Geosynthetics in Mining Applications: Africa

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GEOANZ #1 ADVANCES IN GEOSYNTHETICS
7–9 JUNE 2022 | BRISBANE CONVENTION & EXHIBITION CENTRE

Introduction

- Mining projects are characterised by:
  - Fast programme
  - Remote and challenging location
  - Design criteria based on the mine stage
  - Design often adjusted during the project to suit site conditions or change in scope
  - Specific contract (EPC / EPCM)
- Geosynthetics are characterised by:
  - Quick installation
  - Transport of GSY is much easier than other products (10-20% of cost)
  - Inherited margin of safety
  - Adaptable to conditions and not fit for purpose
  - Expert in geosynthetics sector for design and supply

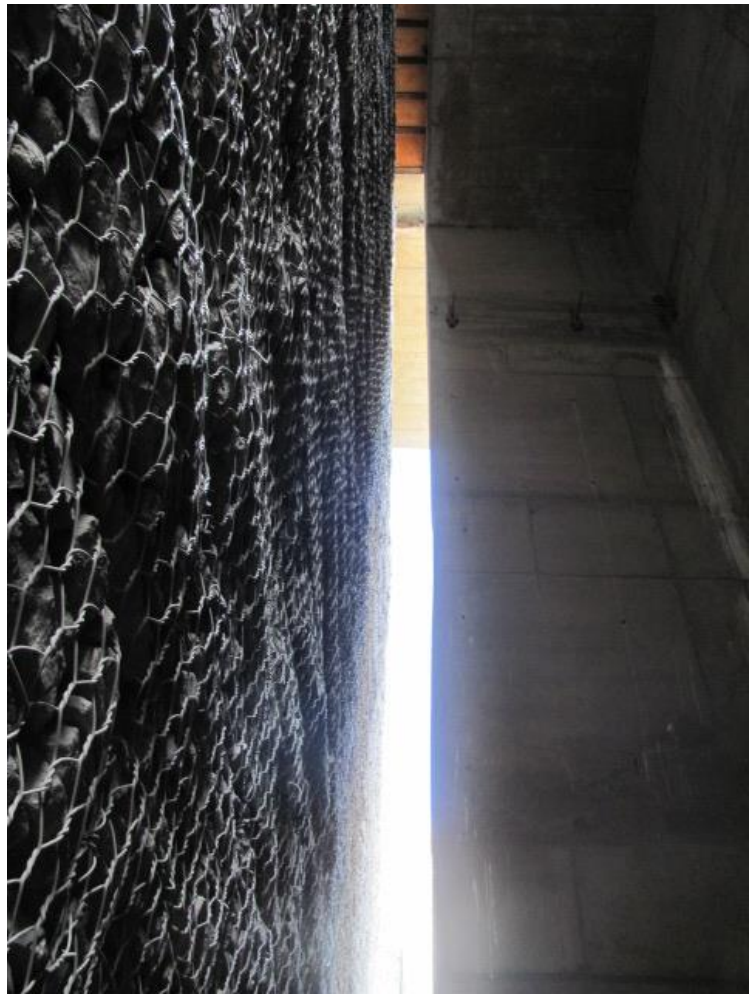
Introduction

- Geosynthetics in mining have been used for:
  - Crusher walls
  - Stabilisation of roads and platforms
  - Barrier system
  - Erosion control
  - Reinforcement of fills
  - Filtration and dewatering

Crusher Walls

Crusher Walls - Introduction

- Crusher walls facilitate the access to the crusher bin (from 10m to 30+m depending on the crusher type) and it must be as close as possible to the bin (less than 500mm)
- The facing is dictated by on site resources, programme and type of contractor. Concrete panels and gabion baskets are the most common



Crusher Walls - Foundation

- Often not an issue as the wall is constructed in layers and it is resilient to movements
- Often no ground improvement (rockfill or basal reinforcement)
- Horizontal movements are often related to QA on site (specs, rain, SOP)

Crusher Walls - Facing

- Most cases is based on time and resources available
- Concrete panels are quick to install but require a skilled contractor
- Gabion baskets can be filled with local rocks and job creation, but require supervision
- Both are very easy to transport on site

Crusher Walls - Facing

- Fit for purpose

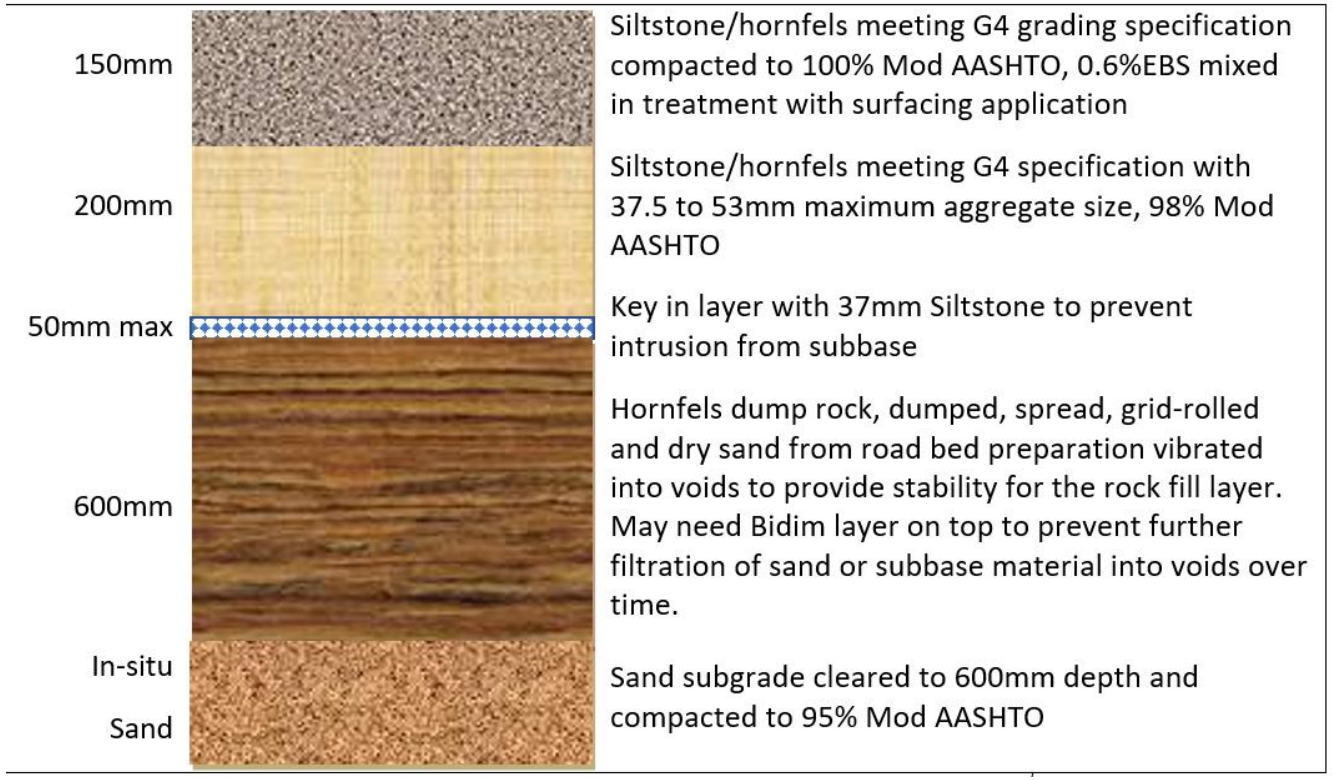
Crusher Walls – Conclusions

- Interference between crusher foundation and wall foundation
- Account for the concrete slab on top (about 1m of no reinforcement)
- Quality assurance on the reinforced fill
- Design with a “mining buffer”

Stabilisation

Khoemacau Copper Mining - Botswana

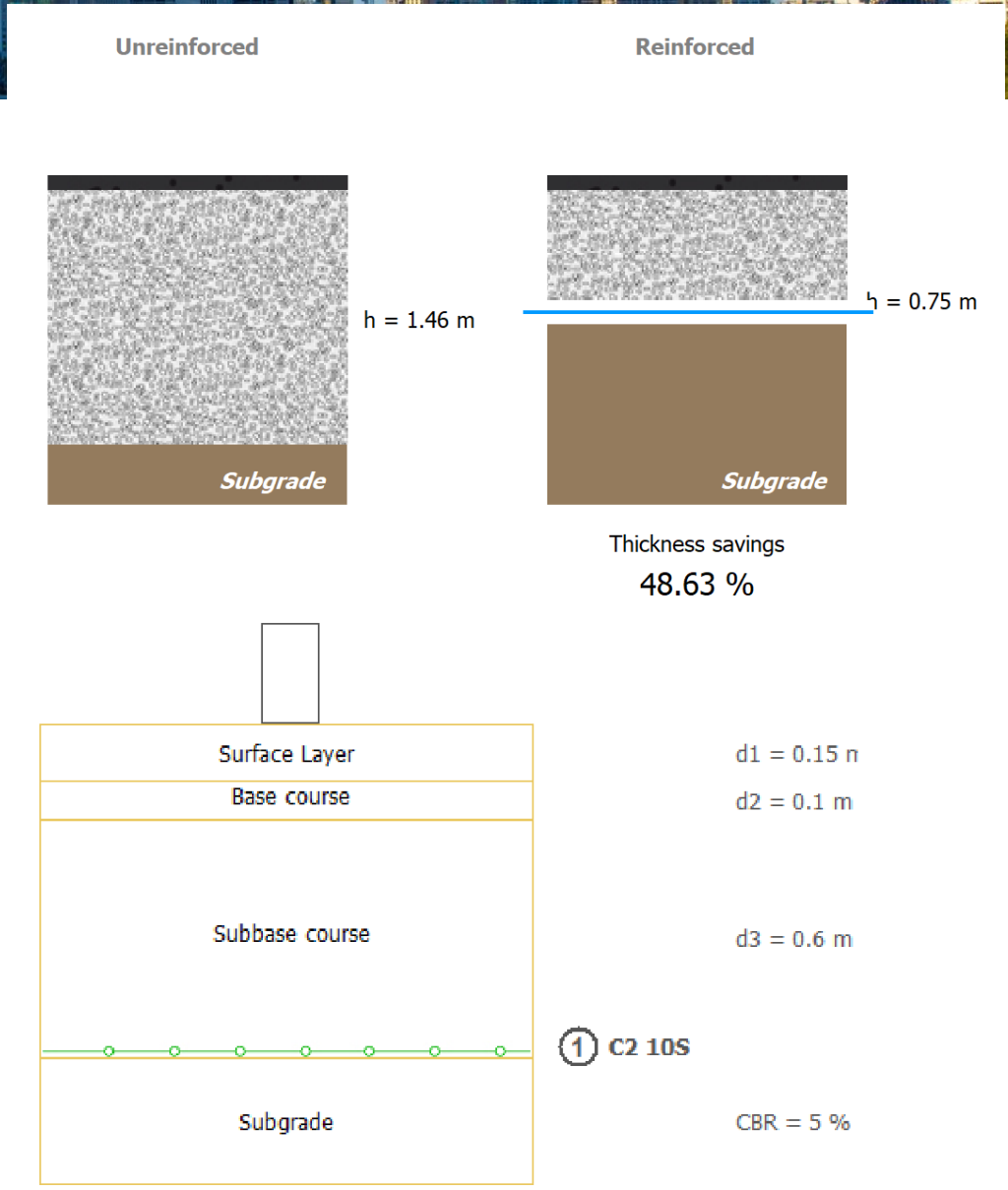
- Khoemacau Copper Mining, situated 40km south of Maun (Okavango Delta Region), north in Botswana;
- A 32km access and haul road was required between the plant and the boxcuts.
- Original design require a 600mm rockfill over a soft Kalahari sand (5 CBR)



Original design – 600mm rockfill

Khoemacau Copper Mining

- A design with 650 kPa and a FoS of 2 was used as static load
- A reinforced geotextile with UTS of 100kN/m in both direction achieved both stabilization and separation function



Khoemacau Copper Mining

- The reinforced geotextile provided separation between the soft Kalahari sand and the calcrete as well as stabilised with a FoS of 2.0 against bearing capacity;
- An overall costs saving of 20%
- 108 000m^2 Geotextile was delivered by trucks (7 days)

Various projects – Foundation improvement

- A storage tank 12m diameter with a bearing pressure of 300kPa over an in situ material with less than 4 CBR
- Limited access as inside the plant
- The fill available was CBR 35-45 from commercial source

Various projects

- Using the static method (Rimoldi, 2016), a 3m deep foundation was required
- The design strength were between 20 and 38 kN/m in 3 layers. In this case the strain at 3% were a higher restriction than the long- term design of the geogrid
- A separation layer using a GTX-W with 100kN/m was placed at the bottom

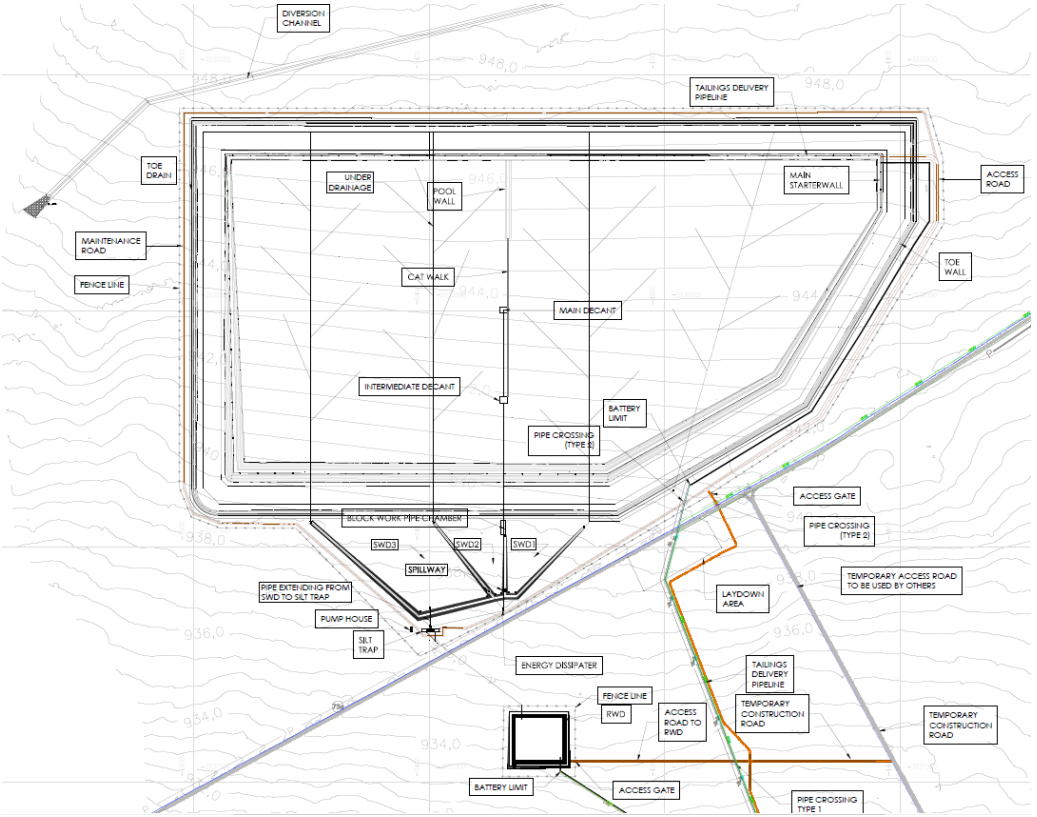
Various projects

- 3 layers of Geogrids with UTS of 200kN/m were installed every 500mm
- It was preferred to install mono-directional geogrids rather than bi-direction to avoid overlapping

Barrier System

Barrier System – Northern Cape (RSA)

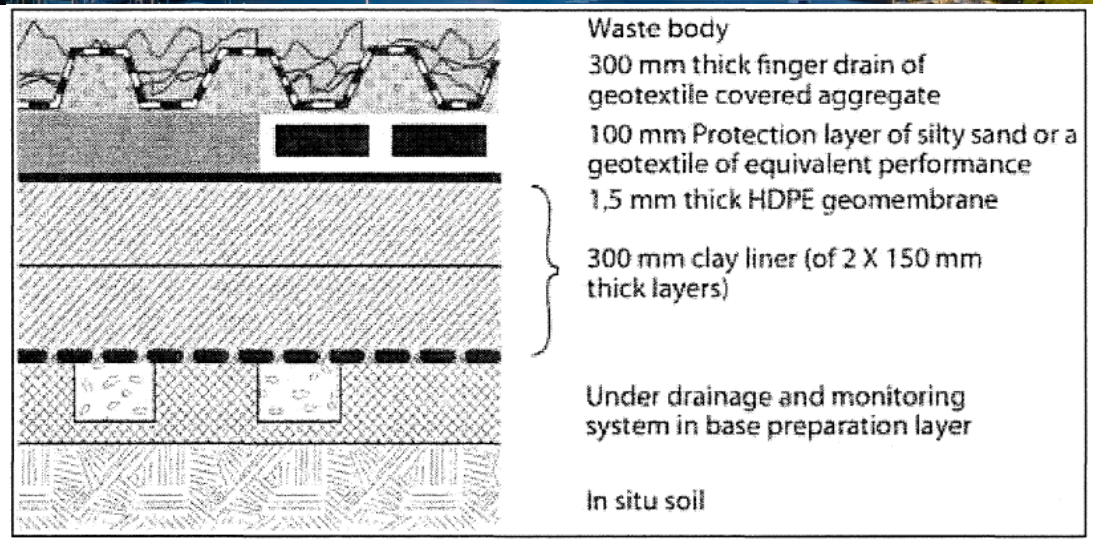
- One of the largest diversified natural resource companies required a TSF facility as part of a new Zinc mine in the Northern Cape – South Africa
- TSF walls
- Drains
- Concrete structures
- 110 ha tailings storage facility
- 20 000 m^3 return water dam



Barrier System – Northern Cape (RSA)

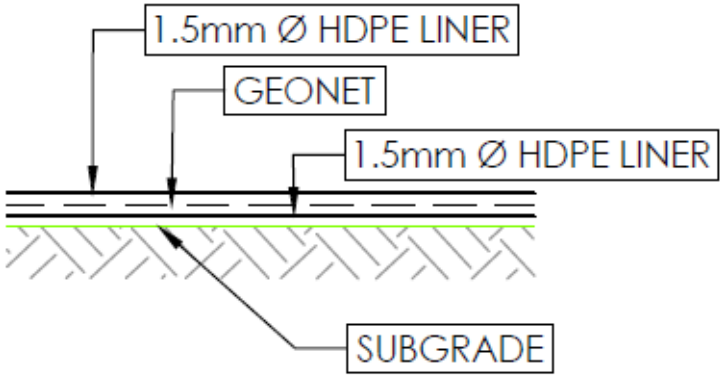
TSF

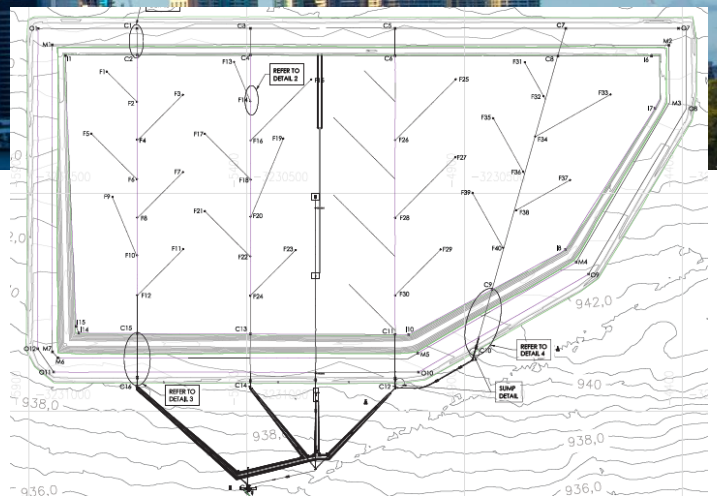
- The waste was categorized as a Type 3 waste which require a Class C barrier
- The in-situ material complied with the CCL



RWD

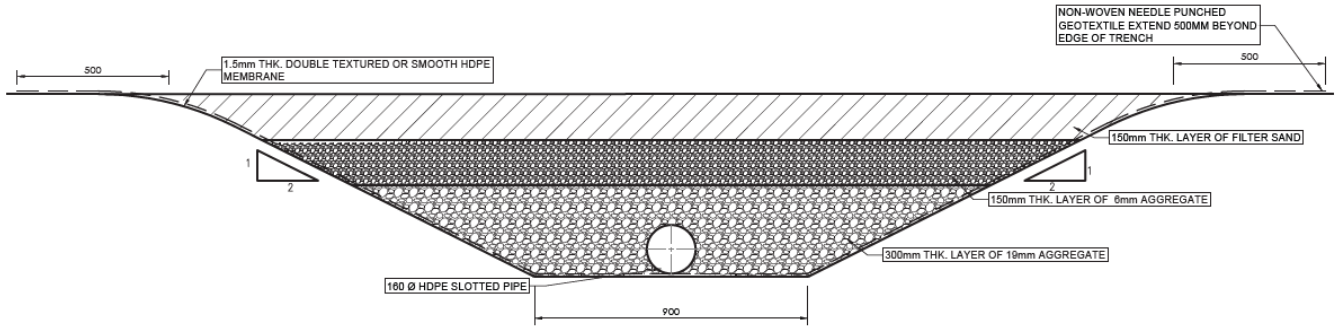
- For the RWD, 2 geomembrane separated by a geonet were preferred
- The geonet was connected to a leakage detection sump





Barrier System – Northern Cape (RSA) Drainage

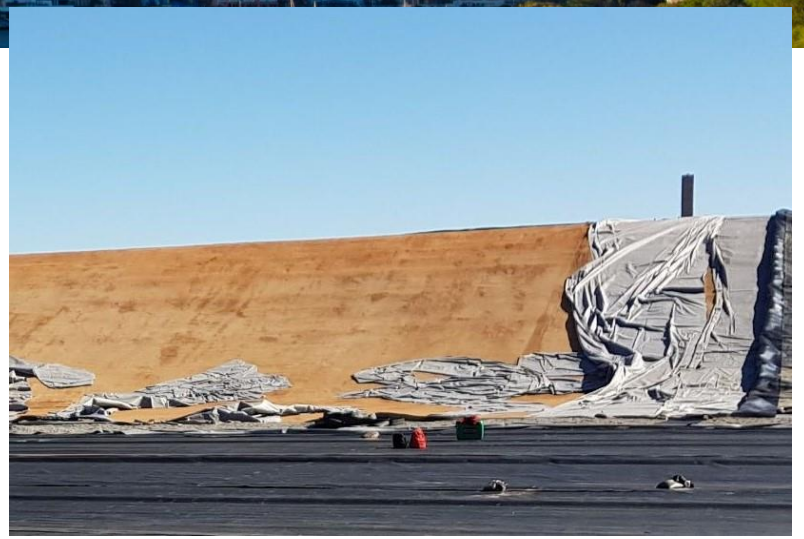
- Herringbone system underneath the TSF with 160mm perforated pipe, 19mm gravel and 6mm then sand



SECTION THROUGH TOE AND COLLECTOR DRAINS FOR 160 Ø PERFORATED SECTIONS
SCALE 1:10

Issues

- Wind uplift
- Compaction of the in-situ material
- High variation in temperature between day and night
- Compaction of the drain



Barrier System – Northern Cape (RSA)

Conclusions

- Project completed in 1.5 years
- Few lesson learned:
  - Installation of gmb at night
  - Earthworks to thing forward for the installation of the gmb
  - Use of in-situ material requires higher QA
  - Wind uplift and hidden issue under the gmb

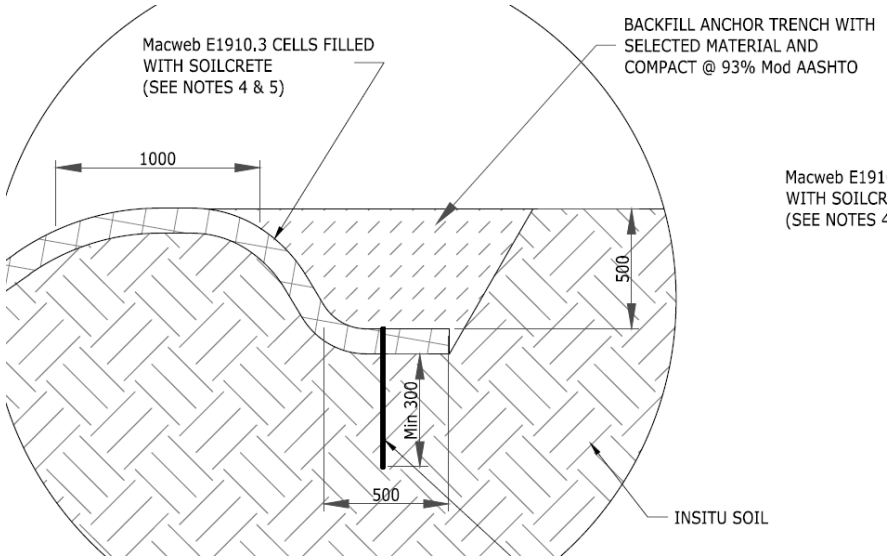
Erosion Control

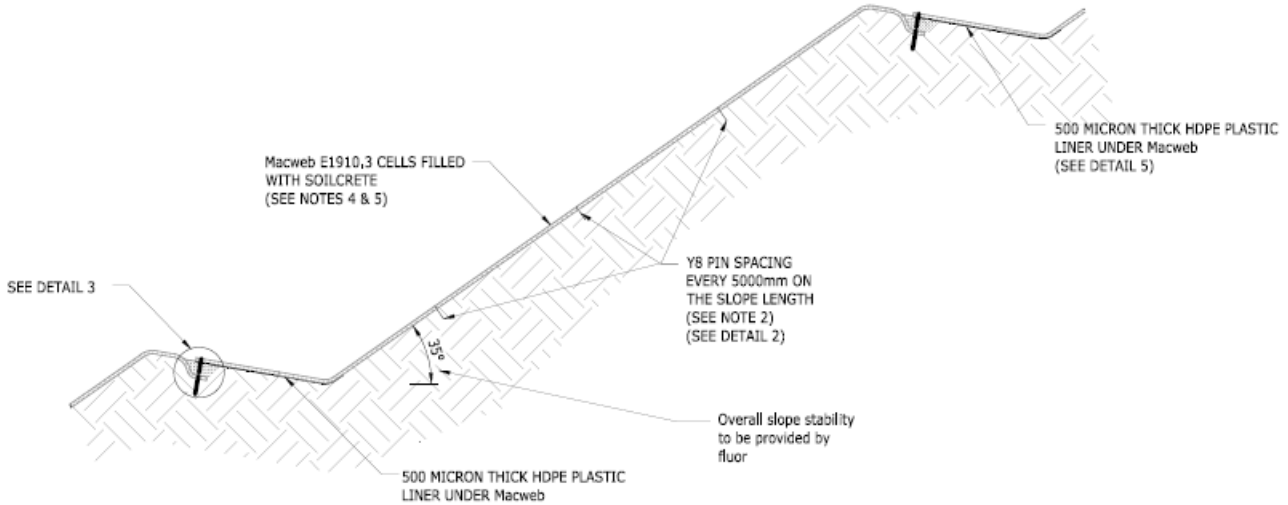
Khoemacau Copper Mining

- The mine required 3 boxcuts up to 52m deep with configuration has 4 benches, 10m high at 35° in Kalahari sand, then sandstone and competent rock with bottom bench at 68°.
- Protection against heavy thunderstorms and rains to prevent sand washing into the boxcuts;
- Semi arid region discourage any vegetation erosion control and the use of in-situ material was a considerable cost saving

Khoemacau Copper Mining – Design Criteria

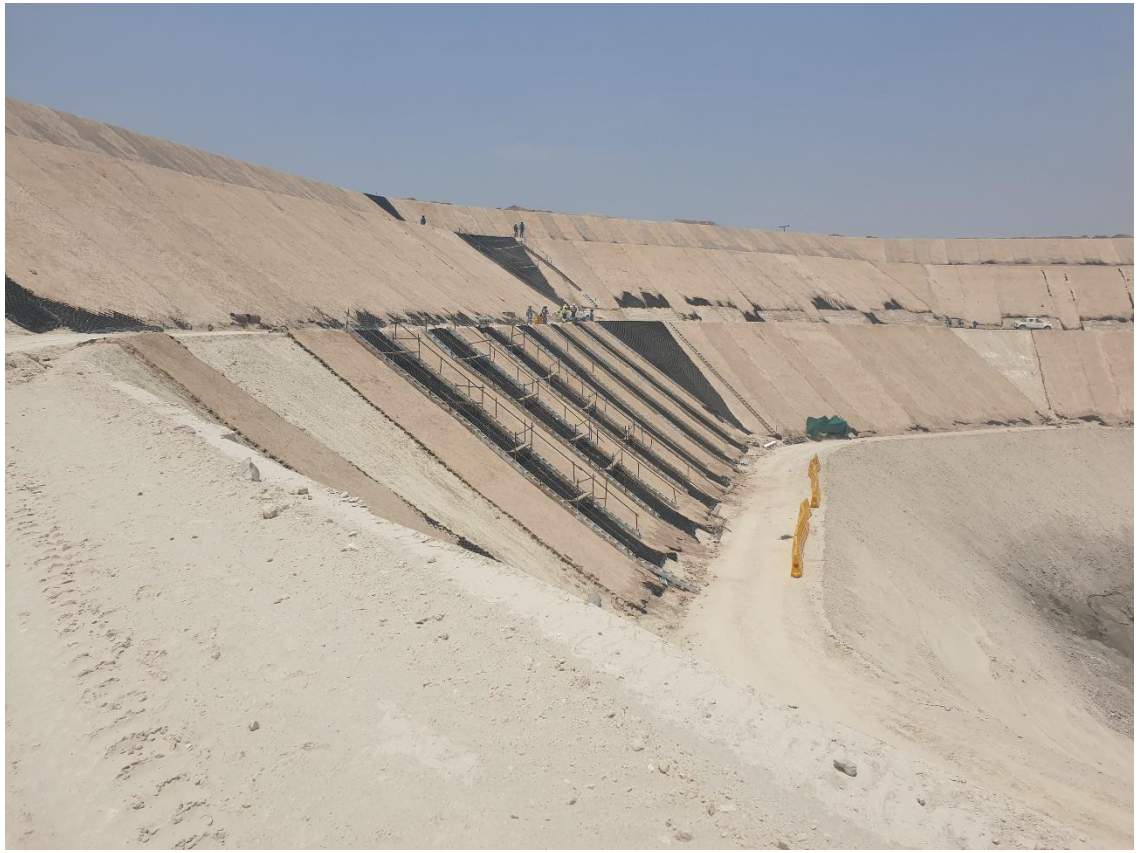
- The availability of Kalahari sand which mixed with cement would provide a minimum UCS of 1.0 MPa supported the use of geocells.
- An 100mm HDPE geocell (380mm opening) with Y8 steel rods every 5m and 500mm anchor trench ensure long term stability is met with an FoS of 1.3





Khoemacau Copper Mining – Construction

Staple gun for joining of panels



Filling procedure

Khoemacau Copper Mining – Construction

Anchor trench detail

Rain damage during construction

Khoemacau Copper Mining

- The use of geocells filled with locally sourced material was a cost-effective erosion protection;
- Steep learning curve for the contractor working on steep slopes;
- Delivery using 8 trucks;
- 180.000m^2 installed over 4 months,

Conclusions

- Geosynthetics are able to convert poor material in suitable material for construction
- Often simple design can be implemented by semi-skilled and earthworks equipment
- It can be adjusted while on construction to cater for different conditions or design changes (if there is enough material)

- GSY are not the “magic wand” of engineering;
- Require knowledge on the product (storage, installation);
- Ad-hoc contractors;
- Lead time might be months;
- One more level of quality assurance (ie. barrier system or crusher walls);
- MQA is a must

Credits

- Jeremy Hocking - Fluor
- Emile Horak - Kobu Engineering
- Chrisjan van Wyk - Khoemacau Copper Mining
- Joseph Meadows - Maccaferri Africa
- Antonie Van Der Westhuizen – Knight Piesold

Thank you for your attention

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