TC211-218 Workshop
MSE Walls and Reinforced Fills

The use of polymeric geogrids in structures with non-standard reinforced fills

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OUTLINE

- Historic Background of polymeric geogrids
- Special considerations for non-standard fills
- Benefits
- Case studies of non-standard reinforced fills

Background - Origin of Geogrids

The first **polymeric geogrid** was invented in the late 1970s in Lancashire, North West of the UK by Brian Mercer

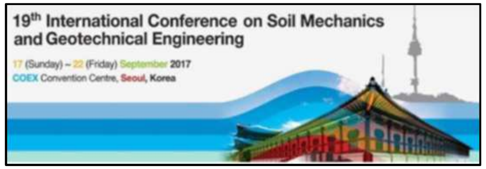
Portrait of Brian Mercer by Salvador Dali

Uniaxial Geogrid

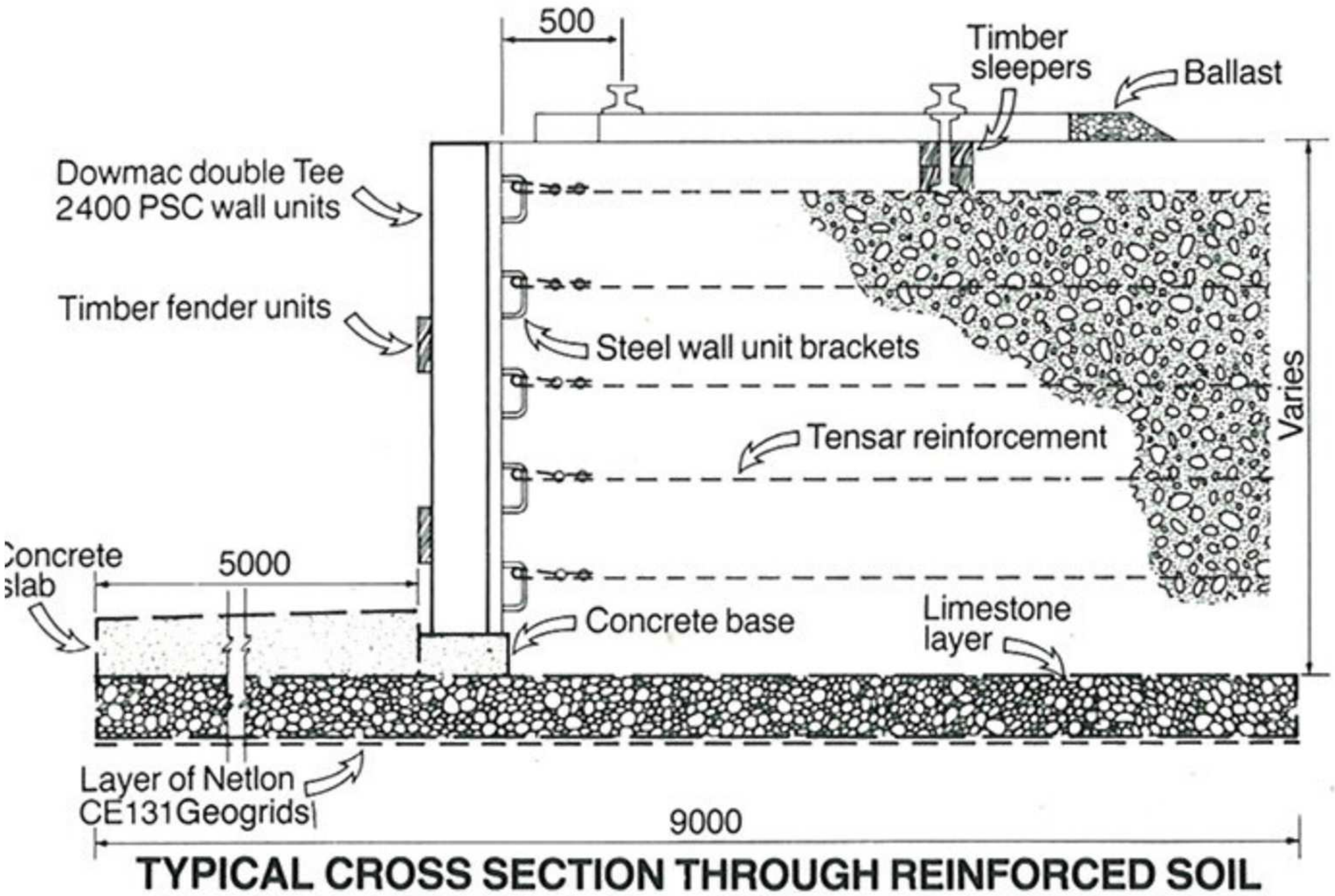
The first Polymeric MSE Wall

The very first application of **polymeric geogrid reinforcement in an MSE wall** was pioneered by West Yorkshire County Council and Prof. Colin Jones and was to construct an elevated temporary railway facility, 2.5m high, at Newmarket/Silkstone colliery in West Yorkshire, UK using <u>non-standard reinforced fill</u>

The structure used mine stone waste (unburned colliery waste) as the fill, precast concrete facing units and sliding connections between the reinforcement and the facing.



The first Polymeric MSE Wall



- ***February 1980 - Newmarket Silkstone Colliery, Yorkshire – reinforced fill was unburnt shale***

The first Polymeric MSE Wall

‘Standard’ Reinforced soil fill

- Majority of reinforce soil structures have since been constructed with ‘standard’ fill, which is selected, good quality, well graded, preferably angular (crushed), granular fill free from organic substances
- What can be achieved with good quality ‘standard’ fill?

Non-Standard Reinforced soil fills

BUT, as Clients focus more and more on cost and CO_2 cutting, a variety of non-standard fills are being used/investigated with HDPE geogrids (flexible, inert and 'forgiving'):

- Cohesive/marginal fills, such as clay rich fills – case study (1)
- Mine industry by-products, i.e. mine stone
- Coal industry by-products, i.e. pulverised fuel ash – case study (2)
- Steel industry by-products, i.e. slag
- Recycled demolition material, i.e. including bricks, concrete
- Landfill waste material – case study (3)
- Chalk fill – CIRIA 574 – case study (4)
- EPS – case study (5)
- Light weight fill, i.e. Leca – case study (6)
- Recycled tyres!

Non-standard reinforced fill – selection criteria

- Project location: site won fill available/suitable? Transportation to nearest quarry/fill source?
- Topography: water features nearby? Susceptible to flooding? Combination of free draining lower and cohesive upper maybe the solution
- Foundation type: light(er) weight fill expense may counterbalance savings from reduction in piling – LWA & PFA
- type of structure: i.e. bridge abutments or very high walls need very good quality fill to minimise the risk of long term deformations; ‘soft’ face structures can accommodate some deformation so lesser fill quality OK, even cohesive fill can be acceptable
- Time: tight construction programme may detect the nearest source or easiest to build, even if not the most economic

Design considerations for non-standard fills

<u>Design/durability considerations/testing requirements</u>

- Shear box/pull-out testing - fill material properties and interaction factors (especially sliding, i.e. rounded or fine fill material)
- Shear box – correct (slow) rate of shearing for 'non-standard', i.e. slow drain clay fills - drained conditions
- chemical analysis – i.e. HDPE is largely inert to chemical attack and to environments with pH2 - pH12.5 but not all soil reinforcement is
- Particle size/angularity - installation damage tests
- Crushability under compaction – particles don't break down under compaction
- Compactability/trafficability of cohesive soils - min Su=35-50kPa

- drainage: even more important for fills like chalk or PFA

Benefits of using non-standard fills

<u>Economic and other Benefits</u>

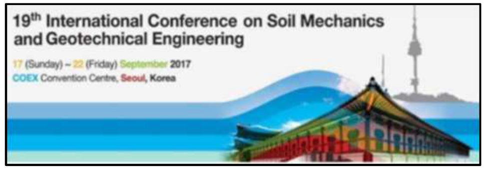
- Site won - free of charge!
- No time wasted in importing fill
- No traffic importing quarried fill or exporting site won ‘waste’ fill- financial and environmental benefits
- Promotes recycling - sustainable solution

- Time and money savings by allowing the use of weaker foundations
- Faster construction programme (less transport, less Foundation improvement effort)
- CO_2 reduction

1. Site won cohesive fill material – case study

Monserrat Airport re-construction

- The original Montserrat W H Bramble airport was destroyed during the eruption of Soufrière Hills Volcano in 1995.
- Between 1995 and 2005, Montserrat had been accessible only by helicopters or boats
- New airport constructed in another safer location to the north with the locally available site won cohesive fill material and HDPE polymeric geogrids



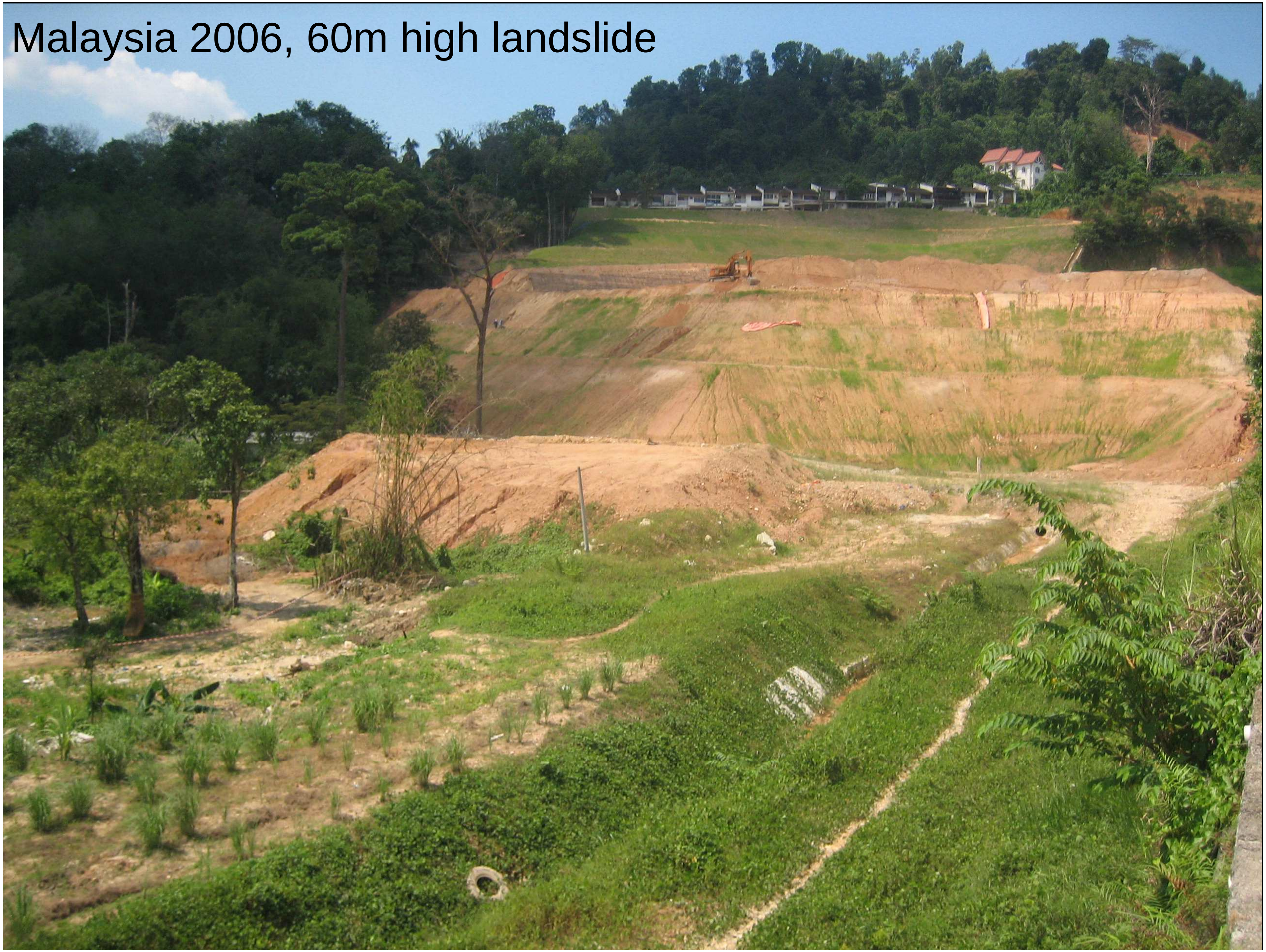
Western Side Embankment

1. Site won cohesive fill material – case study

Monteserat 2005, Airport Embankment 31.5m high

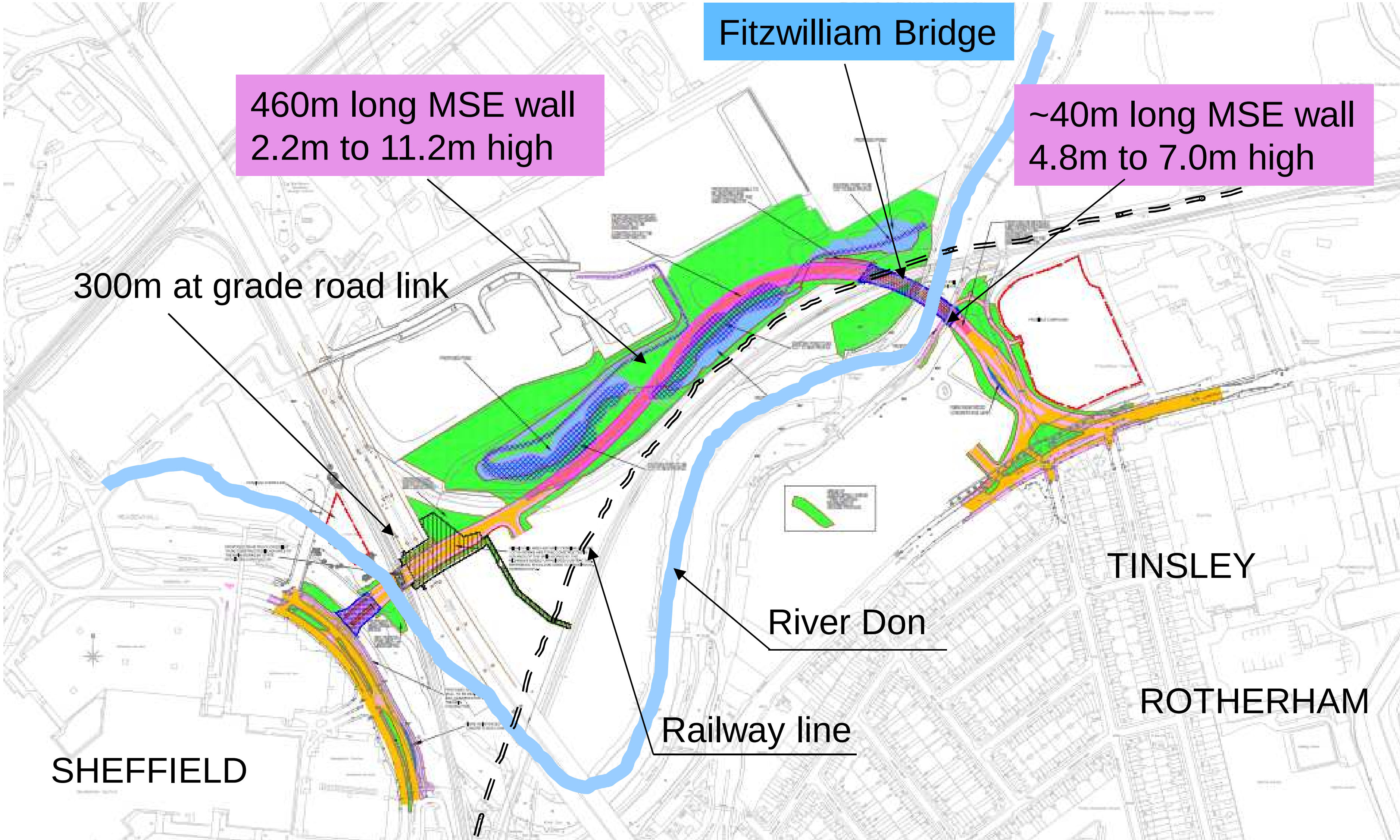
Malaysia 2006, 60m high landslide

Malaysia 2006, 60m high landslide



2. Pulverised Fuel Ash (PFA) – Case Study

New 800m Bus Rapid Transit Link known as 'Tinsley Link', 2015, up to 11m high walls



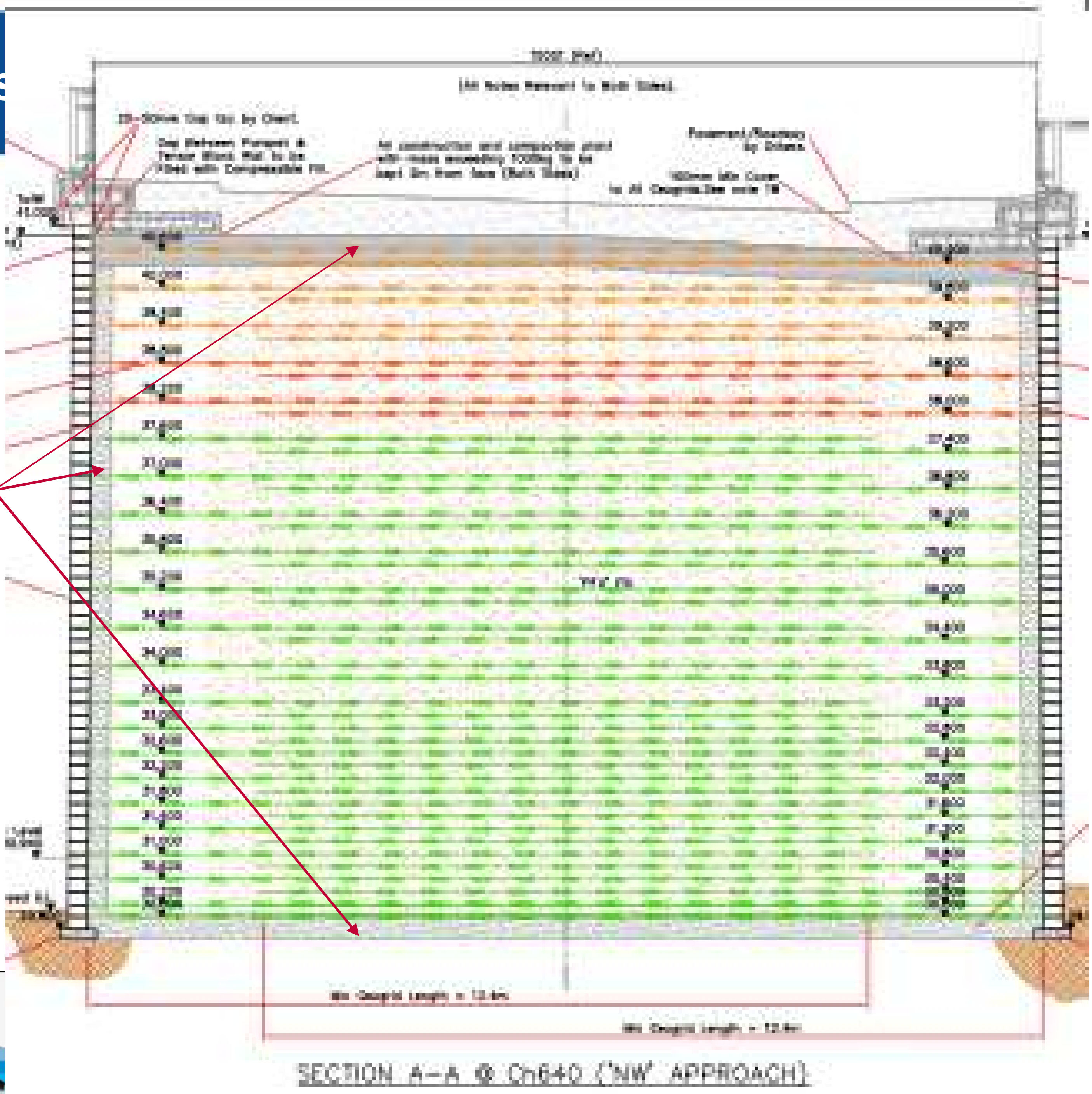
Pulverised Fuel Ash (PFA)

Pulverised fuel ash (PFA), is a very fine (up to 10mm) waste product of coal fired power stations; cements in time and light(er) weight, ~ 15kN/m3

Highly alkaline, typically pH>9 : ok for HDPE geogrids but sensitive materials such as polyester or steel need to be factored in the design

PFA constraints

additional drainage measures must be made as outlined in BS8006:2010 Cl. 6.10.5.2, Cl. 6.10.5.3, and Cl. 6.10.2.6.3



New 800m Sheffield to Rotherham Bus Rapid Transit Link known as 'Tinsley Link', 2015, up to 11m high walls

PFA Case Study

PFA Case Study

3. Use of a landfill waste material – case study

Dan-Y-Lan Landfill (1955-1971) up to 30m high landslip remediation, 2004-6

Use of a landfill waste material

Installation damage factor was increased due to broken glass in the waste

Compaction trial and error: tracked plant to vibrating rollers and small tractor dumper to large dumper tractor

Use of a landfill waste material

Use of a landfill waste material

4. Chalk reinforced Fill – case study

Chalk reinforced Fill

5. Expanded Polystyrene (EPS) reinforced Fill

Photo credits: http://www.epsindustry.org/other-applications/geofoam

6. Light Weight Aggregate (LWA) fill

Light Weight Expanded Clay Aggregate- bulk density of the material vary from 3.75kN/m^3 to 6kN/m^3, $\phi' = 36^o$

Light Weight Aggregate (LWA) reinforced fill

No specific compaction required as pneumatically placed and just compacted by traffic lorries

On weak foundations reduce the amount of foundation upgrade (piling) and therefore the project cost

Geogrid/LWA specific testing must be carried out to obtain the interaction characteristics required for design

Light Weight Aggregate (LWA) reinforced fill

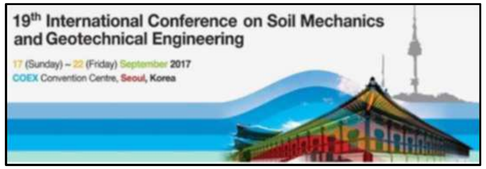
Doncaster (FARRRS) Bridge approach ramps, up to 12.5m high, 2016

The use of polymeric geogrids in structures with non-standard reinforced fills

감사합니다 !

Ευχαριστώ !

THANK YOU!



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