Vegetation Management – chop it all down!

Lee Parry
Vegetation management
Trees - friend or foe?

- Introduction and objectives
- Changing vegetation patterns
- Vegetation impacts
- Moisture, pore pressures and deformation
- Key questions
- Development suggestions
1) Vegetation hazards

Include:

- Track deformation (embankments)
- Strain softening / progressive failure
- Tree / leaf fall
- Safety risk to operatives
- Impaired sighting
- Root ball fall
- Impaired drainage
- Root jacking
- Hamper examinations
- Fire risk
- Interference with track circuits
2) Vegetation benefits

Impacts of well maintained vegetation include:

- Reduction in shallow instability (enhanced cohesion - roots)
- Reduction of porewater pressures in clay slopes
- Shielding chalk cuttings from frost shattering
- Vegetation cover reduces run-off and subsequent erosion
- Visual and / or noise screen
- Habitat corridor
Trees – friend or foe?

‘The influence of vegetation on the railway and earthwork slopes in particular is rarely, if ever, wholly beneficial or wholly detrimental but almost always manifests as some combination of the two extremes.’

Vegetation and slopes, Gellately et al, 1995

- Need to balance the risks and benefits from vegetation – geology, vegetation type & location are key factors
Failure and Deformation

- deep seated instability
  - shrink/swell induced progressive failure
  - most costly renewals
- vegetation effects
  - pore pressure regime
  - seasonal deformations, important cause of summer delays
  - root reinforcement

Precipitation Infiltration and Evapotranspiration

1. Hydro-Geological Processes
   - Seasonal variations of moisture content and pore pressures

2. Slope Deformation Mechanisms
   - Serviceability Issues
   - Ultimate Limit State Stability Issues
     - Seasonal deformation
     - Shrink/swell induced progressive failure
     - Shallow translation slips
     - Reactivation of old shear surfaces

Poor/unacceptable performance of rail assets
- high water demand (HWD) – 10x movement of grass covered area
- rate of movement (PWP change) → temperature/rainfall, tree type
- HWD trees – oak, poplar
- trees – “temporary dewatering wells – on in summer, off in winter”
- Grass area, FoS = 1.1. Tree area, FoS = 1.3
Level Changes With Time
‘Fatigue’ failure of high PI clay fills – consequence of seasonal changes in pore water pressure

High plasticity clay, post-peak strain softening

NB Mechanism observed in both numerical and centrifuge modelling and in field
Climate/vegetation modelling

- Tree covered slope
- **Summer**
  - high suctions in root zone
  - track deformations
- **Winter**
  - infiltration in cracked surface zone (high vert. permeability)
  - persistent suctions maintained at depth in root zone
  - beneficial for stability
  - toe is wetter

Suctions greater than -50kPa shown white
Climate/vegetation modelling

- **Tree removal:**
  - 2/3 Grass – 1/3 Trees

- **Summer**
  - high suctions in root zone
  - shallower for grass
  - less track deformation

- **Winter**
  - persistent suctions lost with time after tree removal
  - trees at toe still helping deep stability

Suctions greater than -50kPa shown white
Highways Agency - London Clay Cuttings

The diagram illustrates the relationship between slope angle (cot(B)) and height, with distinct regions labeled as stable and unstable slopes. The graph highlights critical areas indicating time to failure and the dominance of less weathered material. The axes are labeled with specific values, such as height and slope angle, and the diagram includes annotations for different failure conditions, such as shallow failures dominating at lower heights. The legend explains the stability envelope, with different lines representing specific conditions for London Clay.
M23/M25 Intersection - Surrey
Vegetation: Summary of key points 1

- **Good**
  - reduced water pressure >> enhanced stability (if clay slope and high water demand)
  - root reinforcement
  - screening and ecology

- **Bad**
  - seasonal track deformations (if clay slope and high water demand)
  - train operations (sighting and leaffall)

**High water demand trees cause:**

- >> deformations .....but
- >> persistent suctions prevent failure
When removing vegetation for any reason, need to consider:

- tree removal should only be undertaken within a framework of assessing risks with respect to SLS and ULS
- renewal works may be required in combination with tree removal depending on conditions
Key Question 1
Vegetation Patterns

- Historically cuttings lightly vegetated, today heavily vegetated with an increasing number of trees

- Future aspirations?
Key Question 2

Is it getting wetter?

Rainfall Dec 2013-Feb 2014*
% of 1981-2010 average

- More than 225
- 200-225
- 175-200
- 150-175
- 130-150
- 110-130
- 90-110
- 70-90

Source: Met Office *Data from 1 Dec 2013 to 19 Feb 2014
Future developments - Practitioners

- Unsaturated soil behaviour is relevant for UK
- Non-hydrostatic + transient nature of pore pressure regime
- More effort to assess fabric + permeability
- What are the relevant strengths and groundwater pressure to use?
- Conventional piezometer monitoring – often inadequate
Future developments - Research

- unsaturated hydraulic properties
- field studies
- pore pressure/vegetation/climate interactions
- more reliable field test methods - permeability (near surface and at depth)
- desiccation cracking - mechanisms + effects
Thank you - Questions?