart)

•Enhanced LNG Terminal Operations – Enables year-round LNG cargo movement & increased operational efficiency.

•Strengthening India's LNG Infrastructure – Enhances energy security by ensuring uninterrupted LNG supply.

BREIF ON BREAKWATER

A breakwater is a structure built to protect the jetty from the wave actions, ensuring safe berthing for cargo ships during monsoon.

❖**FUNCTIONS OF BREAKWATERS:**

- Dissipate wave energy
- Reduce coastal erosion
- Provide safe harbor conditions
- Support marine transportation and port operations.

❖**TYPES OF BREAKWATER**:

By Location:

- Offshore Breakwater – Standalone unit in sea, away from sea shore.
- Land-connected Breakwater – Extends from land into the sea.

By Structure:

- Rubble mound Breakwater
- Vertical Wall Breakwater
- Composite Breakwater
- Floating Breakwater

HOW THE BREAKWATER CONTRUCTION AT KONKAN LNG LIMITED IS UNIQUE

- **OFFSHORE:** Being India's first offshore breakwater, it stands in open water away from the coast, creating a protected basin behind it, unlike land connected breakwaters that connect directly to the shore.

- **ENERGY DISSIPATION:** It uses sloping sides and loose, rough stones to break and absorb incoming waves, whereas vertical wall (composite or caisson) breakwaters bounce the wave energy back out to sea.

- **FLEXIBLE STRUCTURE:** It can adjust and settle slightly on soft seabed foundations without failing catastrophically, while rigid concrete walls crack or break under the same movement.

- **CONSTRUCTION MATERIAL:** It is built using locally quarried core stones, Primary and secondary armour and toe cube blocks and Acropodes.

PROJECT LOCATION AT KONKAN LNG LIMITED

- Existing break water length: 475 m
- Length of breakwater to be constructed: 1825 m
- Total length of breakwater: 2300 m
- Approximate distance of breakwater from load out jetty: 3 km

STATUTORY PERMISSIONS REQUIRED FOR BREAKWATER CONSTRUCTION

Ministry of Ports, Shipping & Waterways:

- Port development approval for Dabhol Port (controlled by MPSWT)
- No Objection Certificate (NOC) for offshore construction within port limits
- Port Authority clearance for marine fleet deployment

Ministry of Petroleum & Natural Gas (MoPNG):

- Approval for LNG terminal capacity expansion to all-weather operations
- Regulatory sign-off for GAIL / NTPC JV – Konkan LNG (KLPL) project

Indian Coast Guard / Indian Navy:

- NOC for construction in coastal waters and EEZ zone
- Marine traffic management approval for heavy barge movements
- Clearance for anchoring large crane barges in approach channel area

STATUTORY PERMISSIONS REQUIRED FOR BREAKWATER CONSTRUCTION

Maharashtra Maritime Board (MMB):

- State port authority clearance for breakwater alignment
- Approval for temporary marine structures and load-out jetty
- Clearance for dredging operations around breakwater footprint

Maharashtra Pollution Control Board (MPCB):

- Environmental clearance (EC) for marine construction and dredging
- Marine turbidity monitoring compliance during construction

Ministry of Environment, Forest & Climate Change (MoEFCC)

- Coastal Regulation Zone (CRZ) clearance under CRZ Notification
- Environmental Impact Assessment (EIA) approval for offshore structure
- Compliance with Island Protection Zone regulations

STATUTORY PERMISSIONS REQUIRED FOR BREAKWATER CONSTRUCTION

Directorate General of Shipping (DGS)

- Survey and certificates for all marine vessels deployed
- Inspection of crane barges, split hoppers & tug boats
- Radio communication licenses for all vessels

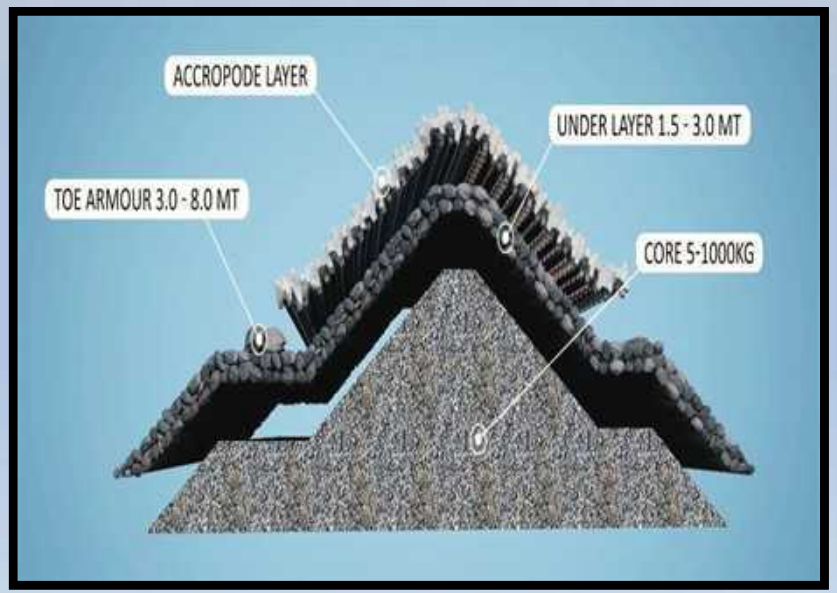
Local Administration (Ratnagiri District)

- Police escort and round-the-clock protection for ACCROPODE™ transport
- District Collector NOC for heavy vehicle movement on public roads

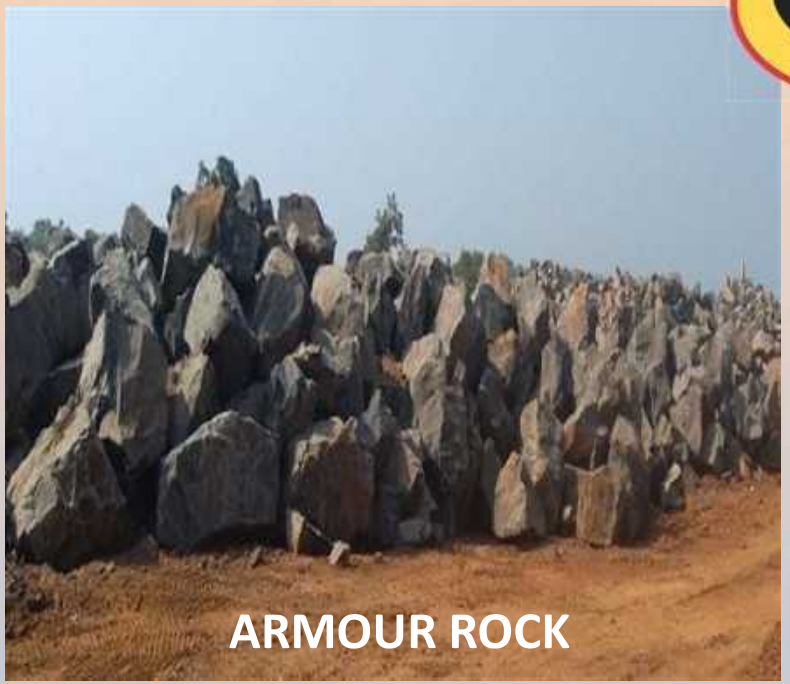
MAJOR CONSTRUCTION MATERIAL FOR BREAKWATER

Major construction Materials:

- ***CORE*** (5-1000 kg): Quarry stones forming the main body of the structure.
- ***SECONDARY ARMOUR*** (1.5-6 T): A layer of rocks laid between the core and the primary armour, also referred to as the under-layer or filter layer.
- ***PRIMARY ARMOUR*** (Accropode 9 Cum & 12 Cum): Outer protective armouring layer consisting of individual armour units designed to dissipate wave energy.
- ***TOE ARMOUR*** (3-8 T): The lowest part of the structure's slope, creating a transition to the seabed.



CORE ROCK

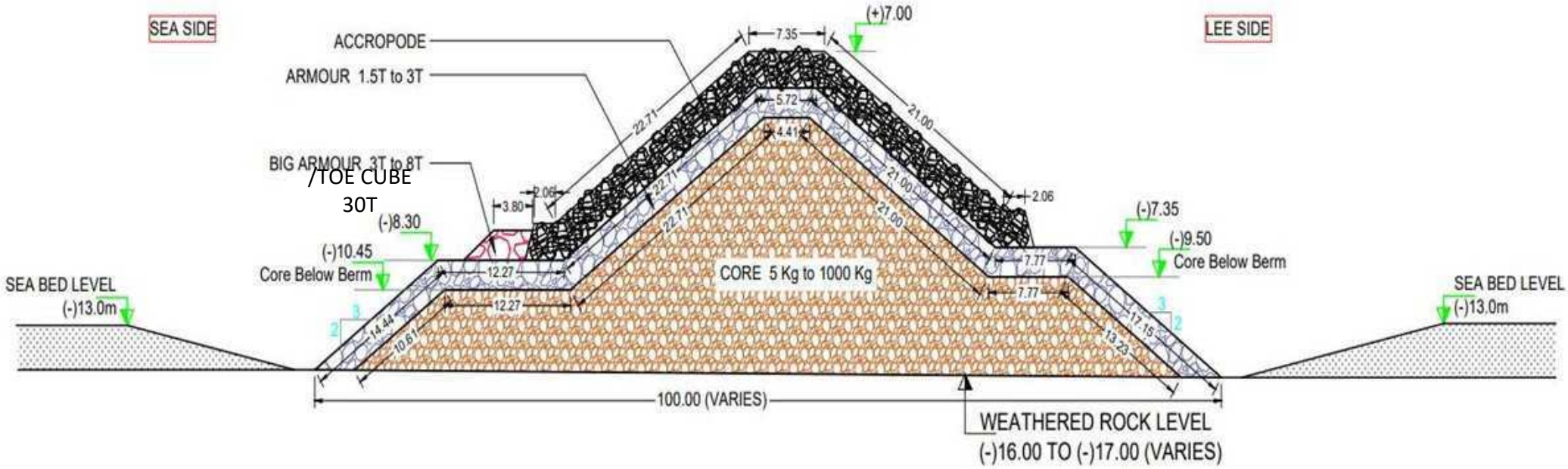


ARMOUR ROCK

ACCROPODE UNITS

TOE BLOCKS

BREAK WATER CROSS SECTION



CONSTRUCTION JOURNEY

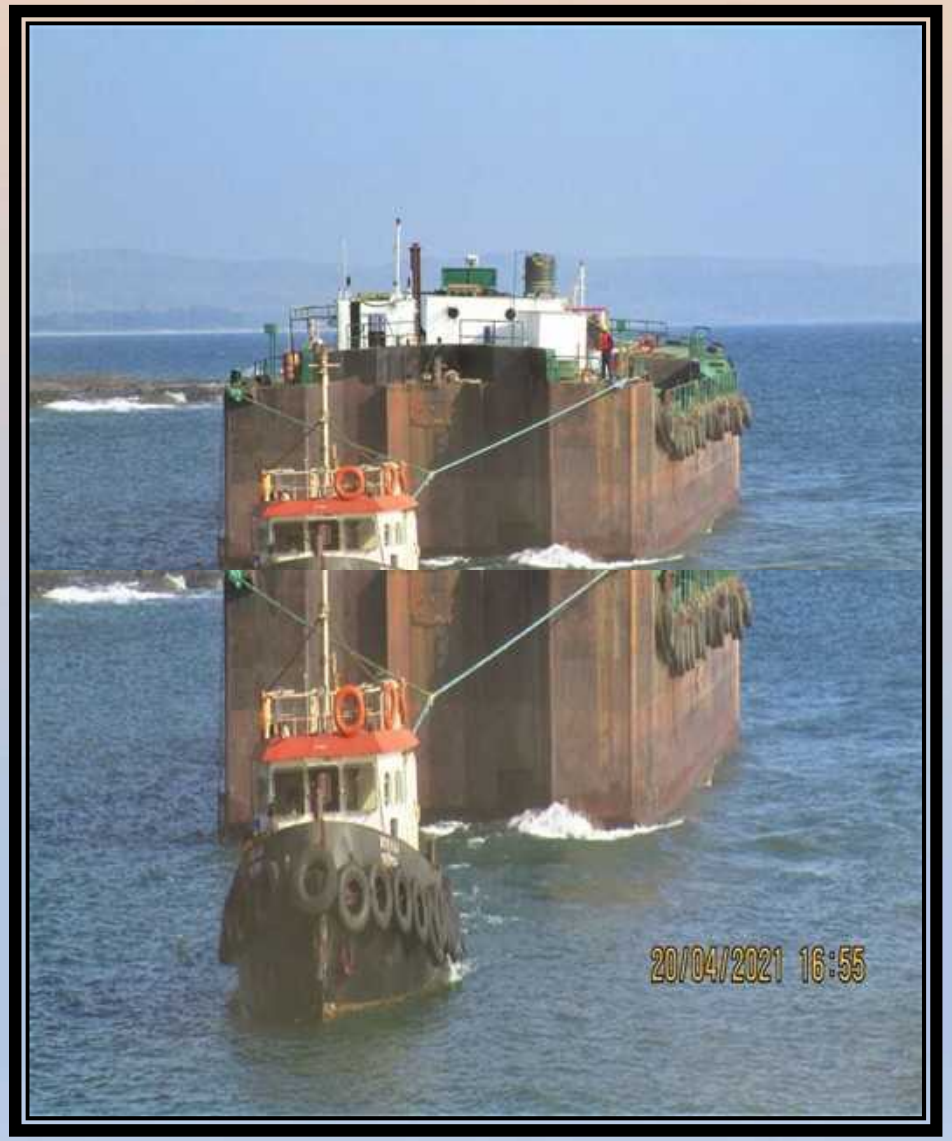
- *Geotechnical Investigation & Various Survey Works.*
- *2D and 3D Model Testing at Srilanka.*
- *Construction of Load Out Jetty and Access road in Ghat Terrain.*
- *Dredging Works*
- *Core & Armour Placement*
- *Accropode & Toe Block Placement*
- *Statutory Clearance for all whether port classification*

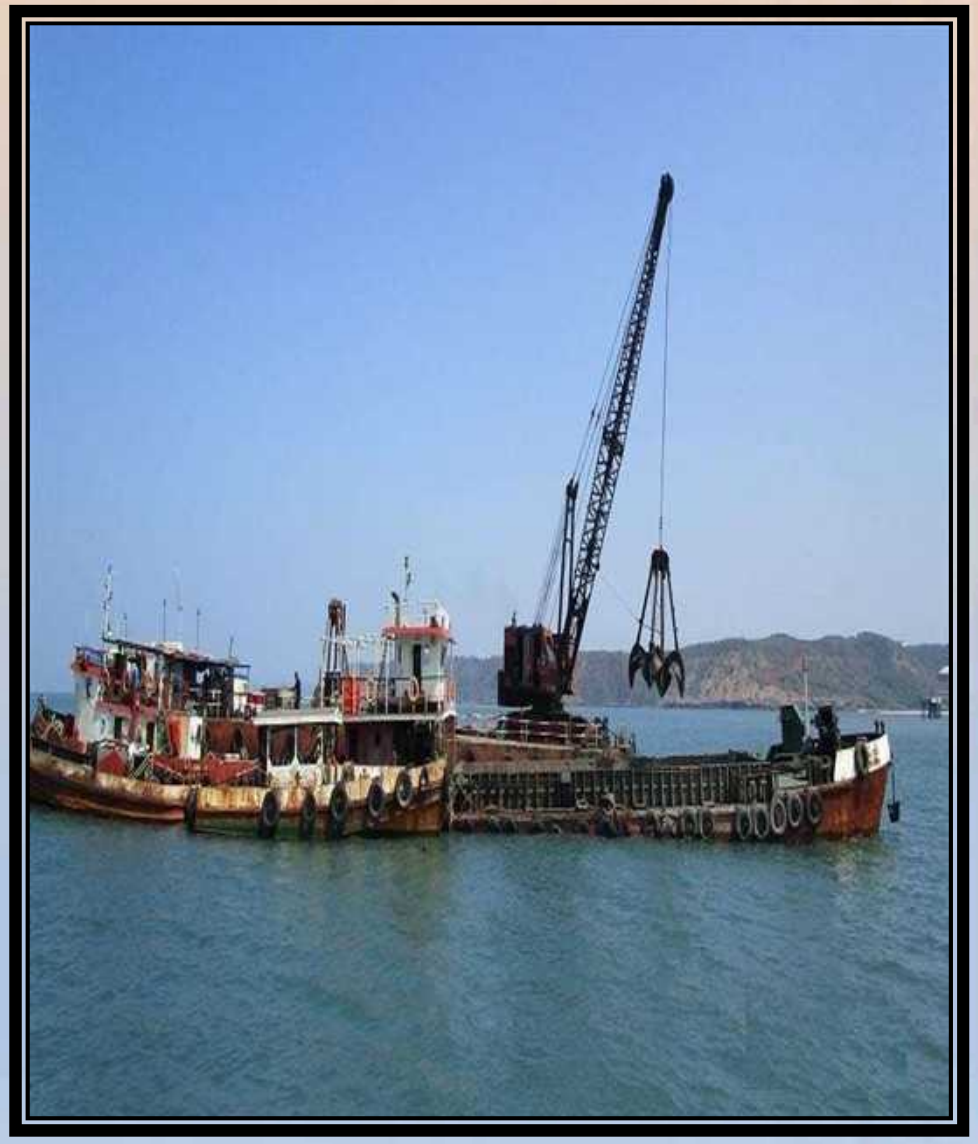
2D & 3D MODEL STUDY

2-D MODEL TESTING

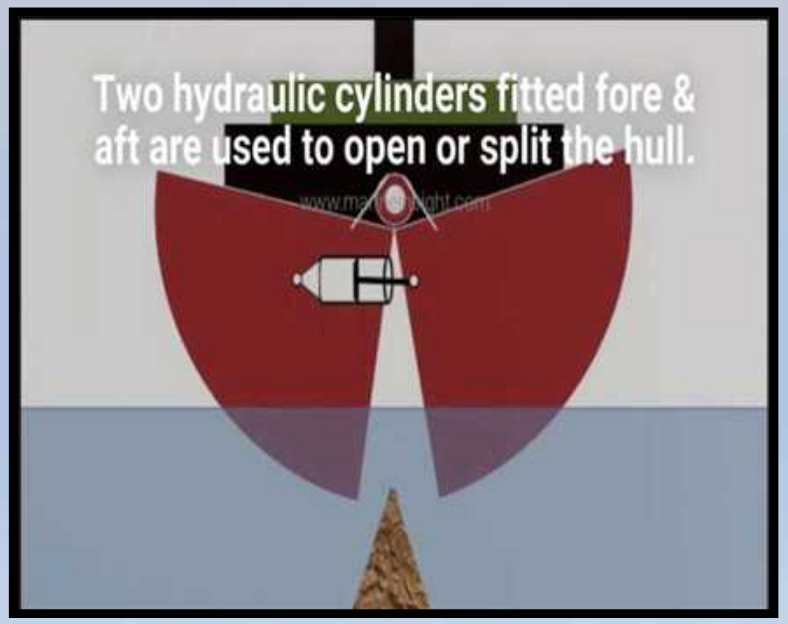
3D MODEL TEST OF ROUNDHEAD AT LAB (SRI LANKA)

TRANSPORTATION AND PLACEMENT OF ROCK



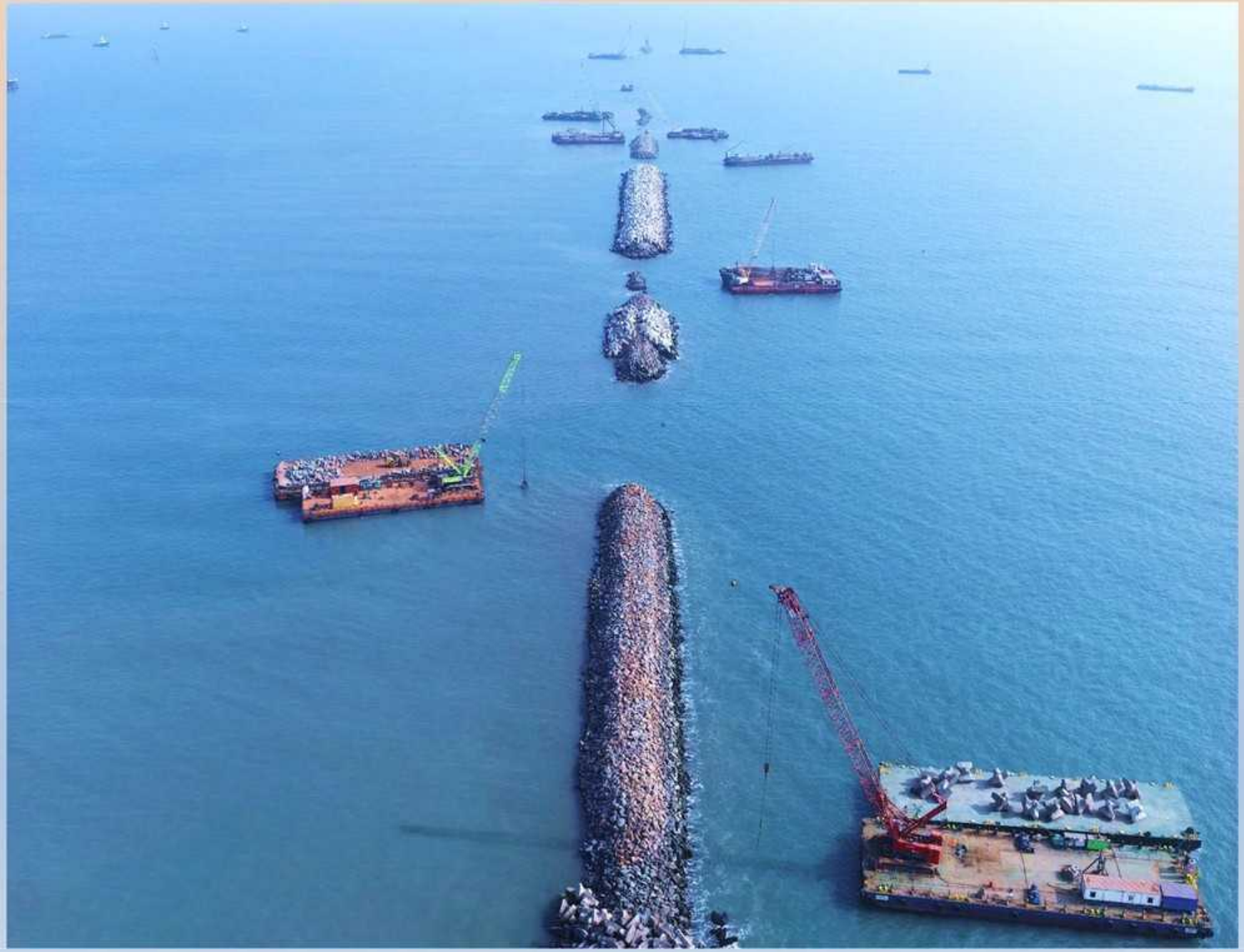


LOADING AND PLACEMENT BY SPLIT BARGE



CRANE BARGE FOR ACCROPODE PLACEMENT

Breakwater Progress



Progress Photos

CHALLENGES

•**Offshore:** Being an offshore breakwater, transporting all the construction material up to the coast and from there to the actual construction site in the middle of the sea posed a major logistical challenge.

•**Remote location/undulating terrain**: Since the terminal is located in remote part of Konkan Area, ensuring uninterrupted availability of manpower and machinery was a big challenge. A new dedicated road had to be constructed in the hilly topography for transportation of large-scale construction material to temporary load out jetty.

•**Local resistance**: Local people created resistance in transporting the accropodes from the nearby village. Accropodes had to be transported in round the clock Police protection. Further, movement of trucks from quarries carrying boulders was hampered by the local people creating traffic management challenges.

CHALLENGES

• **Covid 19**: Construction of the breakwater came to a complete halt due to the pandemic of Covid 19. Being a location far from major cities, re-deployment of resources to resume the work was a great challenge.

•**Cyclone Tauktae**: The terminal faced a great challenge of cyclone Tauktae in May 2021. The impact was so severe that a large portion of TLOJ was washed out and the construction could be resumed only after 4-5 months.

•**Barge Drowning / Sinking Incidents:** Heavy swells and rough sea conditions during transition months caused barge instability events, including partial sinking of loaded material barges. Marine salvage operations were required, causing schedule delays. Zero LTI record maintained throughout with strict marine safety protocols including self-release hooks and three-layer protection systems.

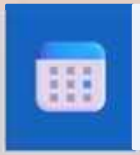
Disorientation of Underwater Armour (Accropode

CHALLENGES

- **Disorientation of Underwater Armour (Accropode):** ACCROPODE™ placement underwater requires precise orientation and interlocking as per CLI guidelines. Underwater currents, poor visibility, and surge conditions led to mislaid or displaced units identified by diving inspection. Round head section especially vulnerable due to converging wave approach from two directions. All displaced units were relocated and re-oriented by diving team.

COMMISSIONING – BENEFITS TO KLL & GAIL INDIA

Konkan LNG Limited (KLL)

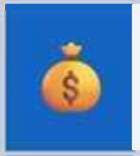


Year-round LNG Unloading

Terminal transitions from ~7-month seasonal operation to full 12-month all-weather operation, maximising asset utilisation.

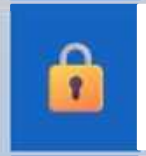
Safe Berthing of LNG Carriers

Breakwater provides sheltered harbor with wave attenuation, enabling safe approach, berthing and mooring of large LNG vessels even during adverse sea states.



Revenue & Capacity Utilisation

Ability to schedule LNG deliveries in monsoon months eliminates seasonal supply gaps. Higher terminal throughput and improved economics for KLL stakeholders.



Energy Security for Western India

Uninterrupted LNG supply to GAIL's distribution network across Maharashtra and other western states, reducing gas supply risk to power, fertiliser and industrial consumers.

Terminal Asset Protection

Breakwater reduces wave action on the 1,750 m trestle, jetty head, berthing/mooring dolphins and tug berths, extending the service life of marine infrastructure.

COMMISSIONING – BENEFITS TO KLL & GAIL INDIA

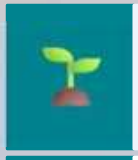
GAIL (India) Limited – Maharatna Company

Reliable LNG Import for National Grid

GAIL's LNG regasification and gas distribution network benefits from a dependable, year-round import point at Dabhol, complementing Dahej and Hazira terminals.

Power Sector Gas Supply

Continuous gas supply to power plants in Maharashtra reduces curtailment due to gas shortage in monsoon months, supporting grid stability.

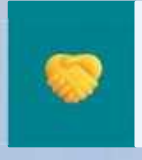


City Gas Distribution (CGD)

Uninterrupted LNG supply enables consistent natural gas availability to CGD networks in western India for domestic, CNG and industrial consumers.

National Energy Policy Alignment

Supports India's target of increasing natural gas share in energy mix to 15% by 2030. All-weather terminal strengthens GAIL's import infrastructure portfolio.



JV Investment Value Enhancement

As a 100% stakeholder in KLL, GAIL's return on investment improves proportionately with higher terminal throughput enabled by all-weather operation.

THANK YOU