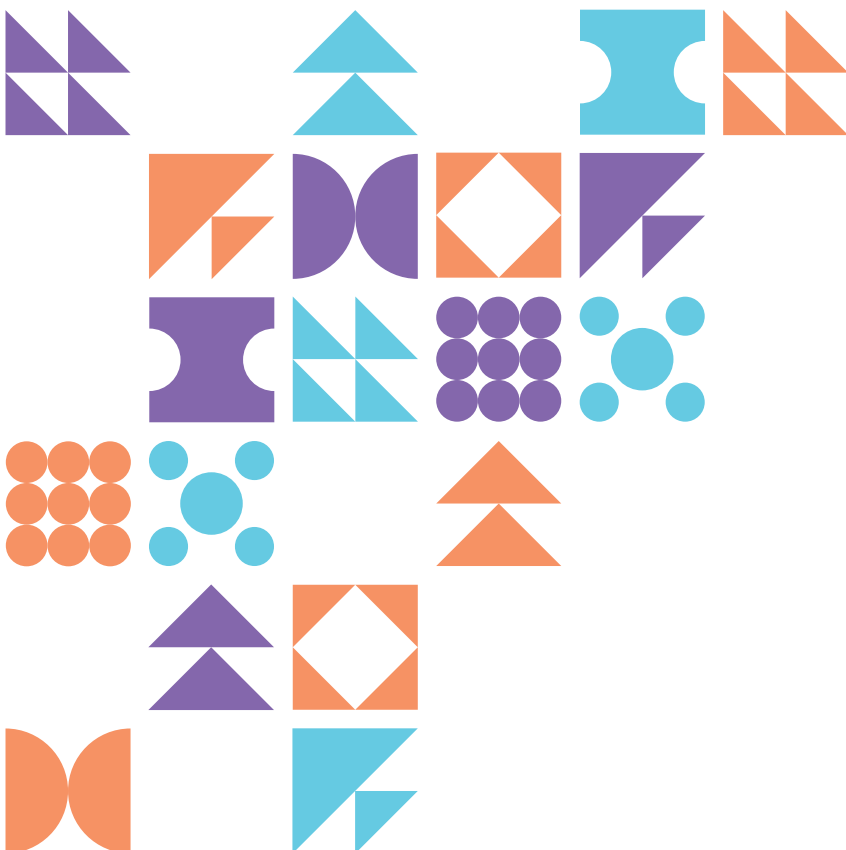


COMPARISION TO USE POLYMER SPRAY FOR SLOPE STABILIZATION

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COMPARISON TO USE POLYMER SPRAY FOR SLOPE STABILIZATION AS MODERN TECHNIQUE FOR ANTI SLOPES SCOURING AS REPLACEMENT OF CONCRETE AND MARL CAPPING

1. PROBLEM STATEMENT / BRIEF INTRODUCTION

During the design and construction of infrastructure projects especially for roads, evaporation ponds there is a persistent need for more efficient and sustainable slope stabilization solutions. While concrete pavement panels and marl capping have been the conventional go-to methods, their limitations in terms of cost, labor, equipment, and environmental impact are becoming more apparent.

So, in order to deal with the soil side slopes protection from the erosion of slopes due to heavy traffic movements on roads or downpouring the area, the advance and easy solution to use of polymer spray for soil slopes to be well stabilized and kept maintained for years to protect the whole scenario.

As slope stabilization is crucial in the building of roads and infrastructure projects, particularly those including evaporation ponds and embankments, to minimize soil erosion caused by heavy traffic movement, rainfall, and other environmental conditions. Slope protection has traditionally been achieved by the use of concrete panels as well as using marl capping. While effective, these technologies have considerable limitations, such as high material costs, labor-intensive processes, and the necessity for heavy machinery, which raises safety concerns and environmental impact. Concrete stabilization requires significant time for application and curing, whereas marl capping, while less expensive, still necessitates significant equipment and labor, resulting in higher overall project costs and longer schedules.

Furthermore, the long-term maintenance expenditures associated with these traditional technologies increase the overall financial burden because both concrete panels construction and marl capping are prone to erosion, necessitating frequent repairs and upkeep. As project sizes increase, there is a greater need for more sustainable, cost-effective, and efficient solutions.

Polymer spray technology presents a modern alternative that addresses these challenges head-on with its ease of application to stabilize slopes. Polymer spray technology provides a modern, environmentally friendly solution that reduces labor and equipment requirements, reduces safety risks, and expedites the construction process. This approach not only successfully stabilizes soil, but it also provides long-term protection with minimal maintenance, cutting overall ownership costs dramatically over time.

This technical paper will evaluate and compare the three methods—concrete panels, marl capping, and polymer spray—in terms of cost, durability, simplicity of application, environmental impact, and long-term sustainability. By examining these aspects, recommendations would be to find the most cost-effective and feasible approach for slope stabilization, as well as insights into how polymer spray can be a better alternative to conventional methods.



II.WHY TO USE POLYMER SPRAY

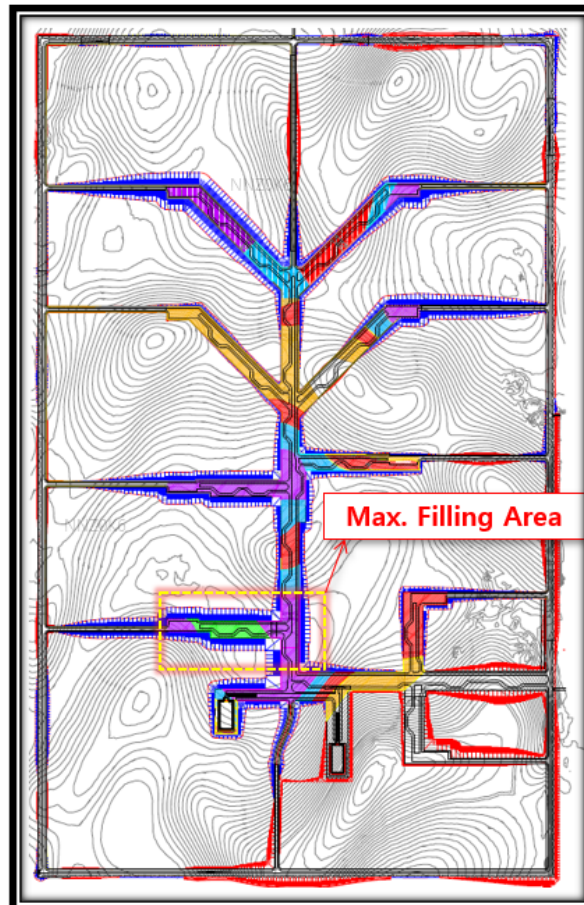
Soil suppression and dust control is normally required for the side slopes for roads / evaporation ponds side slopes works. So, for that it is vital to use Polymer Spray which is eco-safe, non-hazardous, non-toxic, high performance polymer emulsion designed especially for soil stabilization in all soil types especially coarse grain soils, sand etc., polymer spray provides outstanding performance and cost-effective maintenance of unpaved roads and surfaces in a range of applications from road construction to soil erosion and particulate emission control. Polymer spray is Water-based dispersion of synthetic polymers with additives.

III.DESIGN REQUIREMENTS

There are requirements for side slopes designed to increase surface hardness and bearing capacity as a wear course in unpaved road applications. Polymer spray is used in accordance with stated preparation and installation instructions can be applied to a range of soil types and various climatic conditions. Polymer spray is highly water resistant and when cured, remains stable under wet conditions for instance heavy downpour without breakdown of the sand or soil/polymer matrix or leaching of the polymer product.

As per SAES-A-114, Excavation & Backfill, section 8.3, it states that “The Chemical polymer agent is a water-based liquid that can be sprayed on sand and as the water evaporates, the polymer forms a matrix in the sand that bonds the sands particles together forming hard crust. The material is eco-friendly and easy to apply using standard equipment. Chemical polymers shall be used for slope protection from erosion.”

Site Preparation Plan – Analysis for slope stabilization





Analysis Cases

- ❖ Slope Analysis Cases
 - Case 1 : 1.0V : 5.0H (30mm Polymer thickness)
 - Case 2 : 1.0V : 2.5H (30mm Polymer thickness)
 - Case 3 : 1.0V : 2.0H (30mm Polymer thickness)
- ❖ Groundwater condition
 - Scenario 1 : Dry condition
(G.W.L : Depth 7.0m below E.L)
 - Scenario 2 : Up to existing surface
Saturated condition
(G.W.L = Depth 0.0m below E.L)
[WORST CONDITION]

Assumed G.W.L AT +17.00
WORST CONDITION
SCENARIO 2 is considered
due to G.W.L fluctuation.

Existing Surface (E.L.)

FILLING

Scenario 2

Scenario 1

GWL as per investigation

NNZDK6

Slope Analysis of Slope Case 1 [1.0V : 5.0H]

a. Scenario 1 (Dry condition)

Safety Factor : 3.131

Material Properties:

- Name: Dense
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 37°
- Name: Medium Dense
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34°
- Name: FB
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32°
- Name: Chemical Polymer
Unit Weight: 17.6 kN/m³
Cohesion: 1.9 kPa
Phi: 24.8°

b. Scenario 2 (Saturated condition up to E.L)

Safety Factor : 2.616

Material Properties:

- Name: Dense
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 37°
- Name: Medium Dense
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34°
- Name: FB
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32°
- Name: Chemical Polymer
Unit Weight: 17.6 kN/m³
Cohesion: 1.9 kPa
Phi: 24.8°

Slope Analysis of Slope Case 2 [1.0V : 2.5H]

a. Scenario 1 (Dry condition)

Safety Factor : 1.568

Material Properties:

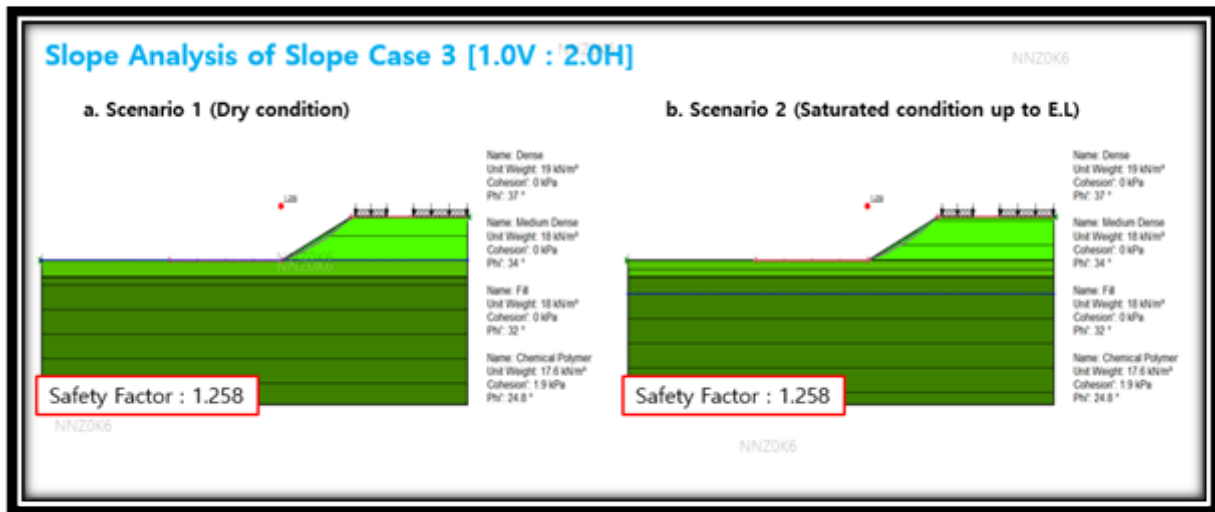
- Name: Dense
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 37°
- Name: Medium Dense
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34°
- Name: FB
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32°
- Name: Chemical Polymer
Unit Weight: 17.6 kN/m³
Cohesion: 1.9 kPa
Phi: 24.8°

b. Scenario 2 (Saturated condition up to E.L)

Safety Factor : 1.566

Material Properties:

- Name: Dense
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 37°
- Name: Medium Dense
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34°
- Name: FB
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32°
- Name: Chemical Polymer
Unit Weight: 17.6 kN/m³
Cohesion: 1.9 kPa
Phi: 24.8°



IV.COMPOSITION OF POLYMER SPRAY

Polymer spray is blend of high-performance polymers and additives designed to agglomerate soil particles into a cohesive matrix. Polymer spray is environmentally friendly product designed to stabilize soil and create improved surface conditions of unpaved roads and side slopes. Polymer spray poses neither physical nor health hazards and is therefore considered non-hazardous according to the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard. In detail, the non-hazardous characteristics of the polymer can be classified as:

- Environmentally safe
- Non-leaching or dissipating
- Non-hazardous
- Non-toxic to animals
- Non-inhibitive to plant growth
- Non-flammable
- Non-corrosive

V.BENEFITS OF USE OF POLYMER SPRAY

Following are benefits to use of Polymer Spray but not limited to followings:

- a) Polymer Spray is used to effectively control particulate emissions on construction sites, Road edges/shoulders, side slopes, landing fields, bridge sides stabilization, tailings stockpiles and many other areas.
- b) The water/polymer dilution ratio can be varied to adjust the application longevity for min (5) years.
- c) The product can be applied in a wide range of temperatures and with its quick drying technology.



VI. MAJOR APPLICATION OF POLYMER SPRAY

Following are benefits to use of Polymer Spray but not limited to followings:

- a) Alternative to traditional asphalt roads, soil decomposition problems, and includes such as Roads Shoulders and Bridges Stabilization.
- b) Water Storage and Embankments construction for Water flow management.
- c) Slopes stabilization and construction.
- d) Control scouring of slopes.
- e) Makes hard crest after application to the side slopes.

VII. LIMITATION OF POLYMER SPRAY

Followings are the limitations for the usage of Polymer spray but are not limited to followings:

- a) Always handled in a well-ventilated area because of organic compounds or ammonia which evaporate during application and drying.
- b) Eye & Skin Protection is needed while executing at site.
- c) Soil properties are to be gauges first before applying Polymer spray because some soil is not compatible with the polymer sprays.
- d) Curing time after spraying using mechanical equipment is form 3 ~ 7 days. Which is time consuming.
- e) Dry conditions are to be ensured before starting the work and until work is completed.
- f) Wind speed not more than 15 km/h during application.

VIII. Comparative Analysis: Concrete Vs Marl Capping Vs Polymer Spray

Criteria	Concrete Pavement Panels	Marl Capping	Polymer Spray Technology
Cost	High	Moderate	Low
Application Time	Long (due to curing)	Moderate	Short
Equipment Requirements	Heavy machinery required	Moderate machinery	Minimal machinery
Durability	High but prone to cracks	Moderate, erosion-prone	High, erosion-resistant
Environmental Impact	High (due to emissions)	Moderate	Low (eco-friendly)
Maintenance Needs	High	Moderate to High	Minimal
Safety Concerns	High (due to equipment)	Moderate	Low



IX.COST COMPARISON

Concrete Stabilization: Traditionally, concrete panels have been used to safeguard slopes. However, this approach necessitates substantial labor and costly machinery, resulting in exorbitant prices. Concrete is expensive not only in terms of material but also in terms of time spent applying and curing it.

Marl Capping: Marl capping is a little less expensive alternative to concrete, but it still requires significant equipment and labor, making it time-consuming. It is better suited for regions where cost savings are critical, but it requires more maintenance due to erosion or scouring hazards over time.

Polymer Spray: is a significantly more cost-effective option. It takes fewer resources in terms of labor and equipment, and its application is considerably faster than concrete and marl. The polymer's long-lasting qualities require less maintenance, making it even more cost-effective in the long term.

COST COMPARISION OF CONCRETE VS MARL CAPPING VS POLYMER SPRAY

COST COMPARISION			REMARKS (IF ANY)
MARL CAPPING	CONCRETE PANELS	POLYMER SPRAY	For Same area slope protection
SAR 99,359,556	SAR 202,962,464 NNZOK6	SAR 46,057,854	
↑ 215.73%	↑ 440.67%	✓ 100%	%age greater than Polymer Spray



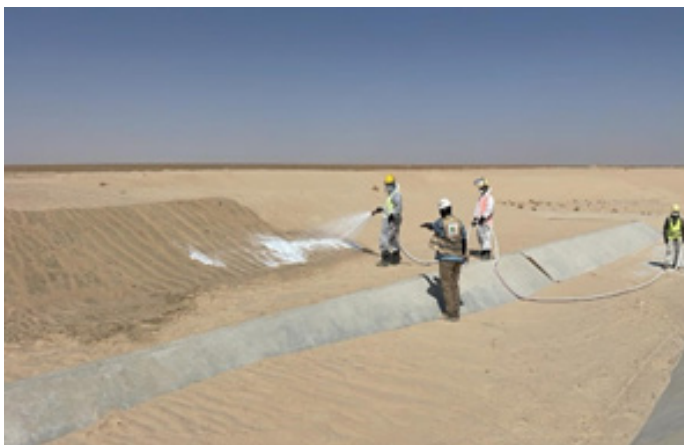
Slope Preparation in East side of Flare Area – for Polymer Spray



Slope Preparation in West side of MEG Pond Area - for Polymer Spray



Polymer Spray Application on slopes



Polymer Spray Application on slopes



X.UTILITIES FLARE AND PIPRACK IN TANAJIB GAS PLANT AREA WITH POLYMER SPRAY

Total area including Roads side slopes / shoulders & evaporation ponds area = 224,516 m²
Spray Surface by Vendor recommendations are 1.75 L / 2.0m²
So, total 128,295 liters of Polymer spray is going to be utilized in utilities flare and piprack areas.

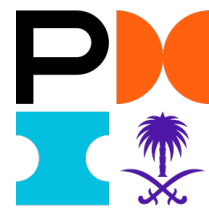
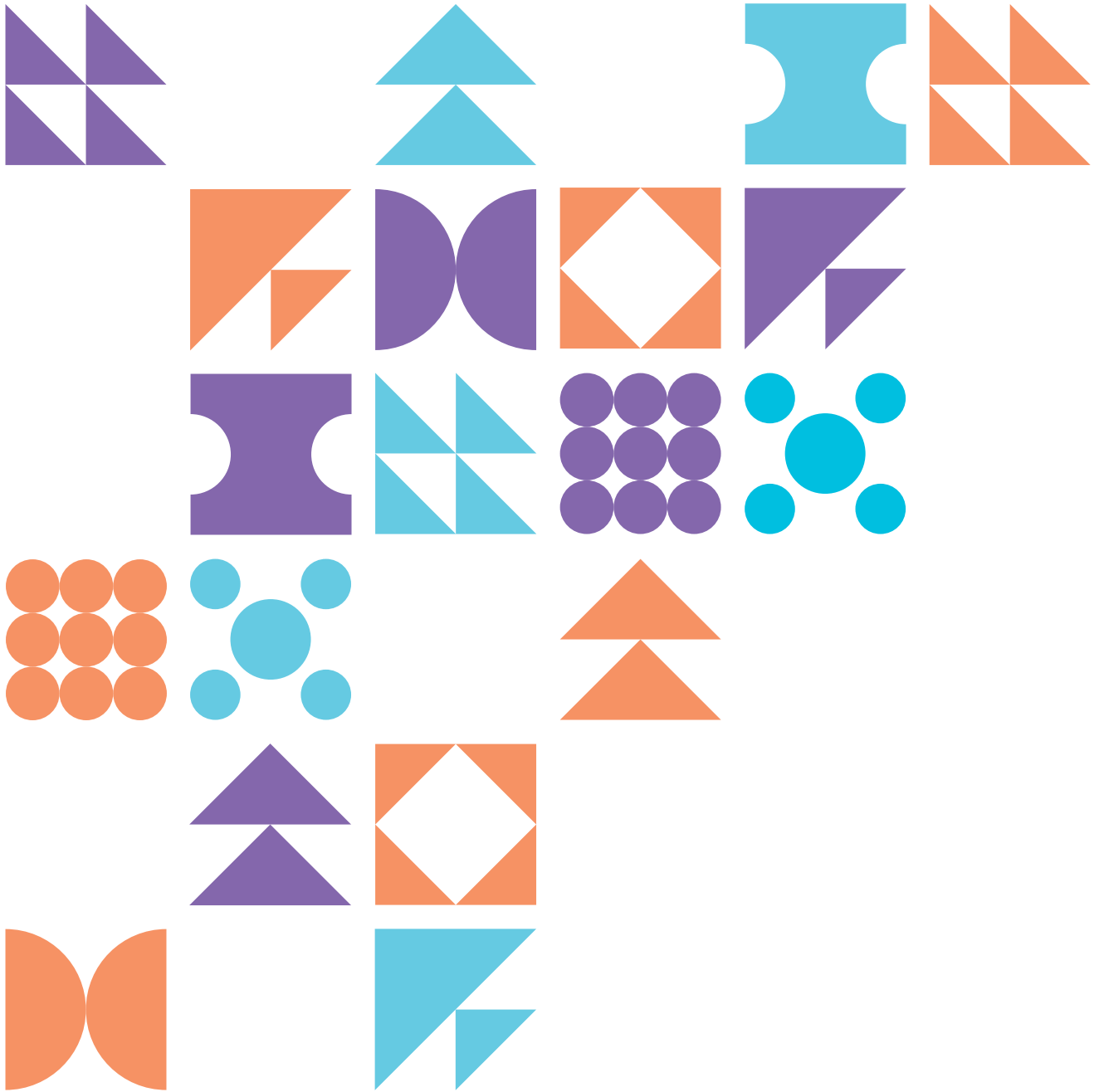
XI.CONCLUSION

In Tanajib Gas Plant Projects, Package-12, “Utilities, Flare & Piperack” successfully implemented for the first time “Use of Polymer spray” to control the scouring / erosion of side slopes for roads and evaporation / ponds areas. There is a pressing need for more efficient and sustainable slope stabilization solutions. The implementation of this advance technique led to significant time saving on construction activities and reduced the usage of concrete or marl application with heavy equipment for side slopes protection as conventional methods. Furthermore, the usage of “Polymer Spray” is easy to apply with minimum manpower and standard equipment and sustain for long time.

In this technical paper, it is explored the benefits and drawbacks of three slope stabilization techniques. i.e, Concrete, Marl capping, and Polymer spraying. Traditional solutions, such as concrete and marl capping, are successful but costly, labor-intensive, and time-consuming. They require large resources and frequent maintenance, which increases the entire cost. In contrast, polymer spray is a modern, eco-friendly, and cost-effective option that is easier to apply, requires less maintenance, and delivers long-term stability. Polymer spray can result in significant cost savings, speedier deployment, and increased environmental sustainability, making it a better alternative to traditional approaches.

XII.REFERENCES

- 1.SAUDI ARAMCO STANDARD (SAES-A-114) FOR EXCAVATION & BACKFILL.
- 2.CONTRACTOR’S (HYUNDAI) INFORMATION REGARDING POLYMER SPRAY.



Project
Management
Institute.
Kingdom of Saudi
Arabia