

Serviceability – Numerical Analysis

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BGA Symposium – Eurocode 7 Today and Tomorrow, Cambridge, England, March 2011

Introduction


- *Today*
 - SLS Design
 - ULS Design
 - ULS Design example
- *Tomorrow*
 - Work in progress



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Today


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SLS

- FEA well-suited to SLS design
 - Predominantly elastic deformations
 - $\gamma = 1.0$
- More emphasis in EC7 on deformation prediction
- Experience
- Soil characterisation
 - EC7 has formalised the process more
 - Appropriate for limit state (e.g. use φ'_{peak} for SLS, φ'_{cs} for ULS)
- Stiffness parameters
 - Linear (uniform or varying with depth)
 - Stress-dependent
 - Strain-dependent
 - Anisotropic



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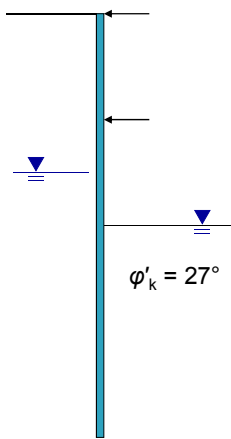
ULS

- FEA not generally suited to ULS in EC7 (still many issues to resolve)
- ULS issues
 - Effect of constitutive model
 - Effect of deformations, consolidation
 - Meshing effects
 - Effect of stress ratio K_0
 - Experience of ULS design using FEA
 - Influence of structural elements
- EC7 issues:
 - Effect of design approach (DA)
 - When and where to apply partial factors?
 - Are National Annex partial factor values intended for FEA?

ULS – Partial factors

- Material factoring (DA1(2) and DA3):
 - More suited to FEA
- Load and resistance factoring (DA1(1) and DA2)
 - Straightforward for external loads (e.g. shallow foundation)
 - More difficult for geotechnical loads (e.g. retaining wall)
 - Loads: factor *effect* of actions
 - Resistances (DA2): difficult. Some NAs allow DA3.
- Partial factors can be applied in two ways:
 - Continuous factoring: partial factors applied throughout all stages
 - Discontinuous factoring: characteristic values in all construction stages with separate ULS verification – suited to $\varphi' - c'$ reduction procedure for material factoring

ULS example

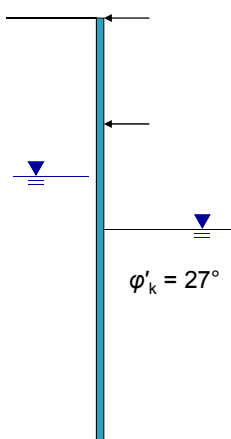


- Embedded cantilever diaphragm wall
- Double-propped, 8m high, 8m embedment
- 2D plane strain FEA
- Linear soil stiffness (increasing with depth)
- Mohr-Coulomb failure criterion

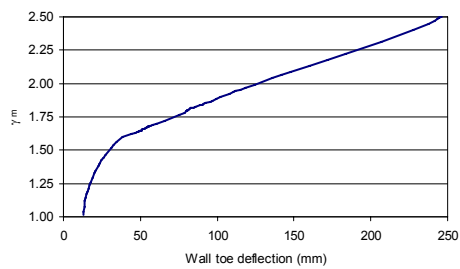


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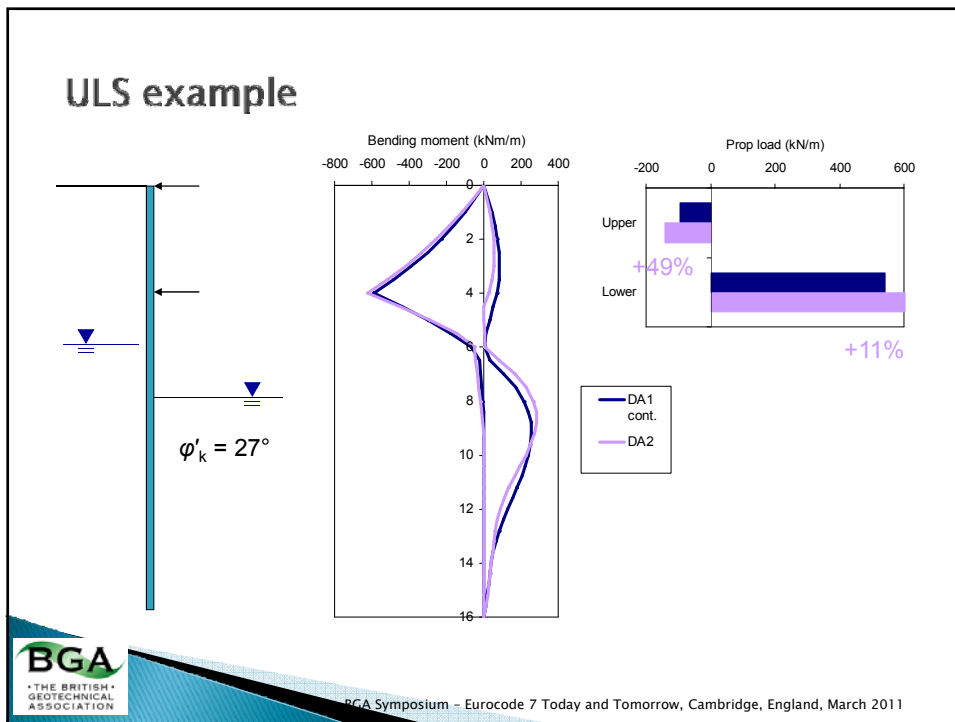
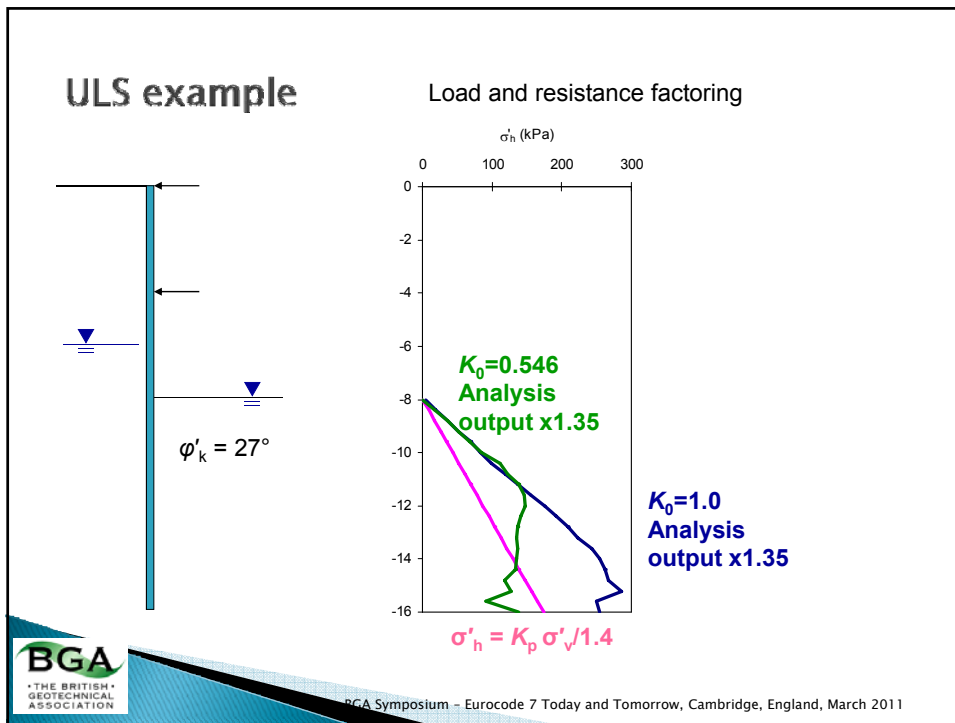
ULS example

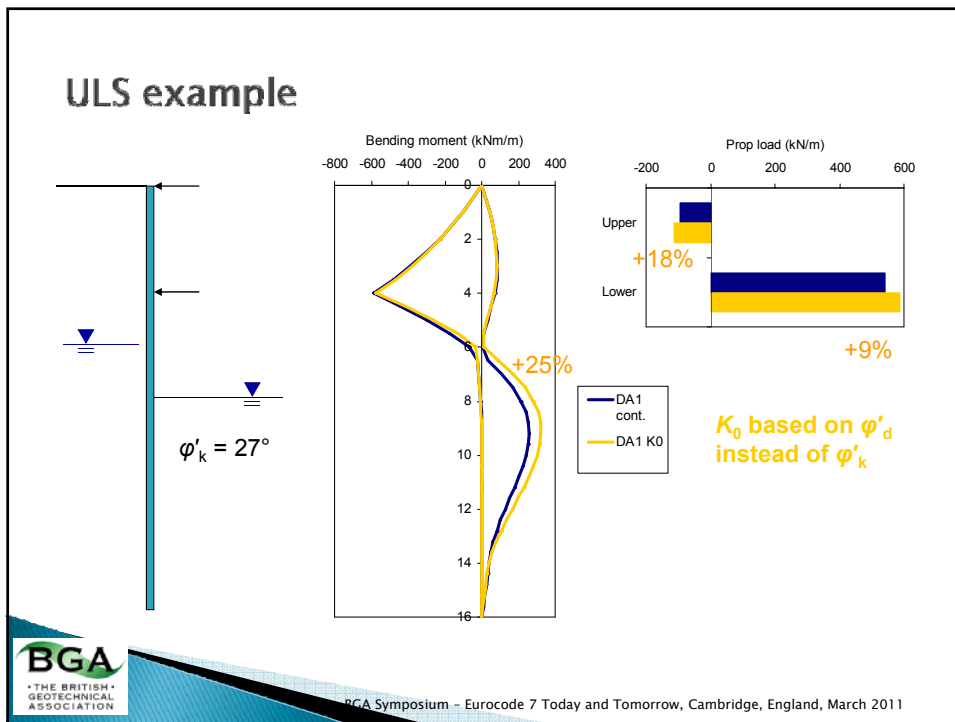
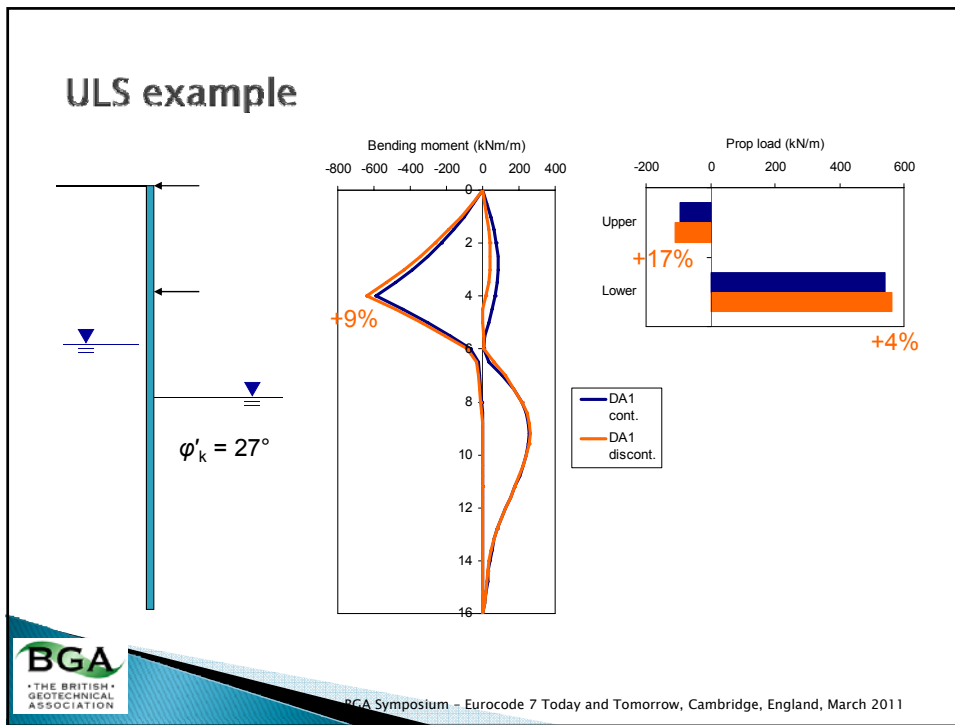


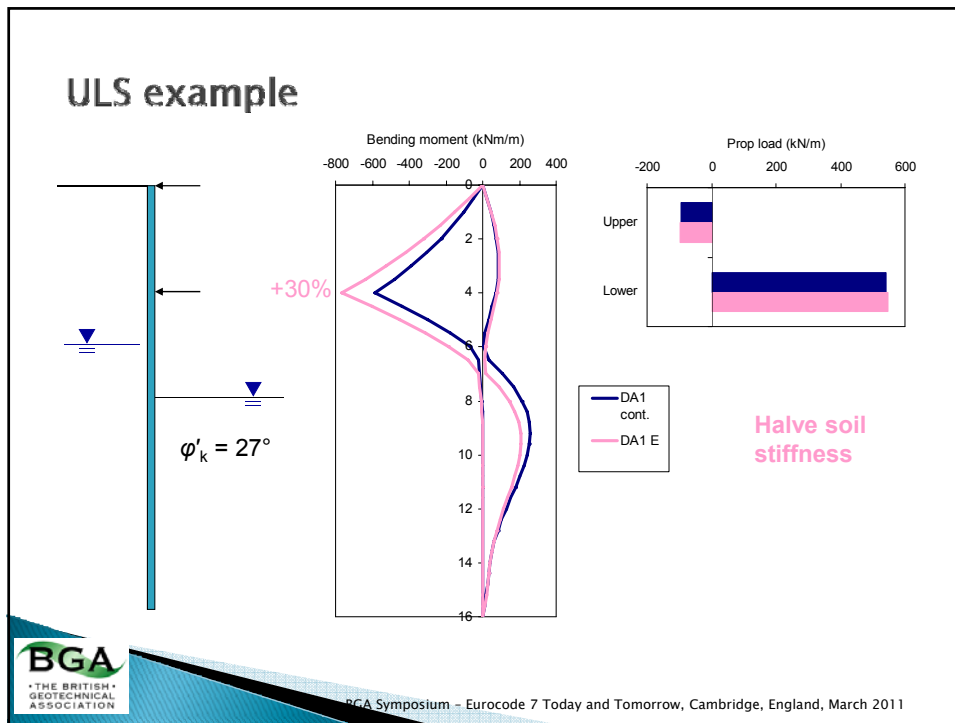
Material factoring: ϕ' - c' reduction



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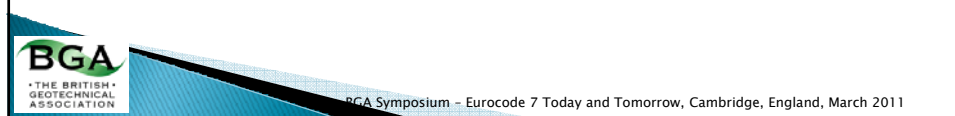






Numerical analysis and EC7

- Numerical methods explicitly recommended in EC7.
- But insufficient provision in the clauses
- SLS design relatively straightforward
- ULS design:
 - Many issues to overcome
 - For now, employ careful validation practices



Tomorrow

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Tomorrow

- Work in progress
 - Eurocode 7 Committee Task Group
 - NAFEMS Geotechnical Committee
 - Needs a Europe-wide effort
- Amend EC7?
 - Annex covering numerical methods
 - Suitably qualified and experienced personnel (SQEP)
 - Link to Geotechnical Categories

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Tomorrow

- EASIT² Project (www.easit2.eu)
 - Defining the generic competences needed in engineering analysis
 - Preparing a competence framework for recording analyst competences and identifying training needs
 - Launching a *Skills Passport* providing recognition of achievement of competences
 - Could be adopted and modified for geotechnical analysis
 - And referred to in EC7?



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Obtaining Parameters...

- Guidebook *Obtaining Geotechnical Parameters for Numerical Analysis*
- Available next year



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