CASE HISTORY

Rev:00, Date : 20.11.2025

GEOSYNTHETIC PROTECTION SYSTEM FOR RESERVOIR LINING WORKS AT GREENKO'S PINNAPURAM PUMPED STORAGE PROJECT, ANDHRA PRADESH

PINNAPURAM, ANDHRA PRADESH, INDIA

Lining Works

Client:	Products used:
GREENKO	• TECHLINK TL 350 • TECHGRID PP3030 BIAXIAL GEOGRID • TECHGEO PN 70 & PN 100
Contractors:	
--	
Manufacturer & Supplier:	Year of Construction:
TECHFAB (INDIA) INDUSTRIES LTD.	2025

Project Brief:

The Greenko Pinnapuram Integrated Renewable Energy Project (IREP), located in Andhra Pradesh, India, is one of the country's flagship efforts to support the transition to clean energy. Developed by Greenko Group, the project integrates 1.2 GW of pumped hydro storage with 1 GW of solar and 600 MW of wind capacity, making it a pioneering example of large-scale renewable energy and storage integration in India.

A key feature of the project is its use of pumped hydro storage, which involves cycling water between two engineered reservoirs situated at different elevations. This process enables the storage of excess renewable energy generated during periods of low demand and its release during peak demand, thereby stabilizing the power grid and maximizing the use of intermittent solar and wind resources.

The construction of these reservoirs presented significant engineering challenges due to the site's complex geology, including fractured and jointed bedrock with active faults. Ensuring the long-term impermeability and structural integrity of the reservoirs was critical to the project's success. Traditional lining methods were deemed insufficient given the geological risks, prompting the adoption of a sophisticated multi-layer geosynthetic liner protection system.

Problem Description:

The construction of the Pinnapuram pumped storage reservoirs faced significant challenges due to the geological complexity of the site. The underlying bedrock consisted of fractured quartzite, limestone, and schist, intersected by numerous faults and joints. These features created zones of weakness and variable permeability, raising concerns about the long-term integrity and watertightness of the reservoirs.

Photo 1 & 2 : Site Conditions Before Execution of Reservoir Works

One of the main issues was the presence of active faults and widely spaced joints, which could experience movement during seismic events or due to natural ground settlement. Such movements risked imposing shear and tensile stresses on any reservoir lining, potentially leading to punctures, tears, or loss of impermeability. Additionally, the irregular and angular nature of the rock surface increased the risk of mechanical damage to the liner during installation and operation.

The high permeability of faulted and jointed zones further increased the risk of water seepage and internal erosion, which could undermine the embankment and cause environmental and operational problems. Conventional single-layer geomembrane liners were considered inadequate for these conditions, as they offered limited protection against both mechanical damage and ground movement.

To address these challenges, a robust, multi-layer geosynthetic lining system was required-one capable of accommodating differential movements, providing enhanced puncture resistance, and ensuring long-term impermeability even in the presence of active geological features.

Proposed Solution: Multi-Layer Geosynthetic Lining System

The design team, in consultation with geosynthetic experts and international best practices, developed a multi-layer composite lining system with following objectives:

- Impermeability: To provide a continuous, robust hydraulic barrier against water loss.
- Mechanical Protection: To shield the geomembrane from puncture and shear forces due to rock movement.
- Reinforcement: To accommodate differential movements and distribute stresses.
- Durability: To ensure a minimum 50-year service life under site-specific conditions.

The proposed system consists of the following layers, from bottom (in contact with insitu strata) to top (exposed to water):

Layer No.	Layer Name	Material/Type	Function
1	Primary Reinforcement Layer	TechLink TL 350 Uniaxial Geogrid	- Bridges faults and joints - Provides tensile reinforcement - Resists ground movement
2	Cushioning/Protection Layer	TechGeo PN70 PP Non-Woven Geotextile	- Cushions geomembrane - Protects against puncture from subgrade
3	Hydraulic Barrier	2.0 & 2.5mm HDPE Geomembrane	- Primary impermeable barrier - Prevents water seepage
4	Protection / Separation Layer	TechGeo PN100 PP Non-Woven Geotextile	- Protects geomembrane from puncturing from armor layer
5	Secondary Reinforcement/ Protection	TechGrid PP3030 Biaxial Geogrid	- Distributes loads - Protects geomembrane - Adds mechanical stability
6	Surface Protection/Armor Layer	Insitu Soil	- Protects geosynthetics from UV radiations - provides surcharge load to geosynthetic materials

Photo 3 : Installation of TechLink TL 350 Geogrid and TechGeoPN 70 Geotextile on Insitu Strata

Installation Procedure of the Proposed Lining Solution:

Following is the installation methodology of the multi-layer geosynthetic liner protection system at the Greenko Pinnapuram Pumped Storage Project reservoirs:

1. **Subgrade Preparation**

- The reservoir area is cleared of vegetation, debris, and sharp rock fragments.
- The rock surface is levelled, and any large voids or joints are filled and compacted to create a smooth, stable base.

2. **Laying the Primary Geogrid (TechLink TL 350)**

- The high-strength uniaxial geogrid is unrolled directly onto the prepared subgrade, aligned parallel to the slope.
- Geogrid panels are overlapped and anchored in trenches at the crest and toe, then tensioned to ensure full contact with the ground.

3. **Placing the Cushion Geotextile (TechGeo PN 70)**

- The non-woven geotextile is spread over the geogrid, with sufficient overlap at seams.
- Seams are joined by thermal bonding to provide continuous protection.

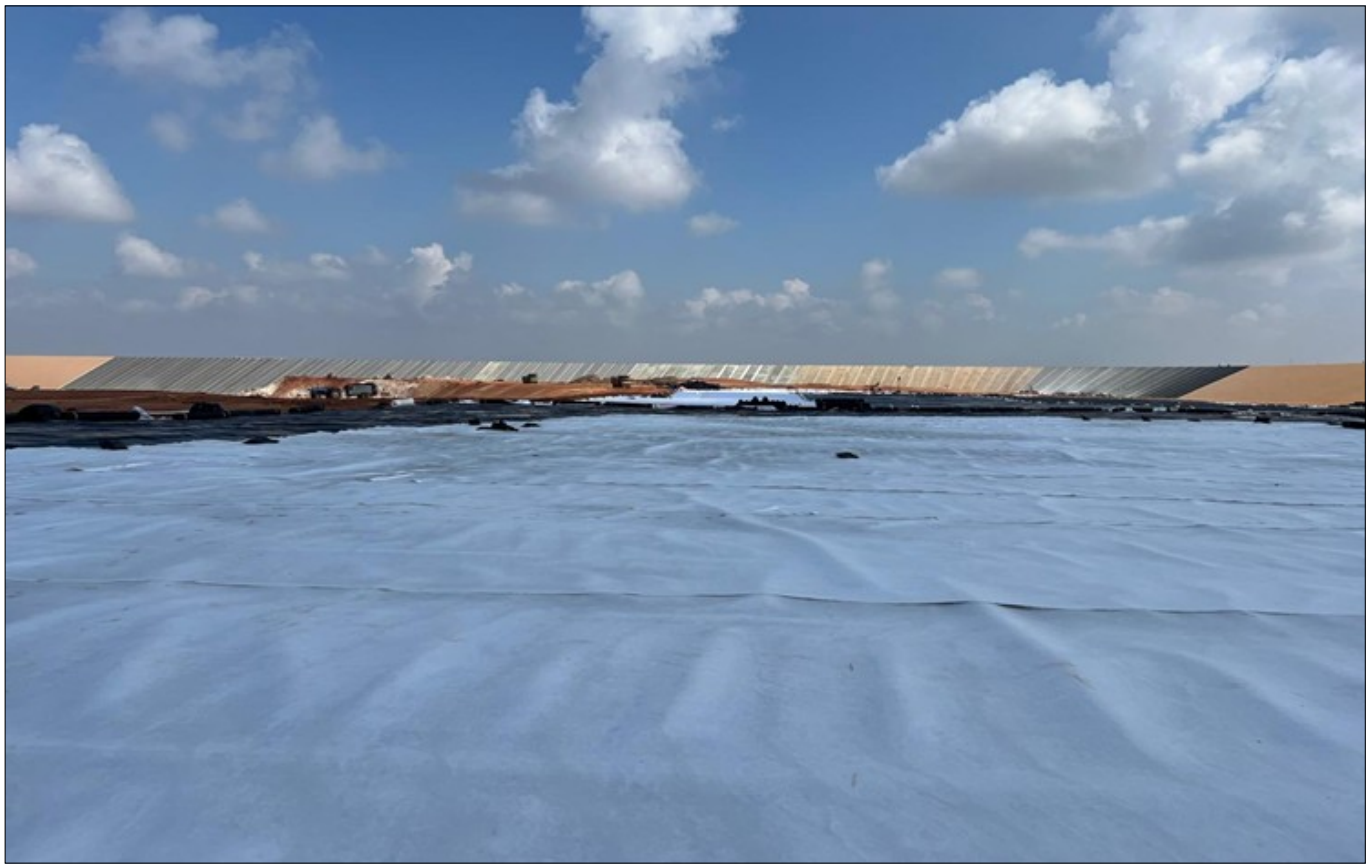

Photo 4 : Installed Geotextile Layer

4. Installing the HDPE Geomembrane (2.0mm and 2.5mm)

- HDPE geomembrane panels are unrolled over the geotextile and positioned to minimize field seams.
- Seams are welded using hot wedge or extrusion welding, then tested for watertightness using air pressure or vacuum methods.
- The geomembrane edges are welded to the HDPE locks cast into the concrete beam cast along the perimeter of the toe of the embankment to ensure suitable anchoring at the edges.

5. Adding the Top Geotextile Layer (TechGeo PN 70)

- A second non-woven geotextile is laid over the secondary geogrid, providing further filtration and cushioning.

6. Placing the Secondary Geogrid (TechGrid PP3030)

- The biaxial geogrid is placed over the geotextile, aligned to distribute loads and protect the liner during subsequent works.
- Overlaps are maintained, and the geogrid is temporarily secured in place.

7. Placement of the Armor Layer

- Insitu muck is carefully placed on top of the geotextile to a specified thickness, using low-ground-pressure equipment to avoid damaging underlying layers.
- The armor layer is shaped and lightly compacted to achieve the final design profile.

Photo 5 : Installed Geosynthetic Layers

Photo 6 : Installed TechLink TL 350 Geogrid on Slope

Photo 7 : Completed Reservoir with Advanced Geosynthetic Protection

Conclusion:

The Greenko Pinnapuram Pumped Storage Project successfully implemented a multi-layer geosynthetic lining system tailored to the challenging fractured rock conditions at the site. This innovative design provided exceptional impermeability and mechanical resilience, effectively preventing leakage and damage from fault movements and joint openings.

Key achievements include significantly reduced seepage rates, enhanced durability with a design life exceeding 50 years, and cost-effective construction compared to traditional lining methods. Rigorous site investigation, quality control, and adaptive construction practices were critical to this success.

This case demonstrates that well-designed geosynthetic composite liners can reliably protect reservoirs in complex geological settings, offering valuable insights for similar renewable energy and water infrastructure projects worldwide.

For further details kindly contact :

TechFab India Industries Ltd.
46&47, Maker Chambers VI, Nariman Point, Mumbai - 400021
Tel: + 91- 22 - 2287 6224 / 6225
E: info@techfabindia.com
W: www.techfabindia.com