KERALA INFRASTRUCTURE INVESTMENT FUND BOARD

Newsletter

Vol 6 Issue 11 December 2023

Projects - Statistics

Department	KIIFB Approved Projects	
	No. of Projects Approved	Approved Amount (₹. in Crore)
PWD	494	₹ 30,904
Agriculture	1	₹ 21
Animal Husbandry	1	₹ 10
Ayush	2	₹ 183
Backward Classes Development Department	1	₹ 18
Coastal Shipping & Inland Navigation	11	₹ 2,302
Culture	17	₹ 485
Devaswom	2	₹ 139
Fisheries and Ports	26	₹ 522
Forest	4	₹ 459
General Education	146	₹ 3,022
Health & Family Welfare	74	₹ 5,776
Higher Education	62	₹ 1,765
Home	6	₹ 225
Industries	1	₹ 62
Information Technology	3	₹ 1,413
Labour & Skills	5	₹ 86
Local Self Government	23	₹ 736
Power	18	₹ 5,200
Registration	6	₹ 89
Revenue	2	₹ 33
SC/ST Development	10	₹ 182
Sports & YA	39	₹ 847
Tourism	13	₹ 584
Transport	3	₹ 601
Water Resources	96	₹ 6,720
Total	**1066**	₹ 62,383

Projects under Land Acquisition Pool of ₹ 20,000 Crore		
PWD-NHAI	1	₹ 6,769
Industrial Parks - 3 projects - ₹13988.63 Cr	6	₹ 16,108
Taking over of land from HNL - ₹ 200.60 Cr		
Kochi - Banglore Industrial Corridor & Gift City - ₹1918.93 Cr		
Total	**7**	**₹ 22,877**

KIIFB Approved Projects Grand Total		
Infrastructure Projects	1066	₹ 62,383
Projects under Land Acquisition Pool	7	₹ 20,000
Total	**1073**	**₹ 82,383**

Fund disbursed to projects *(as on 30/11/2023)*	**₹ 26,926 Crore**

Chief Editor's Page

On November 11, KIIFB celebrated KIIFB Day. A momentous day that allowed us to reflect on our journey, achievements, and shared aspirations. This marks an exciting journey of 24 years of service to the State and the people of Kerala. Today, KIIFB undoubtedly continues to shape the infrastructural landscape of Kerala, fostering economic growth and improving the standard of living for its residents. Through its dynamic role in infrastructure development, KIIFB stands as a testament to the power of strategic investment in creating a sustainable and vibrant future for the state. This day also serves as a reminder for us to embrace the challenges ahead, renew our commitment to innovation, and ensure that the next 24 years are even more remarkable than the last. The journey continues, and we are grateful for your continued support in this shared vision for a prosperous and progressive Kerala.

One noteworthy highlight of this special occasion was the successful blood donation camp organized on 29th November 2023, as part of our commitment to giving back. The blood donation camp exemplified the spirit of altruism and community engagement that defines KIIFB. Our enthusiastic team stepped forward to donate blood and a total of 35 units of blood was collected from KIIFB, contributing to a cause that directly impacts lives and reinforces our collective commitment to social responsibility. The palpable sense of unity and shared purpose during the blood donation camp was truly inspiring.

The articles in this edition of the KIIFB newsletter talks about topics ranging from the various workshops held as part of the Keraleeyam event to the Poonthura Geotube Project. We have two articles specifically focussing on the Geotube Project, including a very detailed one submitted by KSCADC. The articles highlight how the innovative use of geotubes in projects minimizes constructions along the coastline and when strategically placed offshore, how these geotubes act as an effective barrier, diminishing the strength of oncoming sea waves. We also have articles submitted by the team of KIIFCON, which is the consultancy arm of KIIFB. Their main article highlights the Tourism Investors Meet (TIM) 2023 that was held on 16th November 2023, where KIIFCON was given the opportunity to showcase vantage land parcels in Kerala to the potential investors at the investor's meet under Investment Opportunities in Kerala and Project Presentations. I encourage you to explore the pages of this newsletter, engage with the narratives, and join us in celebrating the strides we've made together.

As we commemorate KIIFB Day, let's carry forward the spirit of collaboration and determination that defines us. Here's to another year of success, growth, and unwavering commitment to our mission.

Happy reading!

Regards,

Chief Editor

Promoting a Sustainable and Resilient Blue Economy-Dialogues by Environment and Climate Ministers in India's G20 Presidency

Introduction

The meeting of G20 climate and environment ministers from the world's largest economies – took place in Chennai, in July 2023. This included 41 Ministers from the Group of 20 countries – who together are responsible for about 80% of global planet-warming greenhouse gas emissions. The Group of 20 (G20) environment and climate ministers "resolve(d) to pursue environmentally sustainable and inclusive economic growth and development" in line with the 2030 Agenda for Sustainable Development, the Paris Agreement on climate change, and the Kunming-Montreal Global Biodiversity Framework (GBF), towards achieving Land Degradation Neutrality (LDN) by 2030, and commitments to address pollution. They also adopted a set of voluntary principles for a sustainable and resilient ocean-based economy. For accelerating climate action, the ministers emphasized the importance of the first Global Stocktake (GST) at the 2023 UN Climate Change Conference (UNFCCC COP 28) to assess collective progress towards achieving the goals of the Paris Agreement.

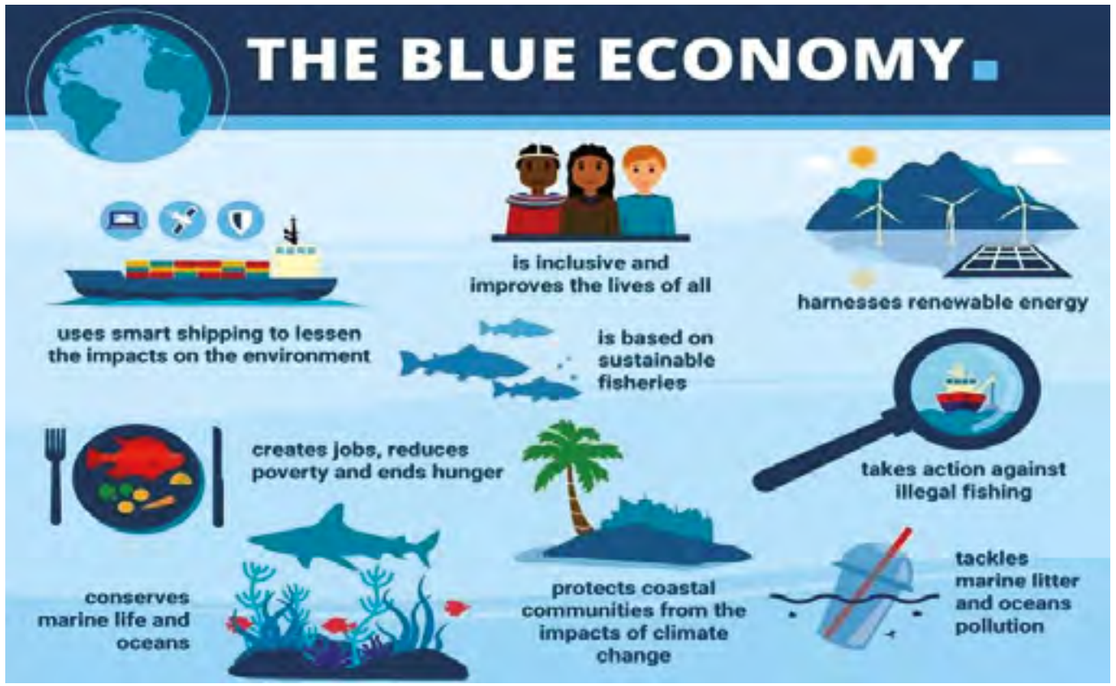
India's G20 Presidency theme - 'Vasudhaiva Kutumbakam – One Earth, One Family, One Future'

Blue Economy

The term "blue economy" refers to the sustainable use of ocean resources for economic growth, improved livelihoods, and the preservation of ocean ecosystems. It encompasses a wide range of economic activities and sectors that are directly or indirectly related to the oceans, seas, and coasts. The blue economy represents a holistic approach to harnessing the economic potential of oceans while safeguarding their ecological integrity. It reflects a shift toward more responsible and sustainable practices to ensure that future generations can continue to benefit from marine resources.

The guiding principle for Blue Economy

In the 'Chennai High-Level Principles for a Sustainable and Resilient Blue/Ocean-based Economy,' the ministers agreed that the following principles may be implemented by the G20 members voluntarily, based on national circumstances and priorities.



- Prioritise ocean health
- Acknowledge & address links between ocean &climate
- Promote social, intergenerational equity & gender equality
- Promote the use of marine spatial planning
- Leverage science, technology & innovation
- Recognise, protect, utilize indigenous & traditional knowledge

Establish & implement monitoring & evaluation mechanisms

Strengthen international co - operation

Enhance ocean finance

The importance of the ocean for the Global South

The Global South includes countries in Asia, Africa, and Latin America which are poorer and less developed, many having a colonial history—over the Global North—the wealthy and economically developed countries such as the US, Europe, Canada, etc. The importance of the oceans for the global south can be understood from the roles it plays in human livelihoods, through the provisioning of the various ecosystem services on which the coastal community is dependent.

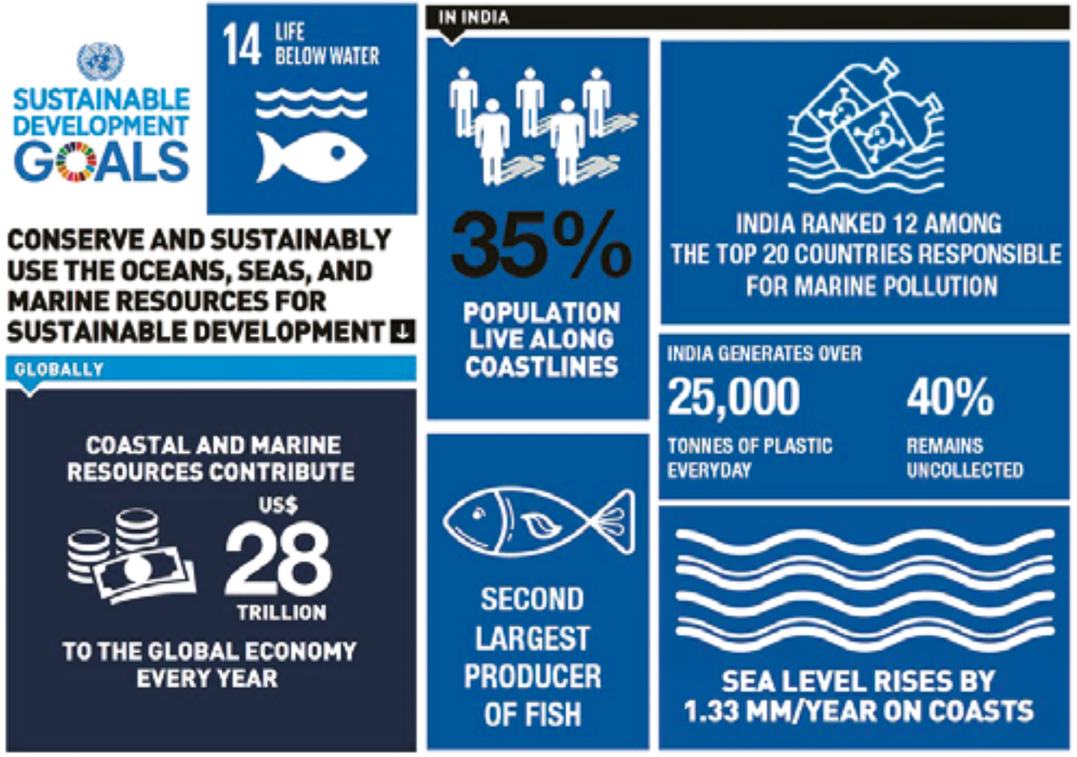
The Millennium Ecosystem Assessment talks of the services provided by the blue economy through the organic functioning of its natural ecosystem. These can be classified as provisioning services (fisheries, building materials, food, etc), regulating services (carbon sink and carbon sequestration, erosion prevention, extreme event moderation, etc), cultural services (tourism, recreational, aesthetic, and spiritual benefits) and supporting services (life-cycle maintenance for both fauna and local, element and nutrient cycling).

The Economics of Ecosystems and Biodiversity (TEEB) termed these ecosystem services as the "GDP of the poor" as the majority of the poor's livelihoods and incomes are drawn from the ecosystem services. The same is true for the poor coastal communities of the global south. Apart from that, the ocean being the next big economic frontier, with rapidly growing numerous ocean-based industries, it is poised to be the future growth driver of the global south through activities like wind energy, offshore aquaculture, seabed mining, and marine genetic biotechnology.

In this context, it needs to be kept in mind that South Asia has been a major contributor to the global food basket through its fisheries sector, with the artisanal fisheries in the Bay of Bengal region, contributing more than 80% of marine fish production. Fishing sector employs 15 million people in India and ranks second (6.3%) in the world's fish produce (INR 10 billion in 2015–16). Further, Coastal and Maritime Tourism which represents 5% of the world GDP and is expected to generate job opportunities for approximately 8.5 million people by 2030 (7 million employed in 2010).

Sustainable Development Goal 14- Life Below Water

Achieving the BE potential is a long way away. This is primarily because of the lack of investment for innovation towards the Blue Economy concerning financial and human capital. A recent survey by KPMG identifies the UN Sustainable Development Goal (SDG) 14: Life Below Water, as one of the least prioritized SDGs from the perspective of the private sector, with only 18 percent of companies prioritizing it.While an estimated USD 174.52 billion per year is needed to fund SDG 14, barely USD 25.05 billion is spent annually indicating a funding gap of USD 149.02 billion per year. This major financial deficit does not augur well with the world's growing vulnerable population which are dependent on oceans for their livelihood. It is therefore essential for governments and organizations to focus on innovation and expansion of a Blue Economy that can provide a clear pathway toward a low-carbon sustainable future. More innovative "blue financial products" like blue bonds and loans, and blue derivative products will have to be thought of, to finance SDG14.



Blue Economy and India

India has been leading the blue economy discourse at the highest level with its geographic and geostrategic position, focusing more on the Indian Ocean region. It has the world's third largest water body, covering 70 million square kilometres with rich mineral resources and connectivity with global cities. India has a vast coastline stretched over 7,517 kilometres and 1,382 offshore islands that bring generous resources and opportunities. Most coastal regions of India are densely populated and low-lying, with around 250 million people active within a 50-kilometre range of coast. There are 486 census towns along the Indian coast, according to the Census data of 2011. Of them, 36 are classified as Class I towns that have a population of more than 100,000 persons. Twelve major ports and 239 non-major ports are located along the Indian coast. More than 1,00,000 ships are estimated to transit close to Indian coastal shores per year. The Indian coastal economy sustains over four million fishermen and coastal towns. India is the second-largest fish-producing nation in the world with a fleet of approximately 2,50,000 fishing boats. In India, shipbuilding and shipping are also important aspects of the blue economy. Schemes such as the Pradhan Mantri Matsya Sampada Yojana on sustainable fisheries, the Maritime India Vision 2030 for coastal infrastructure, and the Coastal Regulation Zone (CRZ) notification for sustainable management of coastal areas highlight how the country is building a blue economy in an environmentally conscious manner.

In Chennai, the G20 countries committed to conserving, protecting, restoring, and sustainably using the world's ocean, and marine ecosystems, making tangible progress to contribute to the 2025 UN Ocean Conference. The countries also adopted the new international legally binding instrument under the UN Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity of areas Beyond National Jurisdiction (BNJ) and called on all countries for its early entry into force and implementation. The countries also decided to support the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), within the Antarctic Treaty system, to establish a representative system of Marine Protected Areas (MPAs) in the CCAMLR Convention area based on the best available scientific evidence.

With its G-20 presidency, India has stepped up to take global leadership on the blue economy. All G-20 member countries are coastal states, together accounting for 45 percent of the world's coastline and 21 percent of Exclusive Economic Zones (EEZs). This makes the forum the leading platform to mainstream the blue economy into the global climate and development narrative. A significant percentage of vulnerable ocean-dependent communities reside in these countries. Yet it is also the next big economic frontier, with rapidly growing numerous ocean-based industries. While bringing the interests of the global south to the fore, India can accelerate adopting global principles on the blue economy, facilitating dialogues and discussions to strengthen narratives, meanings, ideas, and best practices.

Blue Economy and KIIFB

KIIFB can also contribute to the blue economy by using blue bonds to finance the sectors that come under the blue economy. Blue bonds can be used to finance several projects funded by KIIFB as well, especially the projects dealing with sustainable ocean/ marine infrastructures like the construction of groynes and other such mitigation measures, shore protection works, construction of fishing harbours, beach landing facilities, development of inland waterways etc. All this comes under the umbrella of shore protection and beach nourishment which is very much an essential component of the blue economy.

Way Forward

India's engagement in the Blue Economy is rising, as the country issues policy proposals, and actively participates in international and regional dialogues on the Blue Economy, maritime and marine cooperation. The Federation of Indian Chambers of Commerce and Industry (FICCI) published the Blue Economy Vision 2025, which states that the Blue Economy's impacts are not limited to the ocean, but are crucial for countries' food security, poverty, resilience against dangerous consequences of climate change, maritime cooperation, job opportunities and countries' socio-economic growth. The Indian Ministry of Earth Sciences plans to publish a National Policy on the Blue Economy which is still in its draft form. The proposal identifies the great contribution the Blue Economy can make to India's Gross Domestic Product. The impacts of climate change are a reality in the Indian Ocean and littoral States; the survival of the environment and communities is already compromised. Moving forward, faster and more efficient cooperation and multilateral engagements are pivotal to a resilient Blue Economy framework in the region.

Construction Scheduling Innovations in India

Ashwin Alias, Project Associate - R.P., PAD

The construction industry in India is rapidly evolving and adopting new techniques and innovations for efficient project scheduling and management. With massive infrastructure projects underway across the country, scheduling has become a crucial aspect impacting timely completion and cost control. Some of the latest scheduling techniques being deployed in India are:

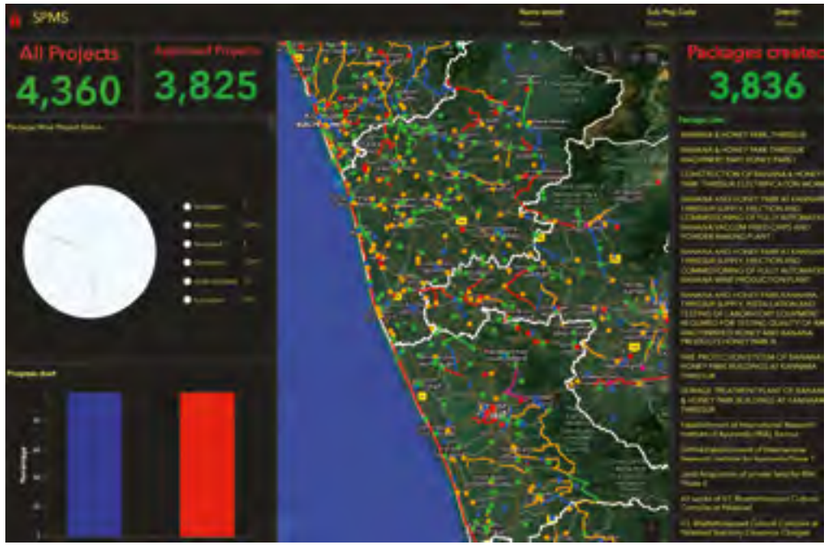
Critical Path Method (CPM) & Program Evaluation and Review Technique (PERT)

CPM and PERT are widely used scheduling techniques for large-scale construction projects in India. They allow managers to identify the sequence of project activities, critical path, and schedule activities considering dependencies and resources. CPM and PERT help optimize time and resource allocation.

Building Information Modeling (BIM)

BIM is transforming construction scheduling in India through its 3D modeling and collaboration capabilities. BIM integrates architectural and engineering data into one model that simulates the construction sequencing and detects clashes early on. This results in improved scheduling, communication, and project control.

Geographic Information Systems (GIS)



GIS technology is being leveraged to geospatially visualize construction schedules and activities. With heat maps and spatial data, GIS enables advanced location-based scheduling optimization especially for large infrastructure projects

Artificial Intelligence for Predictive Scheduling

AI and machine learning are being applied to analyze historical data and identify trends and patterns in construction projects. This enables more accurate predictive scheduling and risk analysis for future projects.

Mobile Applications

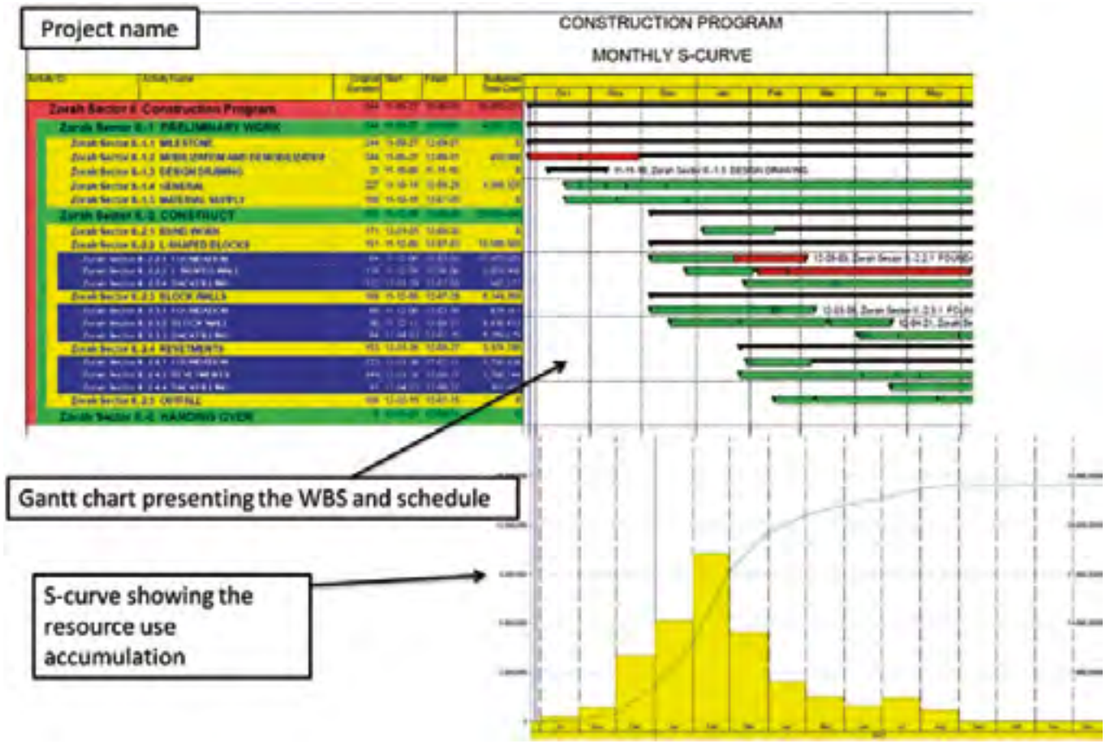
Various mobile apps (such as the KIIFB PMAS app) are being used by construction companies in India for easy on-site schedule updates, progress tracking, and workforce communication and coordination. These enhance real-time visibility and schedule control.

The adoption of these innovations is enabling construction companies to better plan, manage, and complete projects on time and within budget. Scheduling practices in India are evolving at a rapid pace in line with global best practices.

Effective Monitoring and Scheduling for Construction Projects in India

The construction industry in India is booming with large-scale infrastructure and real estate projects underway across the country. Efficient monitoring and scheduling of construction activities are essential for on-time completion and cost control of these projects. Some key considerations for construction monitoring and scheduling in India include:

Activity Monitoring: Detailed activity schedules need to be developed during planning using techniques like critical path method, Gantt charts, etc. Activities must be closely tracked on-site to identify delays and take corrective actions. Mobile apps, drones, and 360-degree cameras are being used for on-site activity monitoring.



Resource Tracking: Resource availability including materials, equipment and labor needs to be continuously monitored. Advanced techniques like RFID tagging of equipment and tools is being adopted for real-time tracking and prevent pilferages.

Analytics and Reporting: Data captured from monitoring is analyzed using BI tools to generate insights like schedule variances, resource utilization trends, etc. Custom reports and dashboards aid data-driven decision making for schedules.

Quality Monitoring: Along with progress, safety and quality compliance also need monitoring. Checklists, periodic audits, and quality management software help prevent accidents and defects that can delay projects.

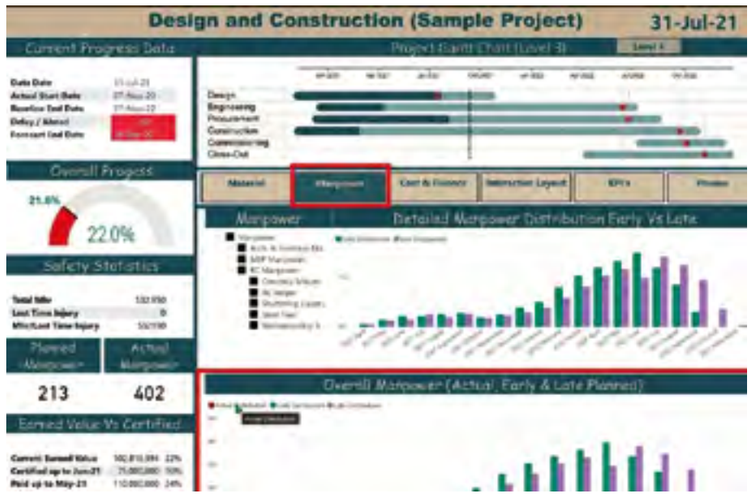
Remote Monitoring: Remote monitoring through live video feeds, aerial imagery from drones, satellite data, and sensors provides enhanced project visibility. It allows schedules to be tracked in remote areas.

Microsoft Project & PowerBi for Construction Monitoring and Scheduling

Microsoft Project and Power BI provide an integrated platform for efficient scheduling, tracking and data-driven decision making in construction projects. Here are some keyways they can be leveraged:

Activity Scheduling: Microsoft Project allows creating a Work Breakdown Structure (WBS) and scheduling of construction activities using Gantt charts. Activities can be sequenced, linked, assigned durations and resources. A realistic project schedule can be developed.

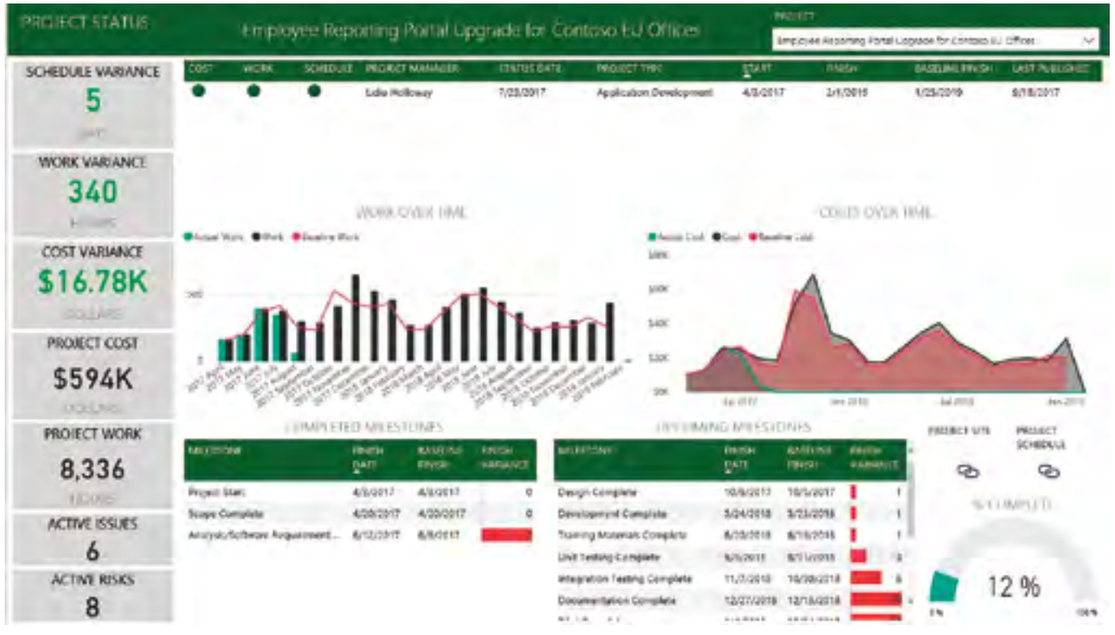
Resource Management: Resources like labor, material and equipment can be assigned to tasks and smoothed across the project timeline considering availability and budget. This ensures optimal resource allocation.



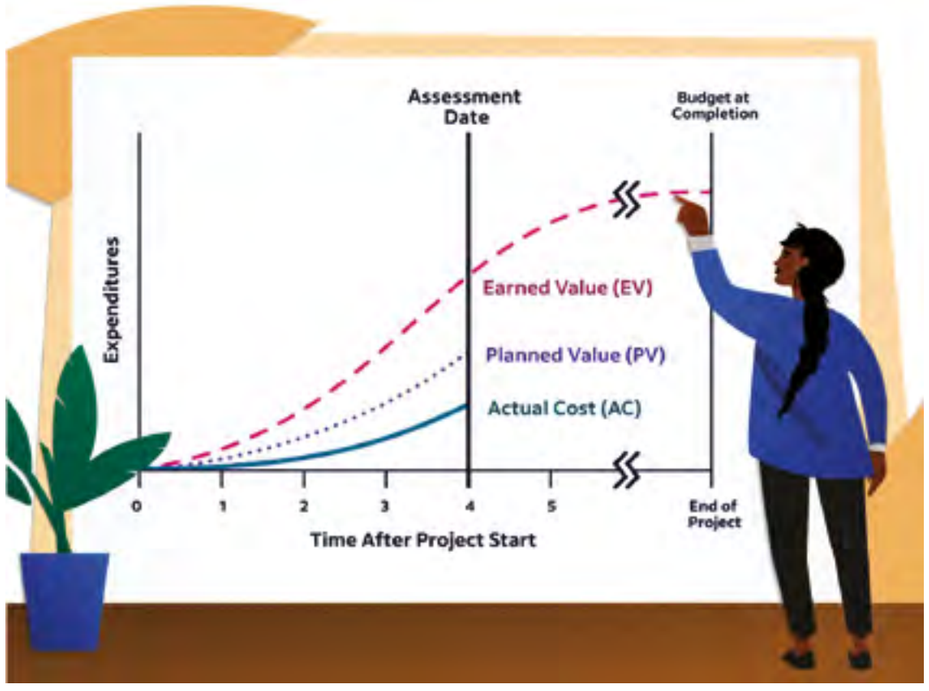
Integrating Schedules with Power BI: The project schedule developed in Microsoft Project can be imported into Power BI for advanced visualization and analytics. Power BI provides an integrated view of the schedule, resources, risks, etc.

Progress Tracking: Teams can update actual start/finish dates, percentage complete and remaining duration of tasks within Microsoft Project. This tracks progress versus baseline schedule. Metrics like schedule variance and critical path are auto updated.

Customized Dashboards: Interactive Power BI dashboards with charts, graphs and KPIs can be created to view key project metrics and schedules. These provide one-source access to project health.



Analytics for Insights: Powerful analytics in Microsoft Project provide insights like critical path analysis, earned value tracking, variance analysis etc. Dashboards and visual reports can be generated. Power BI allows deeper drill-down analytics on project data to derive insights on deviations, resource performance, bottlenecks, etc. Forecasting can also be done using AI models.



Collaboration and Integration: By using Microsoft Project Server and Power BI analytics, construction teams can collaborate for planning and scheduling in real-time. Instant schedule updates are visible across the organization. Microsoft Project integrates seamlessly with other systems like BIM models, ERP, payroll, procurement, etc. This unifies project information across platforms for comprehensive monitoring.

Forecasting: Using past data and machine learning capabilities in Microsoft Project and Power BI, future delays, risks, and project completion can be forecasted through predictive analytics.

With its robust scheduling capabilities and integration with Office 365 tools, Microsoft Project serves as an essential tool for systematic monitoring and scheduling of construction projects. It empowers informed decision making and enhances project control.

The integration of Microsoft Project and Power BI creates a powerful platform for end-to-end project scheduling, work execution, and data analysis. Hence, by leveraging digital technologies and analytics along with robust processes, construction companies in India can achieve significant improvements in monitoring and scheduling - leading to timely project delivery within budget.

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Thermal Energy storage in HVAC systems

Vaishak B, Assistant Project Co-ordinator, KIIFCON

Introduction

HVAC stands for Heating, Ventilating, and Air Conditioning, and HVAC systems are, effectively, everything from air conditioners at home to the large systems used in industrial complexes and apartment blocks. A good HVAC system aims to provide thermal control and indoor comfort to the user.

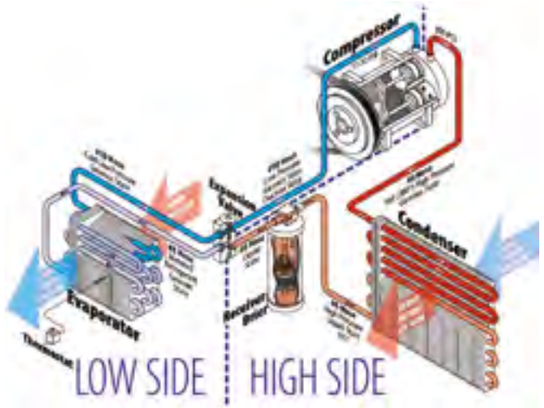


Figure 1: Over-all construction of HVAC system

Why Thermal Energy Storage (TES)?

HVAC energy consumption accounts for more than 40% of a commercial building's total energy use. This signifies the scope of energy saving possibility in HVAC systems (Figure 2 and 3). There are four major areas in which savings are directly possible:

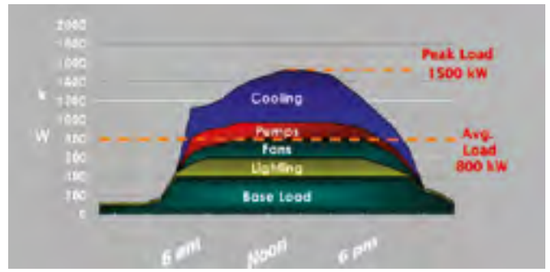


Figure 2: Electrical load in an average office.

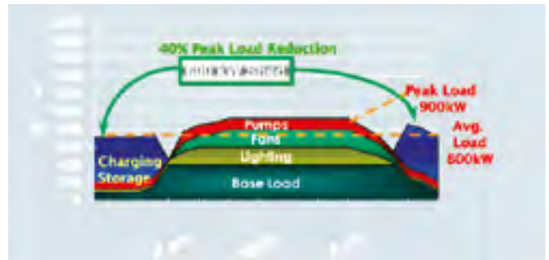


Figure 3 : Energy consumption with TES

1. Run HVAC system strategically to avoid peak demand charges.

Running multiple HVAC units at full capacity during the hottest time of the day requires a huge amount of energy, which translates into inadvertently increasing demand charges. If we know that it's going to be a hot day, we can change the operating schedule of our HVAC and cool the building down earlier in the day, reducing the amount of electricity

needed later. Regulate the amount of outside air intake to match actual occupancy levels.

In many buildings, the amount of fresh air ventilation is maintained at a constant level, usually based on peak occupancy. A demand control ventilation system regulates outside air intake to accommodate actual human occupancy and activity within the building. CO2 levels can be actively monitored and, depending on the readings, the HVAC system is then automatically directed to either reduce the outside air intake or bring in additional outside air. Such a system reduces the work for heating and cooling systems and reduces our energy consumption. We could save as much as 20% on our electricity bill with demand control ventilation.

2. Thermal Energy storage.

There's a growing interest in an alternative method of cooling called thermal energy storage (TES), which is our topic of interest. In Thermal Energy Storage system (TES) ,working substance (usually water) is cooled (or frozen) overnight and it is used later for cooling the building during the following day.

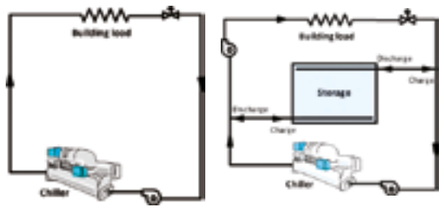


Figure 4: Space cooling system without and with Thermal Energy Storage

Figure 5: Ice based Thermal energy Storage Unit

4. Control the speed of HVAC electric motors.

HVAC systems all use electric motors, which account for a large portion of the total HVAC energy consumption in commercial buildings. That means significant savings can be had simply by operating those motors more efficiently. One way to do that is with the use of variable frequency drives (VFDs).

Thermal Energy Storage (TES): An overview

Thermal Energy Storage (TES) is like a thermal bank or a thermal battery to the Air-Conditioning systems. It is a concept that stores the energy and uses it when necessary. During the night or non-peak hours when the demand for electricity goes down, the chiller system runs at a lower capacity thus storing the surplus energy in the form of thermal energy, which can be utilized during the peak hours. The added advantage being the electricity is cheaper and adequately available during night and off-peak hours.

The types of TES systems are:

1. Ice storage:

Ice thermal storage uses the latent heat of fusion of water. Latent heat of fusion refers to the energy absorbed or released by a substance during a change in its physical state (phase) that occurs without changing its temperature during melting a solid . Storage volume is generally in the range of 2.4 to 3.3 cubic feet per ton-hour, depending on the specific ice storage technology. Thermal energy is stored in ice at 0° C, the freezing point of water

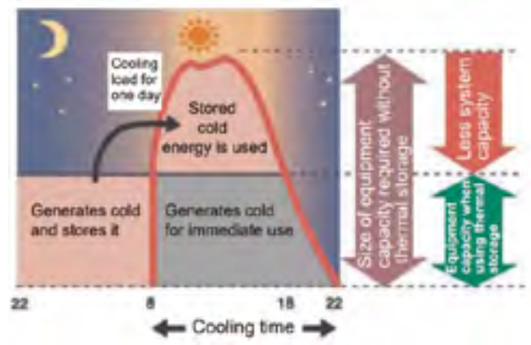


Figure 6: Cooling load comparison with and without Thermal Energy Storage

Depending on the storage technology, special ice-making equipment is used, or standard chillers are selected for low temperature duty.

The heat transfer fluid may be the refrigerant itself or a secondary coolant such as glycol with water or some other antifreeze solution. The low-temperature of ice can also provide lower temperature air for cooling.

Different ice-making strategies include:

Ice harvesting: Ice is formed on an evaporator surface and periodically released into a tank partially filled with water. Cold water is pumped from the tank to meet the cooling load. Return water is then pumped over ice in the tank. ·

External melt ice-on-coil: Ice is formed on submerged pipes or tubes through which a refrigerant or secondary fluid is circulated. Storage is discharged by circulating the water that surrounds the pipes, melting the ice from the outside.

Internal melt ice-on-coil: Ice is formed on submerged pipes or tubes, as in the external melt system. Cooling is discharged by circulating warm coolant through the pipes, melting the ice from the inside.

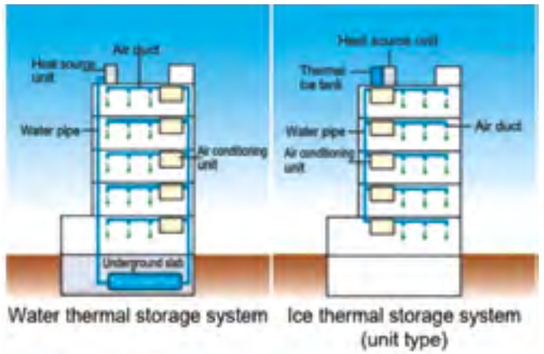


Figure 7: Diagram of water based and ice based thermal storage systems

2. Phase changing material storage:

Phase-change materials, or eutectic salts, are available to melt and freeze at selected temperatures. Most common is a mixture that stores 41 Btu per pound at its melting/freezing point of 8°C. This material is encapsulated in rectangular plastic containers, which are stacked in a storage tank through which water is circulated. The net storage volume of such a system is approximately six cubic feet per ton-hour

Impact / Advantages of TES

1. Reduction in the daytime peak power demand (power load levelling):

The levelling of power load can be achieved as the system can transfer the power used during the peak hours in the daytime to the night-time. The introduction of the heat pump/thermal storage system makes approx. 20 % reduction in the daytime peak power demand by supplying half the cold thermal energy required for the air-conditioning during the daytime from the thermal storage system.

2. Energy conservation and environmental friendliness:

The use of thermal storage tanks makes it possible to operate heat pumps efficiently at a constant rate without being affected by an ever-changing air-conditioning load. The use of the cool outside air at night for the generation of cold thermal energy when cooling is required leads to further improvement in the efficiency of the heat pumps. (The operational efficiency of the heat pump at 25 degrees is approx. 20% better than at 35 degrees.)

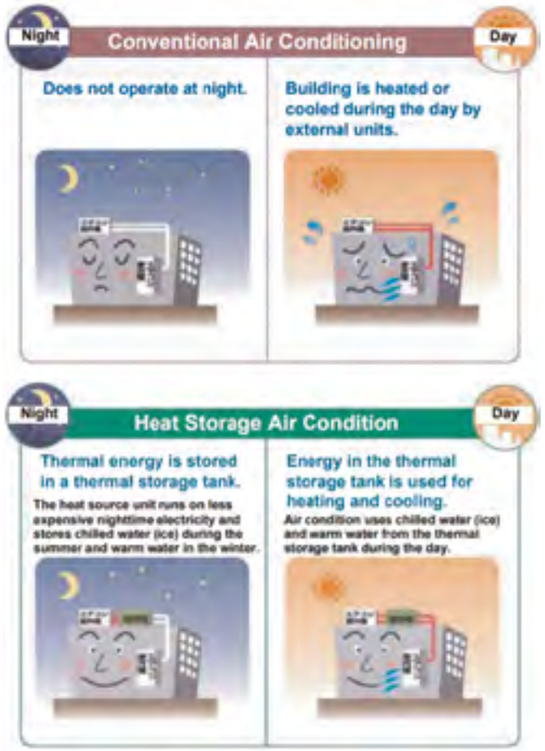


Figure 8: Pictorial representation of advantages of TES

3. Cost Saving:

As this system allows the reduction in the capacity of the heat source unit, the contract demand can be reduced. The reduction in the contract demand means the reduction in the electricity charge. This system allows the use of lower-priced night-time power.

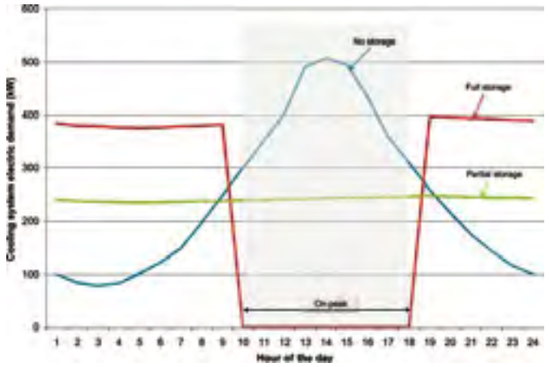


Figure 9: Electrical demand profile for building without thermal energy storage, with the full storage option, and the partial storage option.

4. As a measure of BCP (Business Continuity Plan)

The water in the thermal storage tanks can be used as domestic water or for firefighting at the time of emergency and disaster. There were cases where water in thermal storage tanks was used as domestic water in the relief effort after the Great East Japan Earthquake.

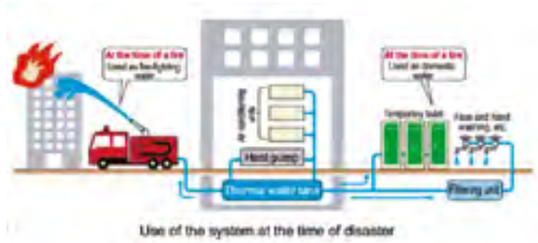


Figure 10: Water from thermal energy storage can be used in case of emergencies

Comparison of Thermal Energy Storage with other energy saving methods.

There are many ways in which energy savings are proposed using innovative energy storage ideas. The major ones in the category include pumped hydro, batteries, flywheels, and compressed air storage methods. A comparison of all these technologies is tabulated below for a quick comparison:

Energy Storage Options Costs*

Energy Storage Technology	Tech Maturity	Useful Eff (%)	Life (Yrs.)	Capital Costs ($/kWh)
Pumped Hydro	mature	70-80	40+	310-380
Na-S Batteries	mature	80	5	650-700
Lead-acid Batteries	mature	85-90	7-15	500-750
Li-Ion Batteries	new	80-90	7-10	450-1125
Flywheels	new	90	20	7800-9000
Compressed Air	demo	70-80	40+	80-150
Thermal Storage	mature	90-100+/-	50+	30-500

Thermal Energy Storage (TES) has low initial cost, high efficiency, and longer useful life

Figure 11: Table comparing different energy storage methods

A general cost comparison of the technology is also given below for a quick cost comparison, both in terms of installation and operational expense.

	Equip	Hours of discharge	Impact Output	kWh per day	Installed cost	Cost / kW	Cost / kWh
Ice Storage	Qty-1 Ice Tank	1 Ice Tank discharging over 6 hrs.	18 kW Cooling	108	$22,000 $7,000	$1,222 / kW $ 388/ kW	$ 203 / kWh $ 64 / kWh
Battery	Qty. 6 18 kWh Batteries	6 Batteries discharging over 6 hrs.	18 kW Electron	108	$100,000	$5,600 / kW	$925 / kWh
Battery	Qty-3 18 kWh Batteries	3 Batteries discharging over 3 hrs.	18 kW Electron	54	$50,000	$2,800 / kW	$925/ kWh

Reinforced Soil Structures

Arjun M, Inspection Engineer, BES

INTRODUCTION

Reinforced soil structures represent a pivotal innovation in modern civil engineering, providing a dynamic and sustainable approach to tackle diverse geotechnical challenges. These structures, designed to withstand lateral pressures, retain earth, stabilize slopes, and support heavy loads, have revolutionized construction methodologies by harnessing the synergy between soil mechanics and advanced materials.

At the core of this engineering innovation lies the integration of reinforcing materials, such as geogrids and geotextiles, within the soil matrix. This synergy aims to fortify soil masses, augmenting their strength, and bestowing upon them the capacity to withstand significant stresses and deformations.

Reinforced soil structures are one of the major developments in the civil engineering construction field. Nowadays they are used for replacements of reinforced concrete structures, sheet pile walls, and other slope stabilization methods. These structures are easy to construct compared to rigid retaining walls. Right-of-way savings can be significant in urban areas compared to embankments with free slopes. One remarkable quality of reinforced soil structures is their higher level of flexibility and higher capability to tolerate differential settlement. Reinforced soil structures shall be different types of facias like concrete panel facia, segmental block facia, gabion facia, or vegetated facia. The use of vegetated facings of Reinforced soil slopes blends with the natural environment and gives an ecofriendly structure with significant carbon footprint reduction.

WHAT ARE REINFORCED SOIL STRUCTURES?

A reinforced soil structure is a construction technique that utilizes various materials to reinforce and stabilize soil, enabling it to support structural loads or retain the earth. These structures are commonly used in civil engineering for retaining walls, embankments, bridge abutments, and slope stabilization. The reinforcement materials, such as geogrids or geotextiles, are integrated within the soil mass to improve its strength and stability.

Key components and considerations of reinforced soil structures include:

- Reinforcement Materials: Geogrids, geotextiles, or other geosynthetic materials are used to reinforce the soil. These materials are placed in layers within the soil to enhance its tensile strength and distribute forces.
- Soil Selection and Preparation: Proper selection of soil and its preparation through compaction and grading are crucial. The soil must have suitable properties to ensure stability and load-bearing capacity.
- Layering and Construction: The construction process involves layering the soil with the reinforcement material at specified intervals or depths. Each layer is compacted to form a stable structure. Different construction techniques may be used depending on the specific application.
- Design Factors: Engineers consider several factors during the design phase, such as the type and magnitude of loads, soil characteristics, site conditions, and environmental factors. The design accounts for the intended purpose of the structure, its dimensions, and the desired lifespan.
- Drainage and Water Management: Adequate drainage behind the reinforced soil structure is critical to prevent water buildup, which could compromise stability. Drainage systems like weep holes, perforated pipes, or geocomposite drains are incorporated into the design.
- Monitoring and Maintenance: Regular inspections and maintenance are necessary to ensure the continued effectiveness of the reinforced soil structure. Monitoring helps detect any signs of degradation, settlement, or other issues that might affect its stability over time.

Reinforced soil structures offer advantages such as cost-effectiveness, versatility in design, and adaptability to various soil conditions. They provide sustainable solutions for stabilizing slopes, retaining earth, and supporting structural loads while being more flexible than traditional concrete structures. Proper design, construction, and maintenance are essential to ensure the long-term stability and functionality of these structures.

CLASSIFICATION OF REINFORCED SOIL WALLS BASED ON FACIA

In a reinforced soil structure, the term “fascia” typically refers to the facing or surface treatment applied to the exposed side of the structure. The fascia serves multiple purposes, including aesthetics, protection, and in some cases, enhancing structural integrity.

➢ Soft facia

In some environmentally conscious projects, vegetation or planting can be incorporated as the fascia, providing a green cover and additional erosion control benefits.

➢ Stone facia

➢ Concrete facia

These can provide a durable and visually appealing finish while offering structural support to the facing system.

- Ideal within city limits
- Where there is a space constrain
- Where stones are scarce, and vegetation is difficult to develop

❖ Segmental Blocks: Interlocking concrete blocks or stone masonry units can be used as facing elements, providing both structural integrity and aesthetic appeal.

The choice of fascia material depends on factors such as the intended use, site conditions, design requirements, and aesthetic preferences. Proper installation and integration of the fascia are crucial to ensuring its effectiveness in protecting and enhancing the reinforced soil structure's overall performance.

REINFORCING ELEMENTS

Reinforced soil structures rely on various reinforcing elements to enhance the stability and strength of the soil mass. These elements are strategically placed within the soil layers to improve its load-bearing capacity and resistance against lateral forces. The primary reinforcing elements used in these structures include:

Geogrids: Geogrids are high-strength polymer materials, typically in grid-like configurations. These elements are placed within compacted soil layers and act as tension members, distributing forces and improving the soil's tensile strength. They prevent soil movement and help create a stable composite structure.

Geotextiles: Geotextiles are woven, or non-woven fabrics made of synthetic materials. While not as load-bearing as geogrids, geotextiles serve various purposes. They're used for separation between different soil layers, filtration to prevent fine particles from clogging drainage paths, and erosion control on exposed surfaces.

Geocomposites: These are combinations of different geosynthetic materials, often engineered to provide multiple functions. Geocomposites may integrate geogrids, geotextiles, or other elements to offer enhanced reinforcement, filtration, drainage, or protection in a single product.

Reinforced Bars or Strips: In some specialized applications, metallic or fiberglass bars or strips can be used as additional reinforcing elements. These

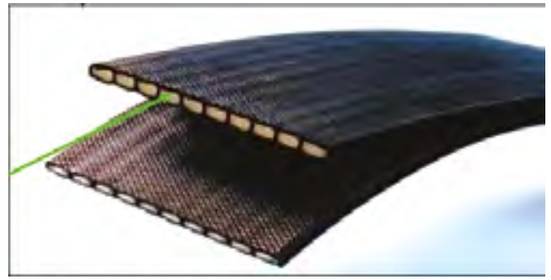
materials provide high tensile strength and are used in scenarios where specific engineering requirements demand greater reinforcement like aluminium alloy strip, copper strip, carbon steel strip, galvanised steel strip, stainless steel strip, ladder.

The choice of reinforcing elements depends on several factors, including the engineering design, soil properties, intended purpose of the structure, and environmental considerations. The elements work collectively to improve the soil's overall stability, prevent deformation, and increase its ability to withstand external loads.

Proper selection and installation of these reinforcing elements are crucial to ensure the effectiveness and longevity of reinforced soil structures. Engineering expertise and adherence to design specifications play vital roles in integrating these elements within the soil mass to create durable and reliable structures capable of withstanding various geotechnical challenges.

Geo Strip as reinforcement

Geotextiles are synthetic materials used in construction for various purposes like soil stabilization, filtration, drainage, and erosion control. Geotextile strips are pieces or strips of this fabric used in specific applications, such as reinforcing soil, separating different soil layers, or providing drainage paths in embankments or retaining walls.



Properties:

- o Polyester tendons encased in Polyethylene sheath.
- o In general, 10 group of strands of high strength polyester.
- o Width of 30kN strip is 85mm rest other are 90mm wide.
- o Strength 30kN, 40kN, 50kN, 60kN, 75 kN, 85kN and 100 kN

Points to Remember:

- Check the grade of Geostrip reinforcement before laying.
- Laying should always begin from the rear end of reinforcement length.
- The lap should always be at the rear end of reinforcement length.
- Tolerance: Reinforcement placement elevation: 25mm of connection elevation.

THE FILL MATERIAL

In reinforced soil slopes, the fill material used as the reinforcing fill plays a crucial role in providing stability and structural support. The choice of fill material depends on various factors such as the specific engineering requirements, site conditions, and the

intended purpose of the slope.

The fill material used as the reinforcing fill in the Reinforced soil slope shall meet section 3100 of MoRTH. The fill material must be free of organic matter and other deleterious substances. Such deleterious materials generally result in poor performance of the structure and enhance the degradation of reinforcement. Normally, reinforced soil structures are not designed for hydrostatic pressures on the assumption that the structural fill and facia are free draining, and drainage accessories like chimney drain will be provided. However, where the fill material has high plasticity index values then additional drainage arrangements are mandatory. Wherever hydrostatic pressure due to submergence may be developed, such pressures need to be considered, A chimney gravel drain of a minimum 600 mm width is provided with two geotextile filters on either side to satisfy the permittivity criteria, retention criteria, and clogging criteria. Alternatively, drainage Geocomposite may be used as specified in IRC SP 59, IRC 34, and MoRTH session 700 as a single composite product replacing 600 mm gravel provided that it is designed for drainage criteria hydraulic design criteria, and mechanical strength criteria.

Gradation	Sieve Size	Percent Passing
	75mm	100
	0.425mm	0-60
	0.075mm	<15
Plasticity Index (%)	≤ 6	
Angle of internal friction (degree)	≥30	

Construction of a reinforced soil structure is considerably simple but needs to adhere to some basic quality adherence requirements. The reinforcement layers can be easily incorporated between the compacted lifts of structural fill. A vibratory roller of 10 tons capacity is used for compacting the main structural fill to make it a 200 mm layer with 95% proctor density.

- Advisable to use granular fill material with fines (% passing 75 micron) less than 15%.
- When two different fill materials are to be used for reinforced and retained fill, some specifications should be provided in the technical specifications for retained fill.
- The design of reinforced soil wall also depends on characteristics of retained fill material as well.
- Flyash or any other mechanically stabilized soil can also be used as fill material.

Some common types of fill materials used in reinforced soil slopes include:

Granular Materials: This category includes materials like gravel, crushed stone, sand, or crushed rock. Granular materials are often preferred for their good drainage properties and ability to compact well, contributing to stability and load-bearing capacity.

Cohesive Soils: Such as clay or silt, which, when properly compacted, can provide adequate strength and stability. However, cohesive soils might require careful compaction and drainage considerations to prevent issues related to water retention and swelling.

Engineered Fill Materials: These materials are specifically designed or modified to meet engineering specifications. They could be mixtures of various soil types, stabilized soils, or synthetic materials engineered to provide optimal strength and stability.

The chosen fill material should possess certain characteristics for use in reinforced soil slopes:

Adequate Compaction: The fill material should be capable of being compacted to the required density to Adequate Compaction: ensure stability and prevent settlement.

Drainage: Good drainage properties are essential to prevent water buildup behind the reinforced slope, which can compromise its stability over time.

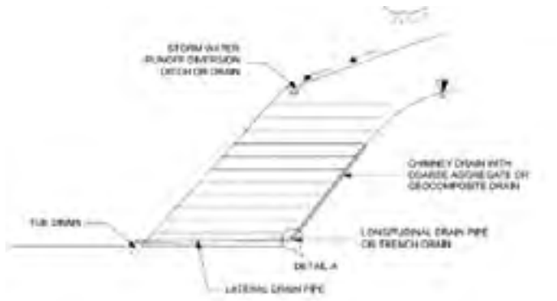
Compatibility: The fill material should be compatible with the reinforcement used (geogrids or geotextiles) to ensure proper interaction and load distribution.

Structural Integrity: The material should maintain its structural integrity under the anticipated loads and environmental conditions.

The selection of the appropriate fill material involves careful consideration of these factors along with engineering assessments to ensure the long-term stability and performance of the reinforced soil slope. Additionally, the compaction methods, placement techniques, and quality control measures during construction are critical to achieving the desired strength and stability of the reinforced soil slope.

FILTER MEDIA

- ❖ The filter media should be checked as per QA plan.
- ❖ The compaction of filter media should be carried out with a vibratory plate compactor or vibro-tamper.
- ❖ The width of the filter media should be consistent



Parameters required for drainage design

- Determination of Rainfall data (IRC-SP-042)
- Determination of Catchment Area (IRC-SP-042)
- Determination of peak runoff (Hydrological Study)
- Hydraulic Design (IRC-SP-042)
- Location of Culverts, Catch drain & Chute drain

REINFORCED SOIL WALL-DESIGN

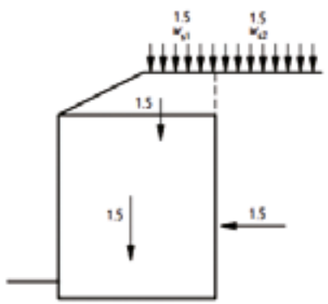
Step 1. Establish Geometric, Loading, and Performance requirements for design

Step 2. Determine the engineering properties of the in-situ soils

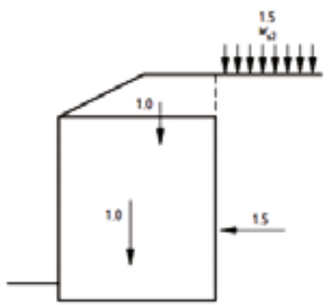
Step 3. Determine the properties of reinforced fill

LOAD COMBINATIONS

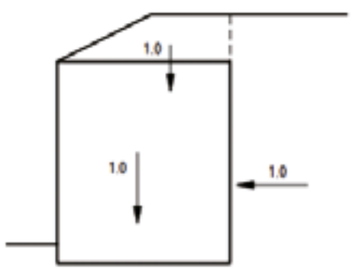
- Load Combination A: will govern the reinforcement tension and the bearing capacity
- Load Combination B: will govern the reinforcement pull-out, sliding along the base and overturning
- Load Combination C: will govern the Serviceability Limit States (settlement and admissible post contraction deformations)



a) External and internal stability



b) External and internal stability



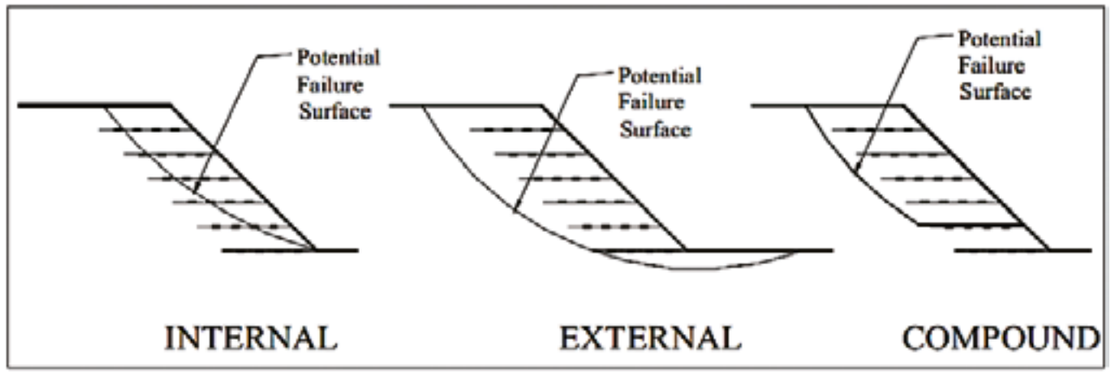
c) Settlement and serviceability

METHOD OF ANALYSIS

- Ultimate Limit State: external and internal stability
- Serviceability Limit State: settlement and deformations
- Partial Factors approach: Loads Factors (Load Combinations), Material Factors and Interaction Factors

REINFORCED SOIL SLOPE-FAILURE MODES

- Internal, where the failure plane passes through the reinforcing elements.
- External, where the failure surface passes behind and underneath the reinforced zone.
- Compound, where the failure surface passes behind and through the reinforced soil zone.



CONSTRUCTION PROCESS

The construction process of a reinforced soil structure involves several key steps that are essential to ensure its stability, durability, and load-bearing capacity. Here's a comprehensive overview of the construction process:

1. Site Preparation and Excavation:

- Clearing and grading the construction site to create a level and stable foundation for the structure.
- Excavating the area to the specified depth and dimensions required for the reinforced soil structure.

2. Selection and Preparation of Reinforcement Materials:

- Choosing appropriate reinforcement materials such as geogrids, geotextiles, or other geosynthetics based on engineering specifications and site requirements.
- Preparing these materials by cutting them to the necessary sizes and configurations as per the design plan.

3. Layering and Compaction:

- Layering the soil and reinforcement materials in a systematic manner as outlined in the construction plans.
- Proper compaction of each soil layer to achieve the desired density and stability. Compaction ensures good contact between soil particles and the reinforcement material.

4. Embedding Reinforcements:

- Installing the reinforcement materials (geogrids or geotextiles) at specified depths or intervals within the compacted soil layers.
- Ensuring proper alignment and overlap of the reinforcement layers to provide structural integrity and load distribution.

5. Backfilling and Compaction:

- Gradually backfilling the area behind the reinforced soil structure while compacting the soil in layers to the recommended density.
- Compaction of the backfilled soil ensures uniform support and reduces the risk of settlement.

6. Drainage Installation:

- Incorporating drainage systems, such as weep holes, drainage pipes, or geocomposite drains, to manage water buildup behind the structure. Adequate drainage prevents hydrostatic pressure that could compromise the stability of the structure.

7. Surface Finish and Protection:

- Depending on the application, applying a surface finish or protection layer to enhance the aesthetics, weather resistance, or erosion control of the reinforced soil structure.

8. Quality Control and Inspection:

- Conducting quality control checks throughout the construction process to ensure compliance with design specifications, proper compaction, and correct installation of reinforcement materials.
- Regular inspection and monitoring to identify any issues that may affect the structure's stability or performance.

9. Documentation and Maintenance:

- Documenting the construction process, including materials used, construction methodologies, and any deviations from the original plans.
- Implementing a maintenance plan that includes periodic inspections and necessary repairs to uphold the structural integrity of the reinforced soil structure over its lifespan.

Each phase of the construction process of a reinforced soil structure demands precision, adherence to design specifications, and thorough quality control measures to create a stable and long-lasting engineering solution.

CONSTRUCTION ISSUES

❖ Non – Uniform Gap Between the Panels

❖ Improper Fill Material

❖ Improper Fill Material

CONCLUSION

In the realm of civil engineering, reinforced soil structures stand as a testament to innovation and adaptability, offering multifaceted solutions to diverse geotechnical challenges. From the strategic integration of geosynthetics to the meticulous layering and compaction techniques, the construction process unfolds as a testament to engineering ingenuity.

Reinforced soil structures offer sustainable alternatives to traditional construction methods, exhibiting adaptability, cost-efficiency, and reliability. Understanding the core principles and considerations in design, construction, and maintenance is vital to ensuring the long-term stability and effectiveness of these engineered systems.

In a nutshell, reinforced soil structures are like superheroes in construction, using special materials to make the ground stronger. These structures help hold back soil, support big things like roads or walls, and stop erosion. They're smart because they use things like strong fabrics or grids to make the soil really tough. These structures are like a team effort between the ground and these special materials, making everything stronger and safer. As they keep getting better, they're becoming the go-to solution for building things that last a long, long time.

Technical Talks in KERALEEYAM –2023

SARANYA S KUMAR, Project Assistant, TIW

Keraleeyam, the biggest celebration of Kerala was held in Trivandrum, from November 1st to November 7th, 2023. The Kerala government organized Keraleeyam with the goal of showcasing Kerala's development, accomplishments, and cultural legacy to the global community. Keraleeyam presented the 'Best of Kerala' through lectures, events, fairs, festivals, exhibitions, and shows at more than 40 locations. KIIFB held a technical exposition at their office complex that highlighted some of the State's largest projects funded by KIIFB. Technical seminars were held on several significant advancements in construction technologies for students at engineering college, engineering graduates, and the general public.

A brief summary of the technical talks held are listed below:

1. "Vizhinjam port- A Game Changer"

By Dr. Jayakumar, CEO, Vizhinjam International Seaport Ltd.

Vizhinjam International Seaport Limited (VISL), which is carrying out the nation's deep-water container transshipment port project in Vizhinjam near Thiruvananthapuram, is led by Dr. Jayakumar as its CEO and Director. The future port, which is slated to open in 2024, will revolutionize the development of India's marine potential due to its advantageous position, inherent benefits, and reliance on foreign ports for the transshipment of containers. Dr. Jayakumar had a key role in the planning, design, project structure, and implementation of the future port at Vizhinjam while serving as the company's first CEO in 2004. In addition, Dr. Jayakumar is a Kerala Maritime Board member. Before that, from 2007 to 2016, he served as the CEO of Pondicherry Port and Special Economic Zone.

In his technical talk, Dr. Jayakumar pointed out that India will join the transshipment club through Vizhinjam Port, which it had not done before, despite growing trade with other countries. A transshipment port is an essential hub where cargo is moved from a large ship to several smaller ones for onward unloading.

The port is being developed in three phases and is the first Deep Water Transshipment Terminal in India and it is India's first automated seaport. There is no littoral sedimentation in Vizhinjam. With a natural depth of eighteen meters (59 feet), the construction requires little to no dredging.

Public-private partnership (PPP) funding is being provided by the Kerala Government, Government of India, and the developer, Adani Ports Private Limited, for the construction of the Vizhinjam port. In actuality, the Indian government is providing viability gap funding for the first greenfield port project.

65 percent of the project has been completed according to the most recent assessment. There has been about 68 percent progress made on the 2,960-meter breakwater construction project. The construction of the berth has advanced by 82 percent while dredging and reclamation stand at around 68 percent.

2. "Innovative Method in Coastal Protection Works"

By Dr V Sundar, Prof Ocean Engineering IITM, Chennai

Dr. V. Sundar is working as an advisor since June 2023 after serving as a Professor in the Department of Ocean Engineering at IIT Madras from June 2018 to June 2023. He is the recipient of ten prestigious honors from the scientific community, including an honorary doctorate from the University of Wuppertal in Germany. From 2007 to 2011, he chaired the International Association of Hydro Environmental Research's (IAHR) Asia Pacific division.

During his talk, he described how coastal protection operates. Hard constructions like groynes, breakwaters, and revetments are frequently used for coastal protection. Due to high waves during the southwest monsoon, Kerala's densely populated coastal zones suffer from severe beach and coastal erosion. Consequently, dynamic levels of wave refraction have been occurring alongside continuous erosion and accretion. The coastal management works aim to lessen the likelihood of flooding by reducing erosion, absorbing wave energy, and building wave-restraining barriers. This is crucial to safeguard against more frequent and powerful storms due to climate change and rising sea levels. detached seawalls, offshore reefs, groynes, seawalls, and revetments, etc. Innovative techniques include artificial reef balls, stone-filled gabions, sand-filled Geotextile tubes, containers, bags, and mats.

3. "Innovative Planning, Design & Construction of a Cable Stayed Bridge in Delhi."

By Shri Jose Kurian, Rtd. CE, CPWD

Shri. Jose Kurian has led a distinguished career in civil engineering and infrastructure development. He served as an officer in the Central Engineering Services and retired from the Central Public Works Department as a Chief Engineer.

His talk was about a Signature Bridge, i.e., a cantilever span cable-stayed bridge that connects Wazirabad and East Delhi by spanning the Yamuna at the Shourya section. It's the first asymmetric cable-stayed bridge in India. With a viewing box that reaches 154 meters and serves as a selfie spot for tourists, the Signature bridge's pylon is the highest building in Delhi and twice as tall as Qutub Minar.

The bridge is a Cantilever span cable-stayed bridge, a type of Cable-stayed bridge in which cables are in a combination of radial and semi-harp arrangement; cables are spaced apart on the pylon, like the harp design, but connected to one point or a number of closely spaced points on the deck. The dynamically shaped pylon consists of inclined columns, which are rigidly connected to the driving lanes and bend mid-way. The self-weight of the pylon balances the self-weight of the superstructure through the eccentric location of its center of gravity with respect to the pivot point of the pylon footing, reducing the load on the back-stay cables, which are fewer in number and converged from the main-span cables. The upper portion of the pylon anchors both the main-span and back-stay cables. The span is 35.2 meters wide and 675 meters long. This bridge, which spans the Yamuna River, links Wazirabad and east Delhi. Travelers can be taken to the 154-meter summit of the main pillar, which offers views over North Delhi in the distance.

4. "Sustainable Technologies for Road Development. "

By Dr. Samson Mathew, Director, NATPAC

Dr. Samson Mathew earned his M. Tech. and Ph.D. from the University of Calicut after completing his B. Tech. at the University of Kerala. In 1994, he was given the Young Scientist Award. He began working as a professor in the Department of Civil Engineering at Regional Engineering College, Tiruchirappalli in 1994. On deputation from NIT Tiruchirappalli, Dr. Samson Mathew is the director of KSCSTE's National Tratransportation Planning and Research Centre (NATPAC), an R&D facility of the Kerala State Council for Science, Technology, and Environment (KSCSTE). At NIT Tiruchirappalli, he previously held the positions of Dean (Students Welfare), Dean (Institute Development) (i/c), and Dean (Planning and Development) (i/c).

He discussed materials that come from the earth and are renewable, like sand, stone, gravel, and clay, are needed to build a sustainable road. Additionally,

materials from plants or animals, like bark or wood chips, can be used. The term "green roads" describes paved streets made of recycled or environmentally friendly materials. Reducing the detrimental effects of road construction on the environment is the goal of constructing such roads. Unheated mineral aggregate is combined with additional emulsified or foamed bitumen to create cold asphalt mix. Cold asphalt mix is less expensive and emits less pollution than hot mix asphalt (HMA) since it doesn't require heating the aggregate.

Also stated by the presenter "A pavement rehabilitation technique in which the full flexible pavement section and a predetermined portion of the underlying materials are uniformly crushed, pulverized, or blended, resulting in a stabilized base course." Full-depth reclamation (FDR) is an effective way to repair these pavements. The process of pulverizing all layers of existing asphalt pavements in place to a depth of up to 20 inches is known as Full-Depth Reclamation (FDR). FDR's appeal has increased in tandem with equipment advancements and increased recycling initiatives.

5. "Usage of Coir Geo-textiles for Soil Stabilization. "

Dr. K. Balan, Rtd. Prof, CET, Trivandrum

Dr. K. Balan was formerly professor at College of Engineering in Trivandrum, Former director of the APJ Abdul Kalam Technological University in Trivandrum's Center for Engineering Research and Development (CERD), The National Coir Research & Management Institute's (NCRMI) founding director Trivandrum Former R&D Manager, Alyaf Industrial Co. (Geosynthetics Manufacturing Co.), KSA; Former Managing Director, Kerala State Coir Corporation Ltd., Alleppey.

He explained about, the role of geosynthetics in stabilizing soil. Geosynthetics with two different mechanisms are used to stabilize roads over time, both paved and unpaved. The individual stones are "seated" in the first mechanism when aggregate is compacted over a geosynthetic, leaving imprints in the subgrade and the geotextile. Geotextiles made of coir shield the ground and encourage rapid vegetation growth. Geotextiles are available in woven and non-woven forms, are an amazing resource for naturally occurring blankets that control erosion and are eco-friendly. Geotextiles, which are entirely biodegradable, support soil stabilization and vegetation renewal on different slopes.

Made from coir yarn, coir geotextiles are entirely natural and biodegradable textiles. They are extensively employed in geotechnical engineering and landscaping to reduce soil erosion and encourage vegetation. In actuality, coir yarn is woven into the fabric to create geotextiles. Coconut fiber, which is entirely natural, is used to make coir yarn.

He summarized by stating that: Biodegradation of the geotextiles can be effectively used to achieve the project life; their potential applications in non-critical civil engineering applications are established; and geosynthetics with natural fibers like jute and coir are abundant in India. Widespread use in the nation of origin will boost end users' trust abroad.

6. "Opportunities for next 10 years for Engineers. "

By Dr. Kuncheria P Isaac, Founder VC of KTU.

In addition to serving as the vice chancellor of A.P.J. Abdul Kalam Technological University (formerly Kerala Technological University), Prof. (Dr.) Kuncheria P. Isaac was also the Director of technical education for the government of Kerala and a member secretary of the All-India Council for Technical Education. Later on, he served as the Hindustan Institute of Technology and Science's (HITS) third Vice Chancellor in Chennai.

He contributed to the production of M-Sand, a substitute for river sand. He discussed the opportunities for engineers in the upcoming decade in his presentation and also gaining new abilities is crucial because it enables you to hone characteristics that are essential for productive work output.

Artificial intelligence (AI), which is the intelligence of machines or software as opposed to the intelligence of humans or animals, was a crucial topic of discussion. Additionally, computer science research in this area focuses on creating and studying intelligent machines. Additionally, he discussed computational technology, simulation and modeling technologies, display and user interface technologies.

He has emphasized the challenges for the engineering fraternity in the upcoming world and emphasized the digital and soft skills which engineers should acquire to be competitive.

The distinguished speakers delivered excellent sessions where they offered their knowledge and insights into their respective fields. The attendees found the technical session to be very beneficial and they gained knowledge from the event. The technical session covered a variety of topics that are very much pertinent to the current and future engineering field.

INNOVATIVE APPROACH ON PROTECTING KERALA COAST - Geotube Offshore Breakwaters

P.I. Sheik Pareeth, Managing Director KSCADC

Coastal erosion poses a formidable environmental challenge along the enchanting coastline of Kerala, a southwestern state in India. This recurrent issue, shaped by a confluence of natural processes and human activities, reverberates across the state's environment, economy, and the well-being of coastal communities.

The picturesque coastal areas of Kerala are grappling with an alarming surge in coastline erosion, a trend attributed primarily to the intensification of strong storms and altered weather patterns. The implications are profound, affecting the state's environment and economy and significantly impacting the safety and livelihoods of coastal residents.

The current practice of installing coastal defence structures like rock fills, revetments, groins, etc. has transformed the naturally dynamic, erosive, and depositional soft shore coastlines into artificially static hard-substrates. Presently, the installation of coastal protection structures is on the rise along the Indian coast. Physical impacts on the adjacent shorelines due to the presence of these structures are high. It is inevitable for these structures to create ecological changes also in the vicinity due to the introduction of materials alien to the area. The consequence of shoreline armoring in the marine environment includes destruction of the existing shoreline habitat and introduction of novel habitat; the effects of which have only recently received attention.

In recent years, severe storms, particularly the Okhi cyclones and recurrent low- pressure systems, have become the chief catalysts of coastal erosion in Kerala. Unfolding between October and April, these extreme weather events, coupled with towering waves, disrupt the natural beach development process, exacerbating the erosion challenge. This growing menace has prompted serious concerns among both the government and coastal communities regarding the future well-being of their coastal regions. The Okhi tragedy of 2018 served as a stark reminder of the threat posed by unnatural sea attacks, prompting the government to investigate the risks associated with coastal erosion and sea incursion. Recognizing the urgency of finding a lasting solution, the state government, in collaboration with the Fisheries department, embarked on a

project based on recommendations derived from a model study conducted by the National Institute of Ocean Technology (NIOT) in Chennai.

Despite encountering delays in project initiation and contractor selection, the Offshore Breakwater Project garnered widespread support and optimism from the local fishing community and coastal residents. Traditional methods of coastal protection, such as rock barriers, have raised environmental concerns and resource depletion issues. In response, the innovative use of Geotube segments is gaining traction as a more sustainable coastal protection solution.

The Poonthura Valiyathura area in the Thiruvananthapuram district stands out as one of the most severely affected regions, grappling incessantly with coastal erosion and sea-level rise. Conventional methods, including sea walls, have proven insufficient against persistent sea attacks, leading to recurrent expenses for rebuilding and rehabilitating affected communities. The resulting loss of employment opportunities for fishermen further compounds the challenges faced by this beleaguered area. The Offshore Breakwater Project, with its innovative approach, aims to provide a long-term solution, offering hope and resilience to the communities on Kerala's vulnerable coastline.

Houses lost due to sea attack in Poonthura area

In areas experiencing continuous loss of shorelines, it becomes imperative to explore and implement techniques for shoreline restoration and maintenance. The Geotube Offshore Breakwater Coastal Protection Project at Poonthura emerges as a pioneering initiative, exemplifying a forward-thinking strategy to mitigate the challenges of shoreline erosion and circumvent traditional quarrying operations.

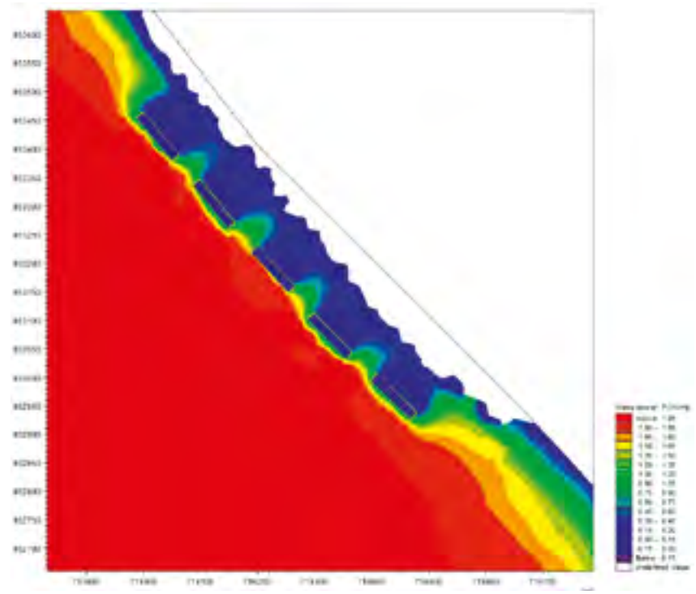
Recognizing the urgency of coastal protection, the State Government allocated Rs. 150 crores on July 4, 2018, through the Kerala Infrastructure Investment Fund Board (KIIFB) for an offshore breakwater using Geotube technology from Poonthura to Valiyathura. Entrusted to the Kerala State Coastal Area Development Corporation, the project aimed to safeguard the coastline while enhancing its usability for fishermen and tourists.

Typical Pattern of Beach formation

The innovative use of geotubes in the project minimizes constructions along the coastline. Strategically placed offshore, these geotubes act as an effective barrier, diminishing the strength of oncoming sea waves. The result is a gentler wave action depositing sand particles onto the shore, creating a stable and usable beach. This environmentally friendly approach benefits both local fishermen and tourists, presenting a holistic solution to coastal protection.

After a meticulous review, the government made significant advancements in the Poonthura coastal protection project. On September 6, 2019, as per an official order, the decision was made to initiate a pilot project, implementing 700 meters of coastal protection in the Poonthura area as an innovative endeavor. An allocation of Rs 20.78 crore was approved for the preliminary phase of this ambitious project, secured from the Kerala Infrastructure Investment Fund Board (KIIFB). The government then proceeded to invite pre-qualification tenders for the project's execution. The work was awarded to a Mumbai based Firm M/s DVP GCC.

The coastal protection initiative in Poonthura marks a substantial departure from traditional methods reliant on diverse rock formations. This groundbreaking project introduces an innovative and sustainable approach that entirely circumvents the use of rocks. As outlined in the NIOT study, the project outlines a meticulous plan. Three layers of geotubes, each with a circumference of 15 meters, are slated for placement on the 6-meter-deep seabed, running parallel to the shore at a distance ranging from 80 to 120 meters. The installation comprises five units, each breakwater unit spanning 100 meters with a fixed distance of 50 meters between them. The surface of the geotube breakwater serves as a formidable barrier, strategically designed to diminish the force of large waves approaching the coastline. This innovative design not only mitigates the risk of coastal erosion but also facilitates the accumulation of additional sand between the existing coast and the offshore breaker, fostering the development of a broader beach. In a holistic approach, the project envisions further enhancing beach nourishment by contemplating the pumping of sand from the deep sea to the coast, ensuring a sustainable and replenished shoreline.

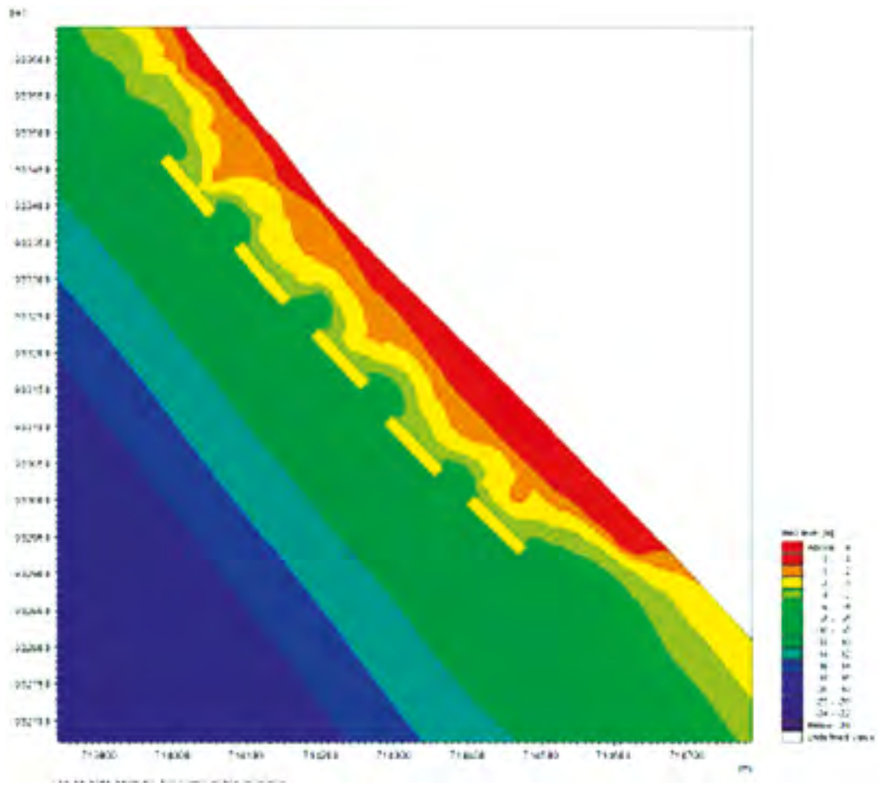


Reduction Patterns of Wave Power

The predominant wave direction at this coast is West/Southwest (WSW). When waves from these directions encounter the breakwater system, they can propagate only through the gaps. This causes a lateral movement of wave crusts, called diffraction. There will be a formation of a distinctive circular pattern of flow. This is the characteristics behavior of an offshore breakwater. The circular pattern of currents will ensure that the sediments mobilized behind the gaps in the submerged breakwater system will be captured and deposited directly behind the segment. This will lead to the formation of a beach in the form of a salient/ tombolo.

According to the salient prediction methodology given by Black and Andrew (2001), a salient formation is expected. A beach in the form of a salient shape can be clearly observed with a width ranging from 10-30 m in one year simulation results itself.

Salient formations of sediments after three year simulation



In February 2022, the Poonthura coastal protection project commenced with all necessary approvals in place. The construction phase employed cutting-edge marine machinery, including 1000-ton capacity barges, high-capacity sand pumps, 800 to 1000-ton dredgers, specialized barges, scuba diving facilities, oxygen generators, and powerful tugs. Ensuring the highest quality in construction, expert agencies meticulously inspected and procured the geotubes necessary for the project. Highlighting the global collaboration involved, the geotubes, crucial components of the project, were sourced from China, requiring special permission from the Central government. These geotubes, varying in lengths of 20 meters, 16 meters, and 12 meters, all with a circumference of 15 meters, serve as the backbone of the coastal protection structure. Notably, each geotube, when filled with sand, weight ranges from 200 to 250 tons.

The first geotube segment of 100 meters in length has already been laid.

Dredging sand offshore and grading

Geotube area converted into fish breeding area

The strategic placement of geotubes preceding the monsoon season yielded remarkable transformations in the coastal landscape behind the Offshore breakwater stretch. A noteworthy outcome was the effective prevention of wave overtopping beyond the seawall, extending roughly twice the length of the Offshore breakwater on the shore side. Notably, the resultant beach formation proved to be sustainable even amid inclement weather conditions.

Beach Formation at the shore side of Breakwater stretch

The geotube technology employed in the Poonthura coastal protection project embodies a contemporary and rigorously tested solution, demonstrating versatility that extends beyond erosion prevention to include protection from UV rays. This advanced technology has undergone meticulous analysis to ensure its harmony with marine life habitats.

The geotube breakwater, a cornerstone of the Poonthura coastal protection initiative, transcends its primary role in safeguarding the coastline. Serving as an artificial spawner, it contributes to the proliferation and survival of marine fish and other species. This dual-purpose application not only fortifies coastal resilience but also significantly enhances the well-being of the fishing community and the broader public.

Financed by the Kerala Infrastructure Investment Fund Board (KIIFB), this collaborative project is a joint endeavor between the National Institute of Ocean Technology (NIOT) and the Kerala State Coastal Area Development Corporation Limited. Beyond its immediate implementation in Poonthura, there is an active plan to assess the success of this pilot project and replicate its model in other regions susceptible to coastal threats.

During the year 2009, 28 geobags of various sizes with a volume fill of 4331 cubic meters were deployed at the southern side of the Kovalam bay by Harbour Engineering Department. These geobags were expected to protect the beach by mimicking natural reef structures. Inorder to study the impact of the human introduced structure, a pilot study was conducted to assess the faunal assemblage on natural substrate and on artificial submerged reef present in 6 m water depths off Kovalam beach.

Colonization of epibiota on artificial substrate like geotubes left a positive impact on nature and was considered as sustainable shoreline management measure. The observed epibiota developed on geotube at Kovalam was of same nature as that recorded from the adjacent rocky coast. No invasive species was recorded, indicating that there may not be any ecological damage. Also, the epibiotic faunal assemblage prevents the UV exposure of the goetube leading to the increased life span of the coastal protection structure in addition to enhancing the coastal biodiversity.

The state government's visionary coastal protection project in Poonthura stands as a pioneering milestone in Kerala's environmental initiatives. This project marks the

first of its kind in the region, representing a significant step towards sustainable coastal protection. While ongoing studies and data collection are essential to comprehensively evaluate its impact, the early success of this project holds paramount importance. This coastal protection scheme distinguishes itself by not only embodying principles of eco-friendliness and sustainability but also serving as a vital lifeline for the local fishing community. By creating stable and usable beaches, the project goes beyond safeguarding the coastline; it becomes a catalyst for the economic prosperity and well-being of the entire region. The success of this innovative initiative has the potential to serve as a model for future coastal protection endeavors, showcasing the importance of environmentally conscious solutions that benefit both communities and ecosystems alike.

INVESTMENT OPPORTUNITIES

A Project Presentation by KIIFCON in Tourism Investors Meet (TIM) 2023

Kerala's first-ever Tourism Investors Meet (TIM 2023) was inaugurated by the Hon'ble Chief Minister Shri. Pinarayi Vjayan on 16th November 2023 at Hyatt Regency, Thiruvananthapuram. Hon'ble Minister for Tourism, Shri. Mohamed Riyas, Chief Secretary, Dr. V. Venu, IAS, Secretary for Public Works Department and Tourism, Shri. K. Biju, IAS.

TIM KERALA 2023
TOURISM INVESTORS MEET
16 NOVEMBER, TRIVANDRUM

The meet was expected to : **Inspire private investors and facilitate them in the process** - Tourism has always worked on the synergies of Public and Private sector in developing products, tourism experiences, destination marketing, and more. To speed up this collaboration, the government has a plan to build tourism infrastructure and products with the help of private players. This involves supporting private investment in projects through facilitation, handholding, and creating avenues for Public Private Participation.

Build a bridge between private investors, project proponents and startups - A well-designed and structured public-private partnership can bring great benefits to tourists, private investors, and the Government. Nearly 500 investors and entrepreneurs participated in TIM 2023, including 46 startups and 118 investors from the Responsible tourism sector. A total of 75 projects graced the stage, of which 52 were showcased from the private sector.

Showcase the treasures of the government, places with tourism appeal – to encourage the private players to invest and realize the potential. - Out of the 23 projects that the Tourism

Department suggested, 16 of them were planned as collaborations between the public and private sectors, which attracted investment proposals worth Rs. 2,511.10 Crores.

KIIFCON has been given an opportunity by Shri. K. Biju IAS , Secretary PWD & Tourism, to showcase vantage land parcels in Kerala to the potential investors at the investor's meet under Investment Opportunities in Kerala and Project Presentations.

Shri. Satyajeet Rajan IAS (Rtd.), Chief Executive Officer, KIIFCON briefed upon the objective of KIIFCON, its major projects, activities, and achievements from its inception. He explained the opportunities for real estate development possible in the available land parcels along the fringes of the Kerala Government's Flagship Projects-West Coast Canal (WCC) and Coastal Highway. He also, thanked the Secretary, PWD & Tourism for the giving KIIFCON an opportunity for the same.

Later, Shri. Rajeevan. T, Chief Consultant and Sri. Ramakrishna Sharma, Consultant of KIIFCON presented the details of Commercial Land Development Project of KSRTC, which is planned to be executed in Public Private Partnership (PPP) mode, in which KIIFCON is working as Transaction Advisory for the client KSRTC. The project is a unique initiative

by the Government of Kerala to be implemented in PPP mode. The project involves the "Commercial Development of Eight (8) prime land parcels of KSRTC across Kerala", which has presently completed its Expression of Interest (EoI) stage and the Request for Proposal (RFP) stage is yet to be floated. Post presentation, Mr. Dizon Genuine John, Consultant, KIIFCON with other team members handled B2B sessions in which lot of queries from the delegates and potential investors were addressed wherein the payment mechanism, terms of concession etc were discussed.

Subsequently, the session culminated with B2B meetings wherein the interested investors were addressed and clarified of their doubts. Further, the interested investors were assured of intimation on release of RFPs. The meet also featured technical sessions by experts from various fields such as Tourism, Professional architecture, and Academics and the event concluded with a Closure session by Shri. Mohammed Riyas, the Hon'ble minister for Tourism, Government of Kerala. In a nutshell, the meet was huge success, with the state receiving investment offers worth Rs 15,116.65 crore in the core sector.

Transforming Shorelines: The Poonthura Geotube Project

Joseph Cameron Culas, Project Engineert

Introduction:

Nestled along the coastal stretch of Poonthura, a transformative initiative has taken root—the Poonthura Geotube Project. This groundbreaking endeavor seeks to address coastal erosion and protect the vulnerable shoreline using innovative geotube technology. In this article, we delve into the key aspects of the project, its significance, and the journey from conception to completion.

Understanding the Need:

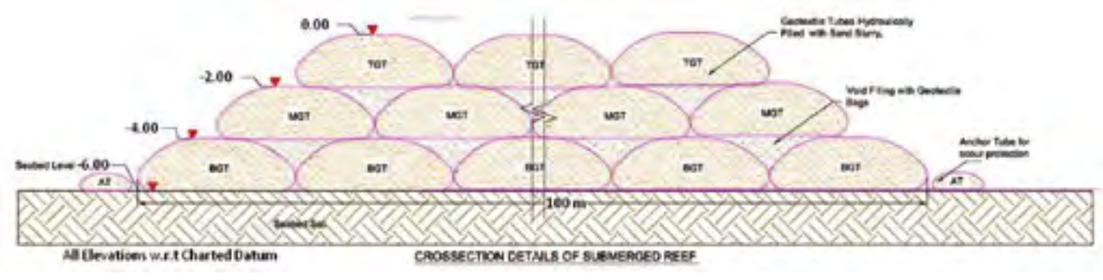
The coastal region of Poonthura has long grappled with the erosive forces of the sea, threatening both infrastructure and the livelihoods of the local community. The sea wall constructed in this area was found to be ineffective in addressing the erosion, moreover, the severe wave topping has caused damage to many houses situated close to the seawall, and some of them have collapsed. The fishermen community in this locality resorts to traditional fishing practices. They prefer to land their crafts on the open sandy beach. This project proposal is to rebuild the beach by constructing a series of offshore breakwaters using Sand-filled Geo Tubes. The project was conceived based on the success of a similar offshore structure constructed by NIOT Chennai, at Kadallur Periyakuppam, near Chennai to rebuild the beach, which was lost in the recent cyclones. Sufficient data including wind, waves, currents, etc were available with NIOT, as they were associated with the data collection for Adani Ports, Vizhinjam. They were entrusted to carry out model studies, bathymetrical data, soil investigation, etc for the proposed project and suggest an appropriate shore protection system for the Poonthura coast. This project is the first of its kind proposed in the state of Kerala and thus it is an experimental project. Initially, two kilometres of shore protection is proposed in this manner. KIIFB has accorded a Financial Sanction of Rs 20.78 Cr in phase 1 for the stretch starting from Poonthura Pozhi towards the north up to 700 metres. Depending upon the success of the project, it will be extended to the rest of the coastal stretches, where severe erosion is being noticed. On completion of the project, it is expected that a beach having an average width of 40 m will be developed behind the offshore breakwater, and the height of the wav

Design of Offshore break water

The alignment of the offshore breakwater was finalized based on the model study conducted by NIOT. The model study report shows five discrete segments of offshore breakwaters each having a length of 100.00 m. In between each segment, a 50.00 m gap is provided. The breakwaters are proposed parallel to the shore at 125m from the shore. The average bed level at the location of the offshore breakwater is 5.50m CD. The top level of the structure is kept at chart datum. Between each segment,

gaps are provided for the flow of water. The gaps are designed in such a way that it will not let significant wave energy through it to cause erosion of the coastline on its leeward side as well as permit the free movement of the fishing boats

Layout of proposal



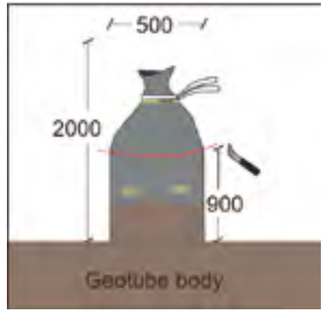
Cross-section details of submerged Breakwater

Geosynthetic tubes are proposed to be of woven fabric. In the Instant case, based on the topography, 3 layers of geo-tubes are proposed. The individual yarns shall be woven together in such a manner, as to provide dimensional stability relative to each other. The material used in the manufacture of the geosynthetic fabric should be Polypropylene. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the material resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Reclaimed or recycled fibers or polymer shall NOT be added to the formulation. The geosynthetic tubes shall be 20/16/12 m long and have a minimum circumference of 15 m. The geosynthetic tube will be used for submerged dyke construction in the marine environment. The geosynthetic tubes/ bags are to be filled with sand slurry underwater. It should resist a pumping pressure at an inlet of at least 35 kPa. The Geosynthetic tubes are to be filled to a maximum height of 2.5 m. It should be provided with filling ports for slurry to be pumped in. Filling ports shall be spaced at intervals not exceeding 10 m along the crest of the tube. The sleeve of each port shall have at least a length of 4m and a diameter of 400mm. Loops or Straps of the same geosynthetic material should be provided along both sides and on top of the tube wherever seams are coming to facilitate anchoring. In addition to those, straps should be provided on the edges. It should be able to withstand the uplift forces acting on it when anchored without tearing off.

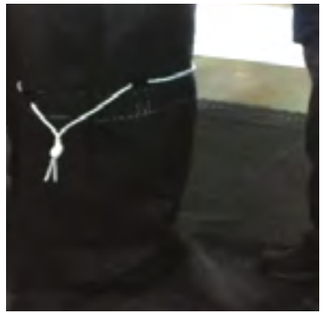
Challenges

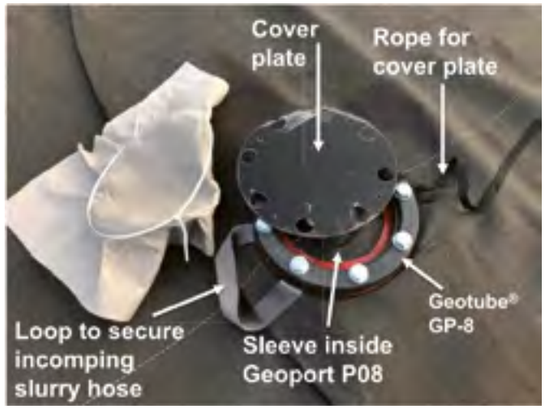
After implementing the 1st segment of the project, the works were suspended temporarily, owing to the rough sea conditions in the monsoon season of 2022, where works were completed by the third layer which was approximately 60cm above the sea level (reported by the SPV). On resuming the work after the monsoon in October 2022 (after nearly 5 months), bathymetry was conducted, to review the top levels of the installed geotube. It was observed that the top level of the geotube has varied from 1.5 to 2.0m, over the expected value of 60cm. The bathymetry was further cross-verified through the Hydrographic survey wing which also exhibited settlement of the tube, over the expected limits.

The cause identified for the failure was the unintended release of sand through the filling port, utilized for slurry pumping, at the construction stage, executed through a rolling down method. Consequently, a revised design with screw and bolt method is currently approved, and the procurement process is underway. With optimism, the project is anticipated to conclude successfully, setting a precedent for offshore breakwater projects throughout the state. Pictures of the two methods (Initially done and currently approved) are appended. To carry forward with the project, KIIFB advised starting the installation of the next breakwater segment with the approved rectification plan to analyze the behavior.



Cross-section details of submerged Breakwater





Screw & Bolt Method

Conclusion

The Geotube breakwater pilot project at Poonthura represents a pioneering effort in coastal protection and management. This innovative approach, employing Geotubes as a primary defence against coastal erosion, has provided valuable insights into the feasibility and effectiveness of this technology. While the project encountered challenges during its execution, notably with the filling port method, the commitment to finding solutions and adapting the design underscores the importance of flexibility in coastal engineering initiatives.

As the project progresses, with a modified design in the procurement stage, there is an optimistic outlook for its success. The lessons learned from the Poonthura pilot project not only contribute to the local community's resilience but also offer valuable knowledge for future coastal protection endeavours. The pilot project's significance extends beyond its immediate impact, serving as a learning platform for coastal engineers, environmentalists, and communities facing similar challenges worldwide.

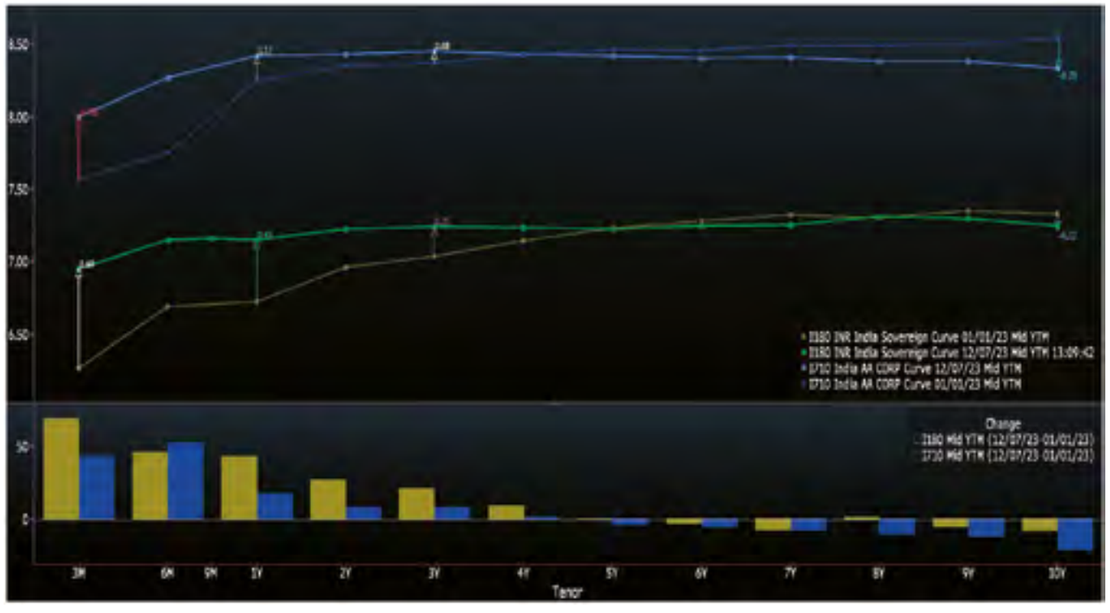
In embracing innovative solutions like Geotubes, the Poonthura pilot project exemplifies the proactive approach needed to address the evolving dynamics of coastal environments. It is anticipated that the success of this project will pave the way for broader applications of Geotube breakwaters, offering sustainable solutions to coastal communities grappling with the effects of climate change and sea-level rise. This endeavour stands as a testament to the power of research, collaboration, and adaptability in shaping resilient coastal landscapes for future generations.

Economy & Market Watch

Ajosh Krishnakumar
DGM, Finance & Administration

In this edition of Economy & Market Watch, we do a study on India sovereign yield curve and AA Corporate yield curve to analyse how the yield curves have evolved since the beginning of calendar year 2023.

The following chart depicts the India Sovereign yield curve and AA Corporate yield curve at the beginning of calendar year 2023 and the corresponding yield curves as on 7th December 2023.



As may be seen from the chart, there has been a significant change in the shape of India Sovereign yield curve in the last 11 months, i.e., from a traditional upward sloping yield curve at the beginning of the year to an almost flat yield curve (spread between 1Y and 10 Y yields at < 10 bps) currently. During the period, while the short-term yields for India Sovereign bonds have increased i.e., by ~69 bps for 3-Month tenor and by ~ 43 bps for 1Y tenor, the yield curve made a downward shift for tenors beyond 5 years, with long-term

yields (10 -Y tenor) for India sovereign bonds dropping by ~12 bps. Additionally, we may also note a slight inversion in the current sovereign yield curve between tenors 2Y – 5Y and 8Y – 10Y.

It may also be noted that there is a similar change in shape for the current AA Corporate yield curve when compared to the AA Corporate yield curve at the beginning of the year. Though the short-term yields for AA Corporate Bonds have increased (i.e. by 43 bps for 3-Month tenor and by 17 bps for 1Y tenor), there has been a downward shift in the current AA Corporate yield curve for tenors beyond 4 years when compared to the corresponding yield curve at the beginning of the year. The yield for Corporate Bonds with 10Y tenor has dropped by 23 bps when compared to the beginning of the year. As in the case of the sovereign yield curve, there is an inversion in the current AA Corporate yield curve between tenors 3Y – 6Y and 7Y -10Y.

Additionally, it may be noted that the spreads between G-Sec yields and AA Corporate yields have decreased consistently across tenors from January 2023 to December 2023. While the yield spread between G-Sec Bonds and AA Corporate Bonds for 1 Y tenor has dropped from 153 bps to 127 bps, the corresponding yield spread for 10 Y tenor has dropped from 122 bps to 110 bps.

Fund Mobilization Status	
Particulars	Amount (₹ Cr.)
Contribution from Government of Kerala	₹ 16,063
Fund mobilized from financial market	₹ 19,634
Total	**₹ 35,697**

** Provisional figure as on 30-06-2023*

PRAVASI Chitty Statistics as of 30th November 2023

Total number of customers	191323
Total number of subscribers	56910
Total amount collected	INR 3496.45 Cr
KIIFB Deposit bond subscribed	INR 927.7 Cr
KIIFB Security bond subscribed	INR 190.52 Cr

PRAVASI Dividend Scheme

Total number of registrations	50344
Total no. of depositors	4144
Total amount deposited	INR 325.03 Cr

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