ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ & ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ

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Άνδεις, Χιλή

Sunrise at Mount Cook, New Zealand

Owyhee river, Idaho, USA

Cliffs at Na-Pali coast, Hawaii, USA

ΑΡΘΡΑ

Geomechanical modelling of the Dutch radioactive waste disposal facility accounting for uncertainties

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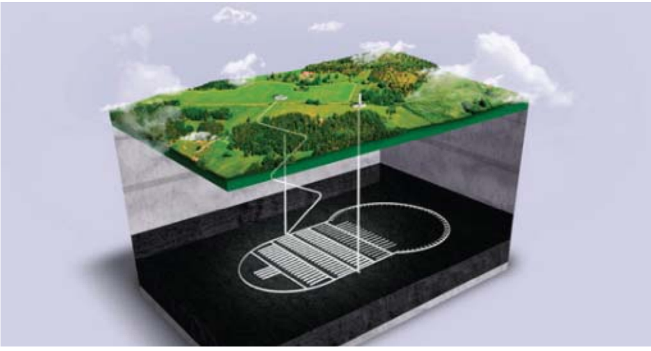


The current generic radioactive waste disposal concept in the Netherlands is designed to be situated in a Boom Clay stratum at approximately 500 m depth. The location of such a repository has not been decided and, as such, the design contains many uncertainties. The impact of these uncertainties are important to the feasibility of the repository design and construction, with respect to both stability and consequential financial performance. The objective of this study is to develop an approach that uses probabilistic methods to quantify uncertainties, and utilises PLAXIS to assess the geomechanical repository behaviour during and after construction. In addition, the new Thermal module in PLAXIS has been utilised to provide an initial assessment of the temperature changes in the Boom Clay. This research project was undertaken as part of the OPERA research programme.

1. Introduction

The current disposal concept for radioactive waste in the Netherlands is based upon the Belgian supercontainer concept and is designed to be situated in a Boom Clay stratum at approximately 500 m depth (Verhoef et al., 2014). The location of such a repository has not been decided and, as such, the design contains many uncertainties. The impact of these uncertainties are important to the feasibility of the repository design and construction, with respect to both geomechanical stability and consequential financial performance. In particular, the tunnel lining, initially estimated to be 50 cm thick (Verhoef et al., 2014), has been estimated to be up to 80% of the total repository construction costs (Barnichon et al., 2000).

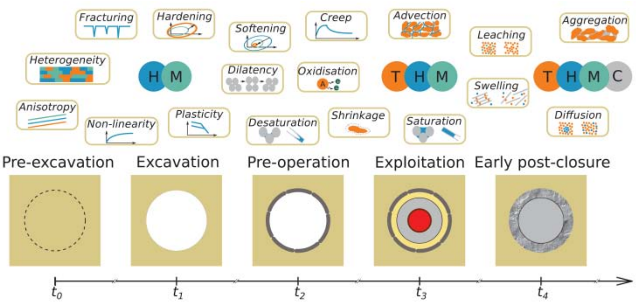


Figure 1: Schematic outline of life-time phases of a radioactive waste repository and processes influencing the repository performance

The life-time of a radioactive waste repository may be categorised into five phases, which are schematically outlined in Figure 1 where different stages of the repository evolution are outlined. The current outline of the OPERA repository is shown in Figure 2. The design consists of a single level with the waste being segregated in specific zones. The main gallery, connecting the shafts with all disposal zones in the repository, is excavated in a single loop and will serve all transportation and access purposes. In Zones A and B, dead end disposal drifts with an envisaged length of 200 m are excavated perpendicular to the secondary galleries. The disposal galleries in Zone C are planned to be excavated directly from the primary gallery, with a length of 45 m. The deep geological repository concept consists of an Engineered Barrier System (EBS) and multiple natural barriers, in order to satisfy all containment and long-term isolation requirements for the disposal of radioactive waste.

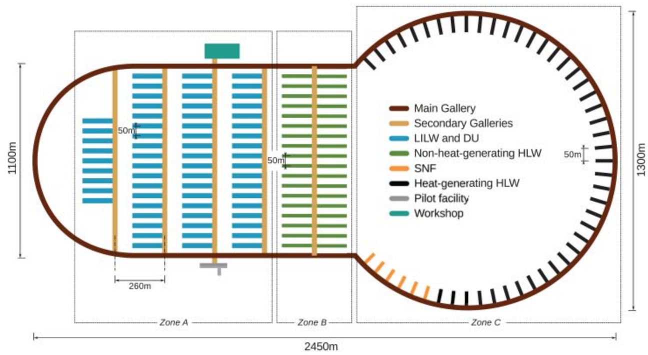


Figure 2: Schematic outline of the OPERA deep geological underground disposal facility in Boom Clay (after Verhoef et al., 2014). LILW is Low and Intermediate Level Waste, DU is Depleted Uranium, SNF is Spent Nuclear Fuel and HLW is High Level Waste

To construct and operate the repository, stability is required. For the tunnels, a lining is required for structural stability and to limit convergence due to the Boom Clay behaviour. Due to the plastic nature of the Boom Clay, a stiff lining was required, and therefore the use of pre-cast concrete segments was specified. A cross section of the tunnel for the disposal galleries is shown in Figure 3.

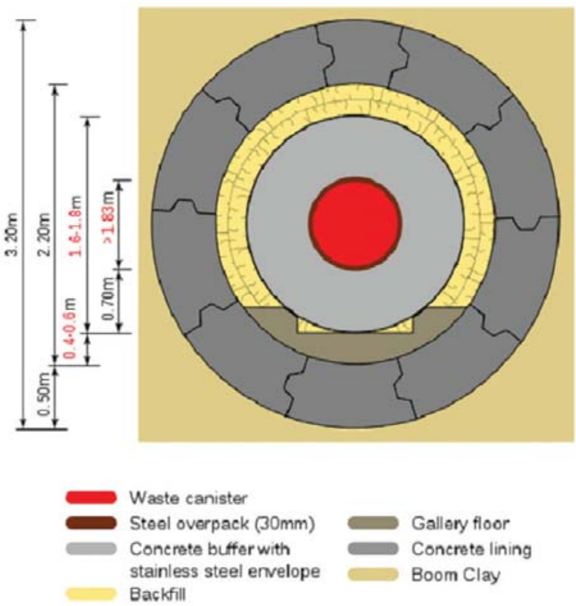


Figure 3: Cross section of the disposal galleries

Assessments of the tunnel stability, including the possible gallery spacing, constitutive model selection and parameterisation, probabilistic analysis of uncertainties and an initial thermal assessment were undertaken. In the main, these analyses fit into the excavation and pre-operation stage and the thermal analyses fit into the early post-closure phase (see Figure 1). This work was undertaken as part of the OPERA research programme and specifically work package 3.1. The final results are available in Arnold et al. (2015).

2. Boom Clay behaviour

Boom Clay is a marine Oligocene shelf deposit from the Lower Oligocene Rupelian stage and builds with the Bilzen and Eigenbilzen Formations the Rupel Group. A detailed analysis of the geological extents and geohydrological setting can be found in Vandenberghe et al. (2014).

In general, Boom Clay can be considered as a non-linear (stress-dependent) material in terms of the stiffness, which may also be anisotropic in behaviour (e.g. Deng et al., 2011). While many studies on Boom Clay have been undertaken, there are little data from appropriate depths for the proposed repository. A number of boreholes have been made, including hydro-mechanical investigations. In addition, the underground laboratory in Mol at -223 m is a source of samples and in-situ data.

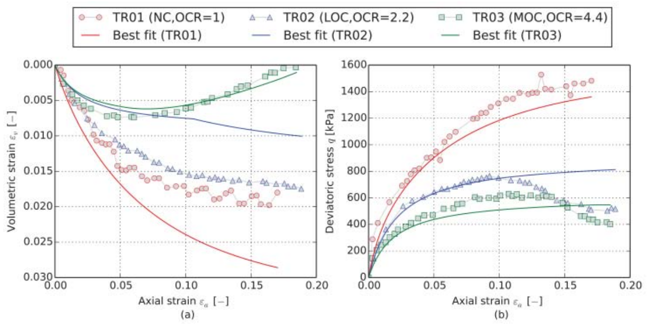


Figure 4: Results of three Boom Clay triaxial tests (after Deng et al., 2011) and best fit material model results, based on a single set of fitting material parameters (Table 1)

Table 1: Boom Clay parameters for the HS model

Property	Symbol	Value from HS calibration
Reference secant modulus*	E_{50}^{ref}	8.53 MPa
Reference un-/reloading modulus*	E_{ur}^{ref}	20.94 MPa
Reference oedometer modulus*	E_{oed}^{ref}	11 MPa
Rate of stress dependency of stiffness	m	0.7
Un-/reloading Poisson's ratio	ν_{ur}	0.3
Dilatancy angle	ψ	0°
Effective friction angle	ϕ'	12.4°
Effective cohesion	c'	0.11 MPa

*Reference stress p_{ref}= 0.1 MPa

Deng et al. (2011) performed a series of triaxial tests at different over-consolidation ratios and the results are shown in Figure 4. From these tests it can be concluded that the soil behaviour is non-linear. The confining stress and the over-consolidation ratio are highly influential in determining the material properties, and the soil stiffness decreases significantly with axial strain.

A thorough investigation of material models and parameterisation was undertaken to select an appropriate model. For each material model, a single set of parameters was calibrated to best fit all three sets of test data. It was concluded that the Hardening Soil (HS) model was the most appropriate, due to its ability to simulate non-linear material properties and both dilation and contraction due to shearing. However, strain-softening behaviour could not be simulated, as the material model does not include such behaviour. Among the other models tested, the Modified Cam Clay model was able to include strain-softening, but the representation of other behaviour was poor. The best fit results for the three triaxial tests for which the model was calibrated are shown in Figure 4, alongside the experimental data, with the material parameters shown in Table 1. It is emphasised that a single set of parameters (Table 1) was used to give results for all tests.

To show the uncertainty/heterogeneity of the Boom Clay layer, a compilation of selected Boom Clay test data (in terms of the effective stress Mohr-Coulomb failure criterion) with respect to depth, is plotted in Figure 5. It is seen that a wide spread of data exists, with some depth trends apparent in the shear strength profile. A detailed statistical analysis of the small database of available data was carried out, with both depth-related statistics and cross-correlation between material properties being considered. This resulted in a depth dependent trend in measured material parameters, including the confidence levels of the fit and the standard deviation of the residuals (deviation) from the fit (see the example in Figure 6). Figure 7 presents the cross-correlation between the effective cohesion and effective angle of friction (in standard normal space). A clear negative correlation is shown to exist.

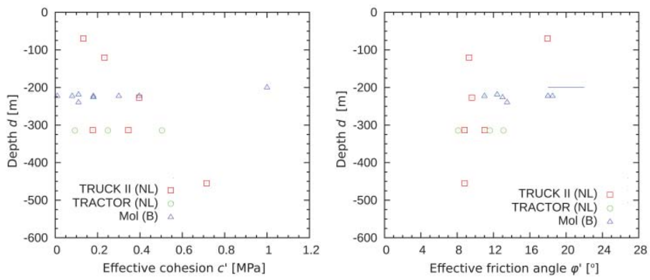


Figure 5: Effective cohesion c' and effective friction angle φ' of Boom Clay samples at different depths, locations and research projects: TRUCK II, TRACTOR and at the HADES in Mol

The analyses presented below utilise the parameters obtained from the triaxial tests shown in Figure 4. However, the clear depth dependency indicates the uncertainty in the parameters, therefore without further experimental data the results should be considered preliminary.

3. Assessment strategy

A probabilistic Reliability Based Design (RBD) framework was used in this project. The variables utilised are set up in a vector, X, along with their statistical distributions. In addition, a limit state, i.e. what part of the design you would like to optimise for, must be defined. In this case, the plastic radius of the tunnel was decided to be a single limit state, with a second being the stability of the tunnel lining.

A RBD module was developed based on the OpenTURNS library (OpenTURNS, 2014) which used PLAXIS as the geomechanical engine. A flowchart of the module operation is presented in Figure 8, where in Figure 8(a) the vector X is established, (b) the geomechanical model is run multiple times utilising selected combinations of the material properties, controlled by OpenTURNS reliability methods, such as the Monte Carlo Method or the First/Second Order Reliability Method (FORM/SORM), (c) outlines the assessment against the limit states and (d) is an output visualisation assessing the sensitivity of various parameters. After this point either more information can be used to constrain the analysis via optimisation of either the design or material parameter uncertainty (e), or the safety can be assessed (f).

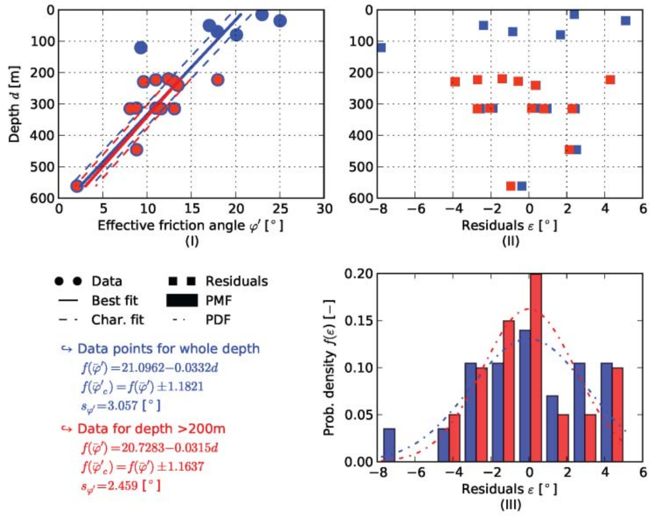


Figure 6: Statistical interpretation of the effective angle of friction

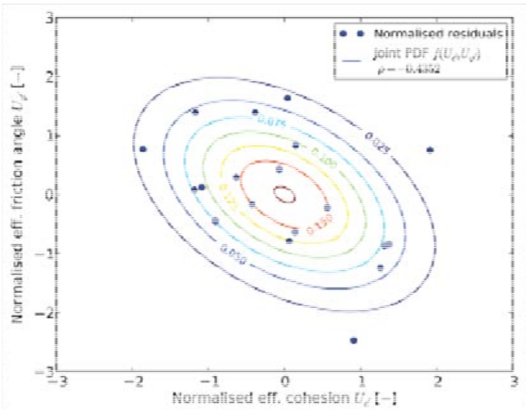


Figure 7: Correlation between normalised residuals of soil cohesion and friction angle of Boom Clay, sampled at different depths and locations, with the isochrones representing the bivariate joint probability density function

The reliability methods used can have a large effect on the amount of computation required. For Monte Carlo methods, in general, a very large amount of computation is required, which is unfeasible for detailed geomechanical models, such as required here. FORM/SORM typically require significantly less, in this work it was found to be ~200 analyses, rather than ~25,000 for the Monte Carlo methods, which were initially tested with an analytical model (see Arnold et al., 2015). This level of computation proved to be unfeasible to use a detailed geomechanical engine, such as PLAXIS.

4. Results

A selection of representative results is shown below. For further results and detailed analysis, please refer to Arnold et al. (2015).

4.1 Deterministic tunnel stability model

In this section the deterministic response of the Boom Clay due to the excavation of a tunnel is investigated. This model is then utilised by the probabilistic module, by varying the HS model parameters. The results are presented in the following section.

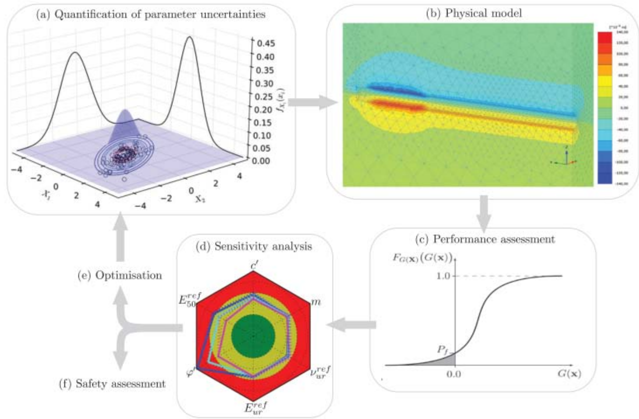


Figure 8: Flow chart schematically showing the employed RBD model framework

Figure 9 shows the model domain, boundary conditions and mesh of the numerical model. The bottom boundary is fixed, with the left-side and right-side boundaries fixed in the horizontal direction and free in the vertical direction. The initial vertical effective stress in the domain was set to be hydrostatic with a depth of 420 m to the top of the domain (initially with an additional part of the domain, not shown on the figure). Initial horizontal effective stresses were computed using the K0 procedure. Subsequently, the additional part of the mesh was removed from the initial domain to result in the 80 × 160 m model domain with a total vertical stress of 4.2 MPa applied along the top boundary. The domain was discretised using 15-node triangular elements and refined in the vicinity of the tunnel. In the basic HLW gallery set-up, the tunnel radius was 1.6 m, and the overcut (distance between the tunnel lining and rock) was 75 mm. The domain was discretised by 8554 elements with 68946 nodes. The tunnel construction process except for the overcut was not considered.

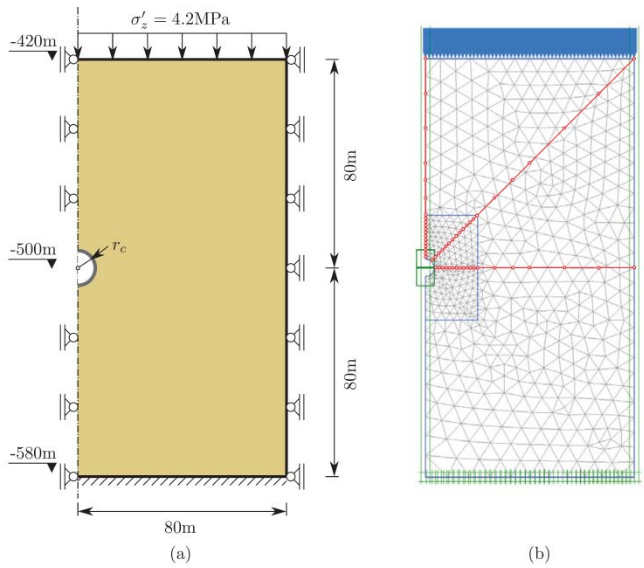
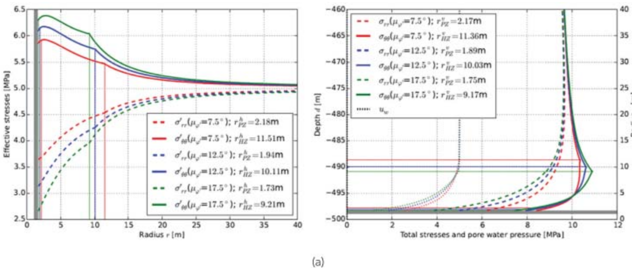


Figure 9: Base set-up for a deterministic two-dimensional plane strain analysis at 500 m depth: (a) Model domain and boundary conditions; and (b) Discretisation using 15-node triangular elements. Red lines represent the data output axes (horizontal, vertical, diagonal)

An example result of the plastic zone is depicted in Figure 10. As expected, it is seen in Figure 10(a) that the radial stresses decrease and the tangential stresses increase, causing hardening and shear failure. The plastic zone is shown in Figure 10(b), where, due to K0 equals 0.9 in this case, the horizontal extent of the plastic zone is higher than the vertical extent. Here, the plastic zone extends about 12 m from the tunnel centre, with a small zone close to the tunnel where the material has reached the failure line.



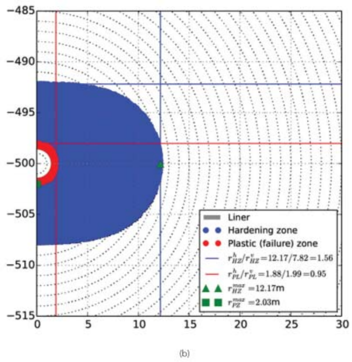


Figure 10: Undrained response: (a) Radial and tangential stresses with a change in friction angle, (b) Gaussian integration points showing the extent of the Plastic Zone (PZ) and Hardening Zone (HZ) for the mean property values and an earth pressure at rest K_0 = 0.9

An initial sensitivity analysis (not presented here, please see Arnold et al., 2015 for details), yielded results that the plastic zone would not be large enough to affect an adjacent tunnel and additionally the radial stress would not be high enough to cause instability in the tunnel lining. This yields the possibility to reduce the tunnel spacing and the lining thickness, if other performance criteria allow, such as changes in permeability or thermo-mechanical behaviour.

4.2 Probabilistic results

As previously stated, the location for such a repository has not been decided and, as such, the design contains many uncertainties. By carrying out a probabilistic assessment, the importance of the uncertainty in the material parameters can be assessed. In this case Figure 8 has been followed from (a) to (d). A metric to define the relation between the relative change in value of a parameter to the relative change in response it causes, can be defined. This is called an importance factor (Eq. 1), and can be defined as:

$$\alpha_i = \partial\beta / \partial u_i \qquad (1)$$

where α_i are the importance factors relating to each material property, i; β is the reliability index (the distance in standard normal space of the expected response to the critical point) and u_i is the material property transformed into standard normal space (e.g. Lemaire, 2009). This means that further research can be directed towards investigating this parameter and reducing its uncertainty.

As the amount of data available is small, a probabilistic reliability analysis was performed to investigate the impact of the various parameters. An example result, from a FORM investigation, showing the impact of different coefficient of variations (V = mean / standard deviation) for the E_{50}^{ref} parameter is shown in Figure 11. For the case of a medium coefficient of variation or Case 2, all coefficients of variation are equal to 0.125. In this case the response due to changes in the effective friction angle, φ', is shown to be the most sensitive, followed by the reference secant modulus, E_{50}^{ref}. When the coefficient of variation of E_{50}^{ref} increases from 0.125 to 0.2 (with all other coefficients of variation remaining the same), then this parameter becomes the most sensitive. In these cases the probability of the lining pressure exceeding 7 MPa (arbitrarily set in this case) were 1.4 × 10^{-6} for Case 1, 5.0 × 10^{-6} for Case 2 and 3.1 × 10^{-4} for Case 3, respectively. The small increase in probability of failure between Case 1 and Case 2 is indicative of the E_{50}^{ref} value not being the most important. However, the large increase in probability of failure in Case 3 is indicative of the E_{50}^{ref} parameters being the most important.

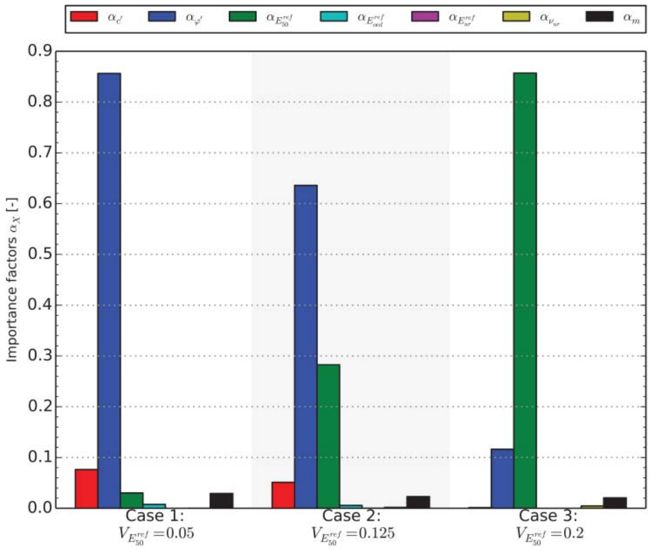


Figure 11: Importance factors α for the three coefficients of variation of E_{50}^{ref}

4.3 Thermal

An initial thermal assessment has been carried out using the new PLAXIS 2D Thermal module. The heat output of the radioactive waste has been assessed, per metre of the disposal tunnel, and included in a 2D model as a boundary condition. The heat output decays over the lifetime of the repository, and a stepwise boundary condition has been utilised.

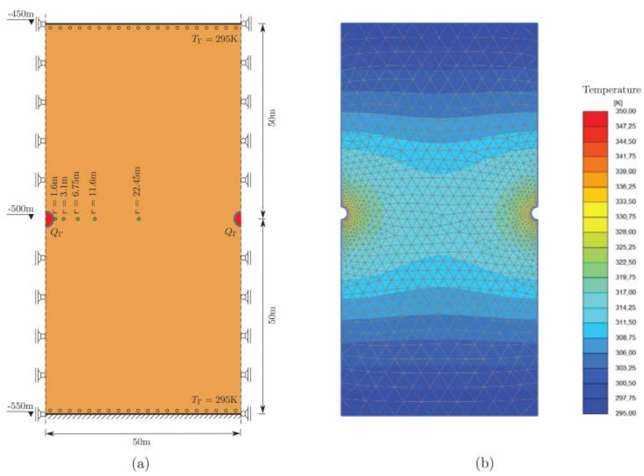


Figure 12: Two-dimensional thermal analysis: (a) Model domain with boundary conditions, (b) Contour plot of the temperature distribution from Scenario Mid at the peak temperature

A 2D model has been adopted, as the disposal tunnels are long compared to their diameter. The corresponding model domain is shown in Figure 12a. The heat flux was applied to the tunnel surface. The side boundaries are 'no heat flow' boundaries due to symmetry, and the top and bottom boundaries are fixed. The initial temperature was 295K (~22°C). Sample results are presented in Figure 12b as a contour plot of temperature and quantitatively in Figure 13. It can be seen in Figure 13 that the predicted maximum temperature is ~335K (~62°C) at approximately 30 years, in the Boom Clay closest to the tunnel. For the following 30 years the temperature seems to remain approximately the same and decreases over time. Sensitivity analyses have been presented in Arnold et al. (2015) to account for uncertainties in the material properties. In none of the cases considered were the temperatures close to thermal limits that have been suggested, e.g. 100°C or 85°C.

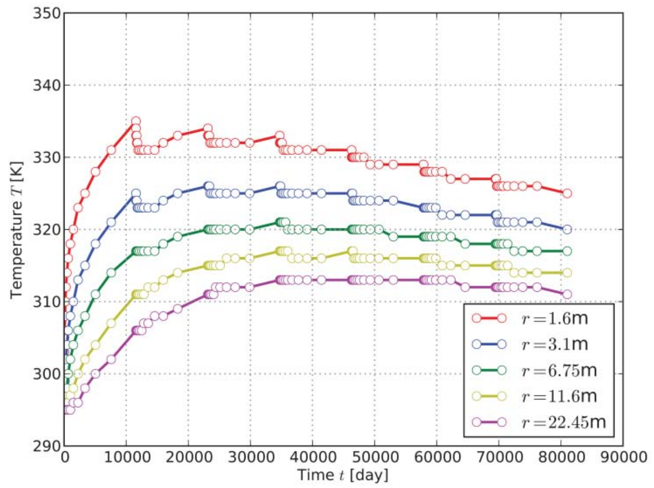


Figure 13: Thermal results in time at points 1.6 m, 3.1 m, 6.75 m, 11.6 m and 22.45 m along a horizontal line from the centre of the tunnel

Conclusions

An investigation into the feasibility of the current OPERA repository reference design has been undertaken for individual tunnel galleries at realistic disposal depths, with respect to the Boom Clay geomechanical behaviour, during the excavation, and during the pre-operational and early post-closure phases. The full report is presented in Arnold et al. (2015).

The location for the repository has not yet been decided and, as such, the design contains many uncertainties. The impact of these uncertainties are important to the feasibility of the repository construction, with respect to both stability and consequential financial performance. An approach has been developed that uses probabilistic methods to quantify uncertainties, and utilises PLAXIS to assess the geomechanical repository behaviour during and after construction. In addition, the new Thermal module has been utilised to provide an initial assessment of the temperature changes in the Boom Clay.

The Hardening Soil model was chosen as the appropriate soil model, since many of the non-linear features of the Boom Clay can be simulated. Strain softening, however, could not be simulated, as this material model does not include such behaviour. This study suggests that the tunnel construction would remain stable, and stability would not be affected by an extension of the plastic zone to adjacent tunnels, or via radial stresses on the tunnel lining. In addition, a thermal analysis indicates that temperatures would be unlikely to reach values that would be in excess of limits chosen. However, there was only a limited amount of experimental data at appropriate depths available. Therefore an investigation into the changes in material variation was undertaken. This approach can be utilised further when additional information becomes available and uncertainties can be reduced.

Acknowledgements

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Back analysis of settlements beneath the foundation of a sugar silo by 3D finite element method

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In the city of Kaposvár, Southwestern Hungary, a new sugar silo with a diameter of approximately 60 m and a storage capacity of 60,000 tons was constructed in 2013 on the site of Magyar Cukor Ltd. (Figure 1). The purpose of the recent study is to back analyse the foundation performance of the sugar silo. The behaviour of the sugar silo and its settlement were continuously monitored during the filling process by using geodetic methods. This enabled the back analysis of the silo foundation's behaviour. The objective of the analysis presented herein is solely academic. Settlements are computed by means of a finite element model created based on the available soil investigation results and the results are compared with the measured data.

Figure 1: Pictures of the sugar silo: (a) Under construction, and (b) After completion

1. Model geometry

The dome-shaped upper structure is connected to the foundation by a circular, vertical wall structure. The stored bulk material is drained from the silo through an underground tunnel.

The most important geometric properties of the silo are as follows (Figure 2):

- top of the base slab:
  ±0.00 or 131.95 m above sea level
- external diameter of the structure: D = 58.34 m
- height of the structure: H ≈ 39 m
- bottom level of the unloading tunnel:
  -4.00 m or 127.95 m above sea level

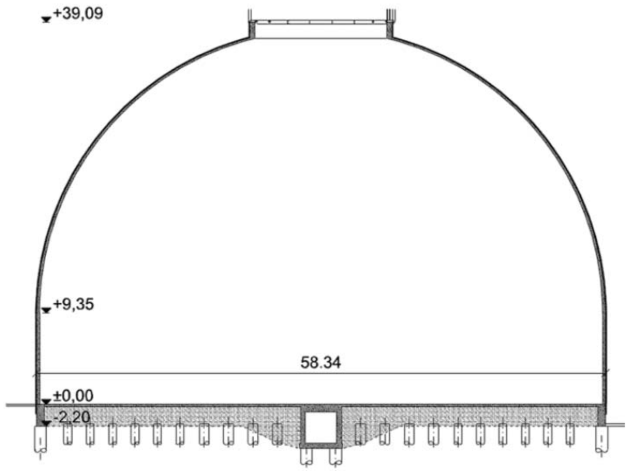


Figure 2: Geometry of the silo

The load transfer from the upper structure to the subsoil is provided by reinforced piles connected to the beam below the outer walls and to the base of unloading tunnel. At the base of the silo, a 25 cm thick reinforced concrete base slab was constructed.

Rigid inclusion technique was used to improve the deformation properties of the underlying soil layers. Within the outer ring, in the inner area of the silo, the load distribution and load transfer to the rigid inclusions are ensured by an approximately 2 m thick, dense, coarse grained subgrade layer reinforced with geogrids (Figure 3).

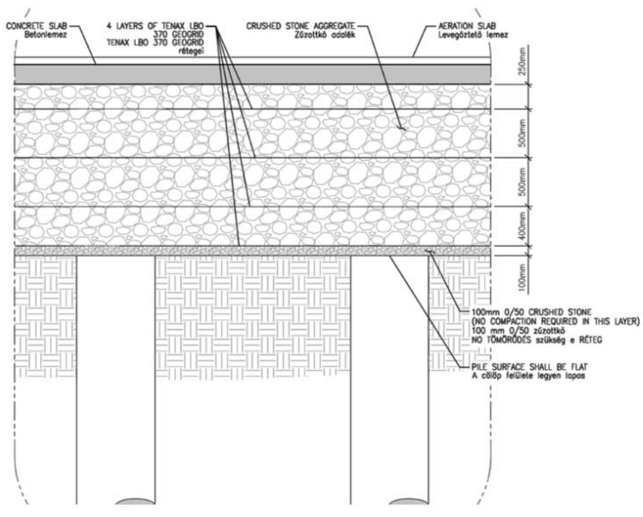


Figure 3: Structural composition of the subgrade

The side-to-side distance between the piles varied over the range from 1.5 m to 2.5 m. Parameters of the used piles and inclusions are summarised in Table 1 and their layout is shown in Figure 4.

The newly built silo is located on the site of Magyar Cukor Ltd., where other heavy-loaded structures had already been built. These buildings are supported by deep foundation, usually by 16 to 20 m long piles.

2. Soil conditions

In the construction area, two 50 m deep borings were performed with a 180 mm diameter hollow stem auger and sampling was carried out with double wall barrel.

Table 1: Properties of the used piles

Pile	Notation	Material	Number of piles	Diameter [cm]	Length [m]
C1	(green)	Reinforced concrete	51	100	14.70
C2	(blue)	Reinforced concrete	1	100	12.52
C3	(black)	Reinforced concrete	38	120	12.52
C4	(light blue)	Concrete	4	120	14.95
C5	(magenta)	Concrete	136	100	14.95
C6	(red)	Concrete	146	80	14.95

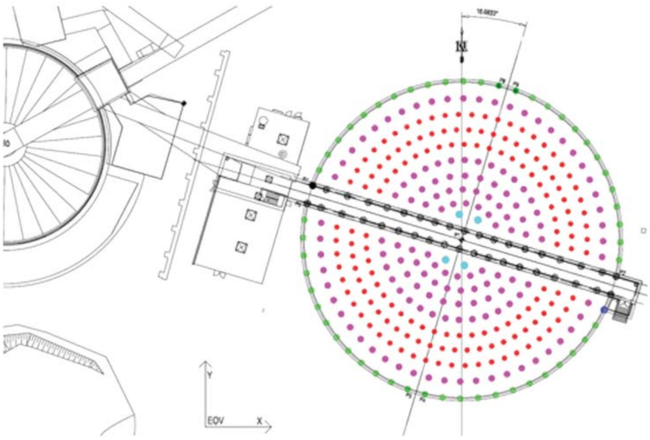


Figure 4: Location of the piles

In order to supplement the information gathered from the borings, one Cone Penetration Test (CPTu) and two seismic CPTu were also carried out. Shear wave velocity measurement was performed in every 2 m. The soil exploration revealed that the layers are approximately horizontal in the investigated area.

Based on these in-situ observations and the subsequent detailed laboratory program, the following soil layers were distinguished:

- Mg: Various manmade fill (0.0-2.2 m),
- A: Plastic SILT / SANDY SILT (2.2-11.0 m),
- B: Firm SANDY SILT / SILTY SAND (11.0-14.9 m),
- C: Medium dense - dense SAND (14.9-19.9 m),
- D: Firm SILTY CLAY / CLAY (19.9-31.7 m),
- E: Stiff, tertiary ("Pannonian") CLAY (31.7 -50.0 m).

The small-strain shear modulus of each layer was obtained from the shear wave velocity measurements of the seismic CPTu-s. Shear strength parameters were determined from simple shear and triaxial tests, while compression characteristics were evaluated by means of oedometer tests.

3. 3D finite element model

The detailed soil investigation results and systematic monitoring of the load and base slab settlements enabled the back analysis of the foundation behaviour. The objective of the analysis is solely academic. The consolidation settlements of the structures are computed (using parameters that fit best to the obtained soil properties) and the results are compared with the measured settlements.

Although the 2D axisymmetric model may be adequate to analyse the settlement of the sugar silo, a three dimensional model is required to calculate the settlement of the basement tunnel and pile foundation. The 3D finite element modelling of the silo was performed using the finite element program PLAXIS 3D AE. Due to the biaxial symmetric geometry of the silo, it is sufficient to implement the quarter of the structure in the model as shown in Figure 5. The geometric dimensions of the model space were selected such that the model boundaries give no effect on the calculation results. For this reason the outer boundary in horizontal direction was placed 30 m from the silo, and the bottom of the model was 50 m depth.

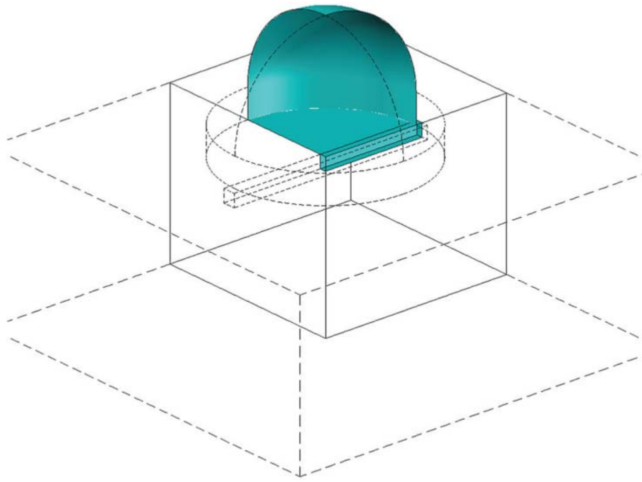


Figure 5: Model space

3.1 Soil model and its properties

Creation of the soil model was based on the reported boring logs and cross section profiles. The thickness of the soil layers was set to their average thickness below the studied area. The physical soil properties of each layer have been also assigned as their average value given in the geotechnical report.

The layers were modelled with Hardening Soil with small-strain stiffness (HSsmall) model in order to avoid the overestimation of the soil deformations at larger depths. For each layer, the required stiffness parameters were determined using oedometer tests. The shear modulus at very small strains was computed from the shear wave velocity of the corresponding layer. The assigned values of the different properties for each material are summarised in Table 2.

Table 2: Material properties

	Fill	Sandy silt	Silty sand	Sand	Silty clay	Clay	Subgrade	Sugar	Concrete
Notation	(dark brown)	(turquoise)	(green)	(yellow)	(magenta)	(dark red)	(yellow)	(light blue)	(dark blue)
Depth interval	0 – 2.2	2.2 – 11.0	11.0 – 14.9	14.9 – 19.9	19.9 – 31.7	31.7 – 50.0	-	-	-
Material model	HSsmall	HSsmall	HSsmall	HSsmall	HSsmall	HSsmall	HS	MC	LE
Type	Drained	Drained	Drained	Drained	Drained	Drained	Drained	Drained	Non Porous
γ_{unsat} [kN/m³]	20	19	18	17	20	21	20	8.5	25
γ_{sat} [kN/m³]	20	20	20	19	22	22	20	8.5	25
E_{50}^{ref} [kN/m²]	6000	5950	4850	20000	3850	10600	70000	30000	33.0E+6
E_{oed}^{ref} [kN/m²]	6000	5950	4850	20000	3850	10600	70000	-	-
E_{ur}^{ref} [kN/m²]	18000	17850	14550	60000	11550	31800	210000	-	-
m [-]	0.7	0.75	0.8	0.7	0.65	0.5	0.5	-	-
ν [-]	-	-	-	-	-	-	-	0.2	0.2
c'_{ref} [kN/m²]	1	16.9	9.5	6.8	40.6	71	10	1	-
ϕ' [°]	20	26.9	31.5	31.9	16.9	16.7	40	35	-
$\gamma_{0.7}$ [-]	0.16E-3	0.21E-3	0.25E-3	0.32E-3	0.15E-3	0.25E-3	-	-	-
G_0^{ref} [kN/m²]	231.6E+3	112.8E+3	85.65E+3	129.1E+3	203.3E+3	344.7E+3	-	-	-
K_0^{nc} [-]	0.658	0.5476	0.4775	0.4716	0.7093	0.7126	0.3572	-	-
k_x, k_y, k_z [m/day]	0.8640	0.233E-3	0.527E-3	0.4752	0.0864E-3	0.0104E-3	864	8.64	-

3.2 Structural elements

For the modelling of structural elements, construction and as-built plans were used in order to form the most realistic geometry. This is important to mention, because during the construction some modifications have been made compared to the design plans.

3.2.1 Piles

Foundation piles were modelled as embedded beams. The base and shaft resistance of the piles were determined using the CPT-based correlations proposed by Szepeshazi (2011) (Table 3). A typical CPT tip resistance curve of the area is illustrated in Figure 6. For those piles that are cut in half due to the geometry of the model space (Figure 7), the values of base and shaft resistance were also divided by two.

Table 3: Characteristics of the piles

Soil type	α_{sq}	$q_{c,\ average}$ [kPa]	q_s [kPa]	Base resistance [kN]
MG	0.55	911	16.6	-
A	0.55	1437	20.8	-
B	0.55	3061	30.4	-
C	0.55	16395	70.4	2257 (D = 0.80m) 3016 (D = 1.00m) 4030 (D = 1.20m)

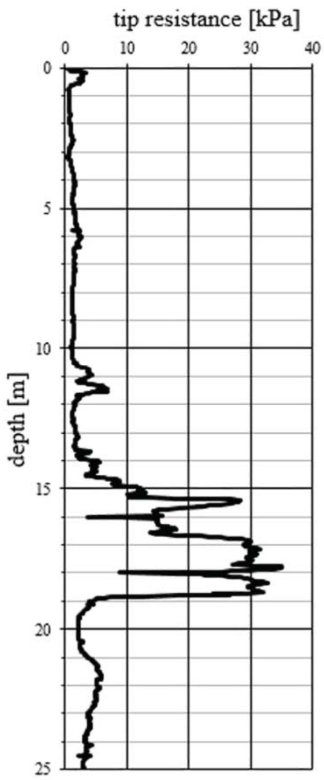


Figure 6: CPT tip resistance

3.2.2 Plate, interface and geogrid elements

The beam running beneath the shell structure was modelled using 3D solid elements. The walls and the base slab of the unloading tunnel, as well as the base slab of the silo were defined as plates and their thickness was selected based on the construction plans.

For these, structural elements were used to represent concrete. It is also assumed that the concrete behaves as a linearly elastic isotropic material. The relevant properties used for the analysis are shown in Table 2.

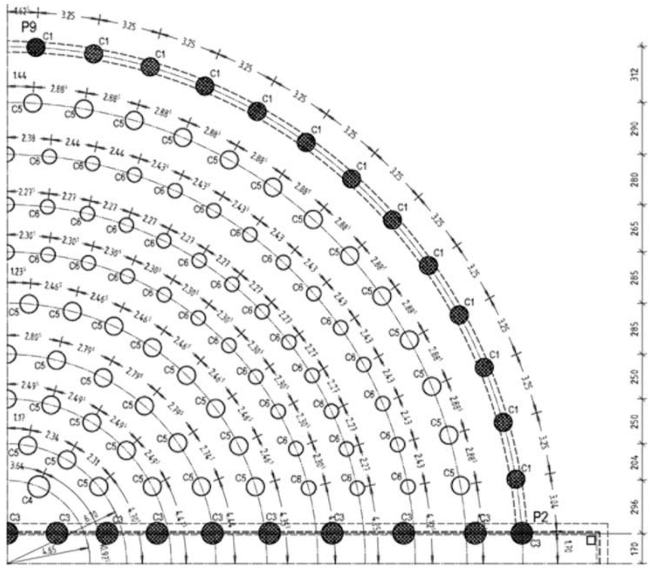


Figure 7: Layout of the piles

The subgrade was assumed to behave according the rules of the Hardening Soil model. The behaviour of the four layers of geogrid strengthening the subgrade was assumed to be elastic with an axial stiffness, *EA*, of 500 kN/m.

At the outer side of the tunnel structure, at the bottom plate and at the upper and bottom side of the silo base, beam interface elements were defined.

4.3 Modelling of the sugar

Instead of considering the effect of stored sugar as a distributed load on the base slab, the sugar was modelled as a granular soil. In this way, the dome-shaped structure could have been involved into the load bearing, so that the load intensities transferred to the bottom plate and to the base slab can portray the real conditions. An interface was defined between the dome structure and the sugar elements to allow sliding between the two materials. The interface parameter was defined based on the sugar properties, and the interface factor, R was taken as 1.0.

Loading and unloading of the silo was modelled as construction stages. Figure 8 shows 4 selected loading stages, for which the geometry of the sugar was calculated using its assigned friction angle value, which was 35°.

5. Results

The construction stages were defined in a way that the model reproduces the recorded loading and unloading history as accurately as possible. The following eleven construction stages have been defined and performed as “consolidation calculation”:

1) Filling to 17.000 tons in 3 weeks;
2) Filling to 51.500 tons in 6 weeks;
3) Resting for 6 weeks;
4) Complete unloading in 16 weeks;
5) Resting for 2 weeks;
6) Filling to 17.000 tons in 14 weeks;
7) Filling to fully filled condition in 11 weeks;
8) Resting for 3 weeks;
9) Unloading to 44.650 tons in 14 weeks;

10) Resting for 4 weeks;

11) Unloading to 0 tons in 13 weeks.

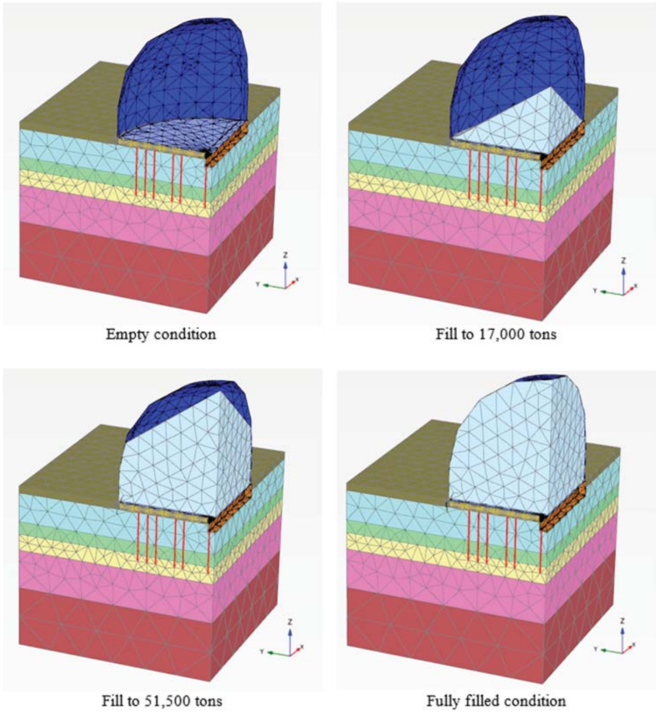
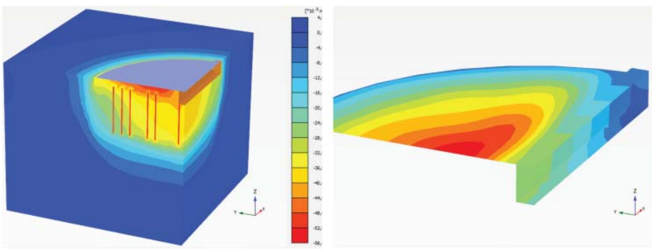


Figure 8: Construction stages

The computed vertical displacements and slab settlements are shown in Figure 9. The results agree well to the well-known tendencies, in which the settlements are high in the middle part and low at the periphery. In this particular situation, the rigid supports (i.e. the reinforced piles) directly connected to the tunnel and the outer beam cause further settlement reduction in these areas. Although there were no settlement measurements inside the sugar silo to confirm these, the results seems realistic. To set-up the monitoring system, 8 measuring points were established on edge of the base slab and 10 points on the wall of the tunnel. In the presented model, the development of deformations was studied in 3 points (Figure 10). The comparison between the in-situ observed settlements and those calculated using PLAXIS are shown in Figure 11.



(a) (b)

Figure 9: Full displacement in direction z (a); Displacements of base slab and tunnel in direction z (b) - Displacements in fully filled condition

6. Summary

This article discusses the performance of a Hungarian sugar silo's foundation by back analysing the loading-unloading history of the structure. The foundation of the dome-shaped silo is rather complex, it includes traditional piles, but also rigid inclusion ground improvement. Therefore, its behaviour can only be modelled properly with sophisticated 3D geotechnical finite element models.

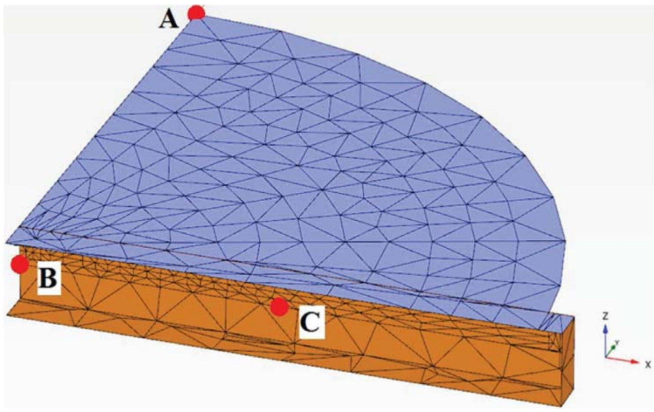


Figure 10: Measuring points of the settlement in the model

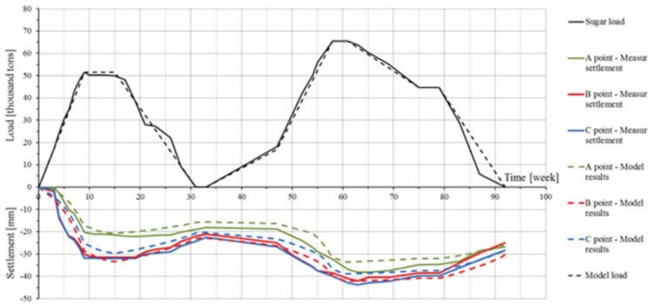


Figure 11: Development of settlements with time

At the back analysis of the structure, the soil layers were modelled using the HSsmall model, for which the input parameters were obtained from the laboratory (oedometer test, simple shear test) and field tests (seismic CPTu, CPTu) carried out for the geotechnical report of the site. The base and shaft resistance of the piles and rigid inclusion bodies were also derived using the records of CPT. The settlements calculated by PLAXIS 3D were compared with the monitored settlements during the loading-unloading history of the silo, and the following conclusions can be drawn:

- The calculated and the measured settlements are in good agreement; the biggest difference between them is only a few mm (approximately 10%).
- Development of the displacements with time shows slightly different tendencies. The measured settlements are significantly smaller in the first few weeks compared to the calculated ones, but later they accumulate faster than the calculated settlements. The reason behind this observation is unknown yet, but previous works also have shown similar tendencies.
- After the first loading the curves of the measured and calculated displacements have similar shapes.
- The calculated settlements of the 3 selected representative points slightly differ from the measured values (however the behaviour of the settlements are comparable).

Overall it can be concluded that soil behaviour and soil-structure interaction determined by the finite element model are in good agreement with the results of monitoring. This indicates that with the use of HSsmall model and input parameters from proper field and laboratory test program, even geotechnical problems with such complexity can be analysed adequately with finite element method with good accuracy.

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(Plaxis Bulletin, Issue 39 / Spring 2016, pp. 12-17, https://www.plaxis.com/content/uploads/2016/10/Plaxis-Bulletin-39.pdf)

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

Για τις παλαιότερες καταχωρήσεις περισσότερες πληροφορίες μπορούν να αναζητηθούν στα προηγούμενα τεύχη του «περιοδικού» και στις παρατιθέμενες ιστοσελίδες.

World Tunnel Congress 2018 "The Role of Underground Space in Future Sustainable Cities", 20-26 April 2018, Dubai, United Arab Emirates, www.wtc2018.ae

5th International Course on Geotechnical and Structural Monitoring, 22 - 25 May 2018, in Rome www.geotechnicalmonitoring.com

EUROCK 2018 Geomechanics and Geodynamics of Rock Masses, 22-26 May 2018, Saint Petersburg, Russia, www.eurock2018.com/en

4th GeoShanghai International Conference, May 27-30, 2018, Shanghai, China, http://geo-shanghai.org

micro to MACRO - Mathematical Modelling in Soil Mechanics, May 29-June 1, 2018, Reggio Calabria, Italy, www.microtomacro2018.unirc.it

GeoReinforcement Workshop
4 - 5 June 2018, Munich, Germany

The IGS Technical Committee - Reinforcement (TC-R) workshop will dedicate a half-day to each of the following technical topics:

- Facings of Walls and Steep Slopes
- Use of Recycled and Amended Marginal Backfills in MSE and Reinforced Embankments/Slopes
- Design of Load-Carrying MSE Bridge Abutments
- Reinforced Veneer Stability

The workshop includes 21 presentations, four blocks of attendees case study/topic contributions, do's and don'ts summaries, and a compilation of summary documents. Speakers include field luminaries such as Richard Bathurst, John Sankey, Chaido Doulala Rigby, George Koerner, Dimiter Alexiew, Jorge Zornberg, and Pietro Rimoldi.

Presentation topics include some of the most pressing issues of the day: veneer stability and seismicity; MSE abutment load carrying; long-term performance of GRS walls; flexible reinforced facings; differing international approaches and standards; and much more.

Online registration: https://igs.wufoo.com/forms/q10dk31u19dx00v/

International Conference on Deep Foundations and Ground Improvement - Urbanization and Infrastructure Development: Future Challenges, June 5-8, 2018, Rome, Italy, www.dfi.org/dfieventlp.asp?13310

GeoBarrier Workshop
6 - 7 June 2018, Munich, Germany

The IGS Technical Committee - Barriers (TC-B) workshop will devote half-day sessions to the following main topics:

- Geomembrane Durability
- Geomembrane Protection
- GCL Hydration and Controlling Factors
- Standard Protocols for Construction/Installation Quality Assurance and Quality Control

The internationally revered speaker list includes experts such as Kerry Rowe, Helmut Zanzinger, Craig Benson, Piet Meyer, Sam Allen, Richard Brachman, and more. Presentations include focuses on historical leakage rates and affiliated CQA strategies; preventing puncture in a geosynthetic barrier system; anti-oxidant depletion in geomembranes; agency perspectives on geomembrane end-of-service life; and more.

Online registration: https://igs.wufoo.com/forms/q10dk31u19dx00v/

XVI Danube-European Conference on Geotechnical Engineering: Geotechnical Hazards and Risks: Experiences and Practices, 7 - 9 June 2018, Skopje, Former Republic of Yugoslav www.decge2018.mk

16th European Conference on Earthquake Engineering (16thECEE), 18-21 June 2018, Thessaloniki, Greece, www.16ecee.org

CPT'18 4th International Symposium on Cone Penetration Testing, 21-22 June 2018, Delft, Netherlands, www.cpt18.org

9th International INQUA Meeting on Paleoseismology, Active Tectonics and Archeoseismology
www.patadays2018.org

PATA Days 2018, in the spirit of all succesful previous meetings, will bring together researchers working on every aspect of active tectonics, with special emphasis on Paleoseismology and Archeoseismology. We welcome contributions in any of the following general themes:

- Active fault systems
- Earthquake geology and paleoseismology
- Archeoseismology and historical seismology
- Seismotectonics
- Geological input in Seismic Hazard Assessment
- Fault hazards in engineering projects
- Risk communication and management, Science and society, Science and outreach
- Sea level changes and coastal geomorphology in response to tectonics

We hope to compile an interesting and interdisciplinary programme, with special emphasis on the work of young researchers.

The events are organized in northern Greece, on the occasion of the 40th anniversary of the deadly 1978 Thessaloniki earthquake. Dates and venues are:

- 24 June 2018: Kassandra field trip (starts in Thessaloniki and finishes in Possidi).
- 25-27 June 2018: Workshop at Possidi Holidays Resort & Suites Hotel (oral sessions) and the Aristotle University's camping (poster sessions and events). This is the **main event** of PATA days 2018.
- 28 June 2018: Summer School at the Aristotle University's camping.
- 29 June 2018: Mygdonia basin field trip (starts in Possidi and finishes in Thessaloniki).

NUMGE 2018 9th European Conference on Numerical Methods in Geotechnical Engineering, 25-27 June 2018, Porto, Portugal, www.numge2018.pt

RockDyn-3 - 3rd International Conference on Rock Dynamics and Applications, 25-29 June 2018, Trondheim, Norway, www.rocdyn.org

ICOLD 2018 26th Congress – 86th Annual Meeting, 1 - 7 July 2018, Vienna, Austria, www.icoldaustria2018.com

www.icpmg2018.london

The Organising Committee for ISSMGE TC104 (Physical Modelling in Geotechnics) would like to invite you to London for the 9th International Conference on Physical Modelling in Geotechnics (ICPMG 2018).

The main theme of this conference will be to communicate and disseminate recent developments in all aspects of geotechnical physical modelling hosted at City, University of London.

We will welcome researchers to the diverse and exciting City of London for a four day physical modelling extravaganza. Highlights will include a banquet at Middle Temple Hall; an ancient Inn of Court, a welcome reception at, the historic Skinners' Hall; home to one of the Great Twelve City of London livery companies, and the Schofield Lecture with reception.

Contact: ICPMG2018@city.ac.uk

ICSSTT 2018 - 20th International Conference on Soil Stabilization Techniques and Technologies, July 19 - 20, 2018, Toronto, Canada, https://waset.org/conference/2018/07/toronto/ICSSTT

GeoChine 2018 - 5th GeoChina International Conference Civil Infrastructures Confronting Severe Weathers and Climate Changes: From Failure to Sustainability, July 23-25, , HangZhou, China, http://geochina2018.geoconf.org

UNSAT2018 The 7th International Conference on Unsaturated Soils, 3 - 5 August 2018, Hong Kong, China, www.unsat2018.org

https://china-euro-geo.com

We would like to invite you to give a lecture at the China-Europe Conference on Geotechnical Engineering in Vienna, Austria on 13-16 August 2018. Europe is the cradle of modern soil mechanics and geotechnical engineering. The old continent still hosts the finest researchers, engineers, contractors and manufacturers. China has the most construction activities of the world with such impressive infrastructure projects as Three Gorges Dam, South-North Water Transport, High Speed Railway. This conference will link the birth place of modern soil mechanics with the country with most construction and research activities in geotechnical engineering.

This conference offers a platform for leading experts from China, Europe and beyond to take stock of recent development and identify emerging trends in geomechanical theory and geoengineering practice. We cordially invite you to our conference with the following distinctive characters:

- Broad topic coverage from theory to practice
- Focus on state-of-the-art in practice and emerging trends in research
- Medium-sized event to promote interaction and communication
- Proceedings in Springer Series in Geomechanics & Geoengineering (EI)
- Selected papers to be published in Acta Geotechnica

Conference topics

We foster broad coverage of topics from geomechanics research and geotechnical engineering practice. Contributions from (not limited to) the following topics are welcome.

- Geomechanics for soil and rock
- Constitutive modelling
- Innovative numerical techniques
- Testing and instrumentation methods in lab and field
- Foundation engineering
- Deep excavation
- Underground construction
- Ground improvement
- Soil dynamics and earthquake engineering
- Landslide and debris flow
- Geosynthetics
- Geotechnics in hydro-engineering
- Geotechnics in transportation
- Geotechnics in energy and environment
- Case studies

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CRETE 2018 6th International Conference on Industrial & Hazardous Waste Management, 4-7 September 2018, Chania, Crete, Greece, www.hwm-conferences.tuc.gr

EUCEET 2018 - 4th International Conference on Civil Engineering Education: Challenges for the Third Millennium, 5-8 September 2018, Barcelona, Spain, http://congress.cimne.com/EUCEET2018/frontal/default.asp

SAHC 2018 11th International Conference on Structural Analysis of Historical Constructions "An interdisciplinary approach", 11-13 September 2018, Cusco, Perú http://sahc2018.com

26th European Young Geotechnical Engineers Conference

11 - 14 September 2018, Reinischkogel, Austria
www.tugraz.at/en/institutes/ibg/events/eygec

On behalf of the ISSMGE, the Austrian Society for Soil Mechanics and Geotechnical Engineering has the pleasure of announcing the 26th European Young Geotechnical Engineers Conference that will be held from Tuesday 11th September to Friday 14th of September 2018. The conference will take place at Hotel Klugbauer (http://www.klugbauer.at/).

Participants

Each European National Society will be asked to select two representatives to attend the Conference. Ideally, they should be 35 years of age, or less, at the time of the meeting. Senior geotechnical engineers will deliver keynote lectures and will engage with the young engineer delegates during the technical sessions.

Email: franz.tschuchnigg@tugraz.at

Conference topics

There is no specific conference theme, any topic related to geotechnical engineering is appropriate. Some examples:

- Site investigation
- Laboratory and field testing
- Field monitoring
- Selection of design parameters
- Constitutive, numerical and physical modelling
- Shallow and deep foundations
- Deep excavations and retaining structures
- Tunnelling and underground structures
- Slope stability and landslides
- Infrastructure projects
- Ground improvement
- Mechanical, hydraulic and thermal behaviour of saturated and unsaturated soils
- Environmental Geotechnics

Organizer

Dr. Franz Tschuchnigg & Prof. Helmut F. Schweiger

Contact Information

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11th International Conference on Geosynthetics (11ICG), 16 - 20 Sep 2018, Seoul, South Korea, www.11icg-seoul.org

CHALK 2018 Engineering in Chalk 2018, 17-18 September 2018, London, U.K., www.chalk2018.org

International Symposium on Energy Geotechnics SEG - 2018, 25-28 September 2018, Lausanne, Switzerland https://seg2018.epfl.ch

Progress through Partnerships
15-17 October 2018, Gdansk, Poland
www.hydropower-dams.com/hydro-2018.php?c_id=88

HYDRO 2018 will be the 25th in Aqua-Media's series of international events hosted in Europe, and will once again be the most significant conference and exhibition of the year for the global hydropower community. The annual conferences have become renowned as the most international gatherings in the profession, with delegations representing all countries with major hydro development programmes underway. An exchange of experience is encouraged on practical and topical issues, and an international steering committee works with the Aqua-Media team to ensure the high quality of papers accepted.

The event will bring together delegations from around 75-80 nations, sharing the common interest of advancing hydro development in all parts of the world. Lessons from past experience will be reviewed, achievements will be showcased, and new challenges will be tackled. The conference sub-title 'Progress through Partnerships' highlights the underlying theme of international collaboration which will be the basis for discussions. The location aims to facilitate participation from more countries in the Central Asian and eastern European region.

Emphasis will be on helping the less developed countries to unlock their hydro potential to advance socio-economic development, on cross-border collaboration and regional projects, and on maximising the potential to increase hydro capacity in the industrialized countries. Timely maintenance of existing hydro assets is another key theme, along with designing for the sustainability of greenfield projects.

MAIN CONFERENCE THEMES

- Development opportunities
- Technical innovation
- International collaboration
- Environmental and social aspects
- Hazard and risk
- Civil engineering
  - Dam design and construction
  - Materials for dams
  - Intakes, gateworks and spillways
  - Dam safety and monitoring
  - Alkali aggregate reaction
  - Refurbishment of civil structures
  - Safety of workers on site
- Training and capacity building
- Project finance and contractual issues
- Pumped storage
- Extending the life of hydro assets
- Sedimentation management
- Small and low-head hydro

Contact

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Tel: +44 20 8773 7244
Fax: + 44 20 8773 7255
Email: Hydro2018@hydropower-dams.com

Global Engineering Congress
Turning Knowledge into Action
22 - 26 October, London, United Kingdom
www.ice.org.uk/events/global-engineering-congress

In October 2018, the World Federation of Engineering Organisations and ICE will hold the first Global Engineering Congress, an ambitious effort to agree a worldwide response to deliver the UN's Sustainable Development Goals.

The world urgently needs to take action on climate change, and engineers have a vital role to play delivering clean water, sustainable energy and a connected world.

The congress represents a unique gathering of the worldwide community, led by ICE, the World Federation of Engineering Organisations, American Society of Civil Engineers, Canadian Society of Civil Engineers and the European Council of Civil Engineers.

Offering five full days of multi-streamed content, 3,000 engineers will hear and discuss practical ways to deliver the goals and improve the lives of millions of people.

Contact

Tel. +44 (0)20 7665 2226, E-mail events@ice.org.uk

ARMS10 - 10th Asian Rock Mechanics Symposium, ISRM Regional Symposium, 29 October - 3 November 2018, Singapore, www.arms10.org

ACUUS 2018 16th World Conference of Associated research Centers for the Urban Underground Space "Integrated Underground Solutions for Compact Metropolitan Cities", 5 – 7 November 2018, Hong Kong, China, www.acuus2018.hk

International Symposium Rock Slope Stability 2018, 13-15 November, 2018, Chambéty, France, www.c2rop.fr/symposium-rss-2018

GeoMEast 2018
International Congress and Exhibition: Sustainable Civil Infrastructures
24 - 28 November 2018, Cairo, Egypt
www.geomeast.org

On behalf of the Organizing Committee, we are pleased to invite you to attend the GeoMEast 2018 International Congress and Exhibition to be held in Cairo, Egypt from November 24 to 28, 2018. The GeoMEast SERIES is managed by SSIGE and supported by a number of leading international professional organizations.

Recent rapid construction in Egypt and the Middle East has provided great opportunities for bridge, pavement, geotechnical, geological, tunnel and all engineers to use their knowledge and talents to solve many challenging problems involving highways, bridge structures, pavements, materials, ground improvements, slopes, excavations, dams, canals and tunnels with innovative solutions and cutting-edge technologies.

GeoMEast 2018 will provide a showcase for recent developments and advancements in design, construction, and safety Inspections of transportation Infrastructures and offer a forum to discuss and debate future directions for the 21st century. Conference topics cover a broad array of contemporary issues for professionals involved in bridge, pavement, Geomechanics, geo-environmental, geotechnical, geosciences, geophysics, tunnel, water structures, railway and emerging techniques for safety inspections. You will have the opportunity to meet colleagues from all over the world for technical, scientific, and commercial discussions.

Technical Themes

Geotechnical, Geological, Geoenvironmental and Geosynthetics:

- Geotechnical, Geoenvironmental and Earthquake Geotechnical Engineering;
- Soil and Rock Mechanics, Geomechanics, Mining, and Geological engineering;
- Geosynthetics and Reinforced Soil Retaining Structures;
- Behavior, Identification and In-situ Test Methods for Site Characterization of Soils, and Lateritic, Problematic, Collapsible, Swelling, Soft, Sabkha and Uncommon Soils;
- Design and Quality Control of Earth Structures and Subgrades;
- Soil Stability and Landslide, Ground improvement and Seismic Hazards;
- Soil-Structure Interaction, Advanced Analysis of Shallow and Deep Foundations, Foundation Failure and Repair, and MicroPiles and its innovative applications;
- Computational Mechanics, Innovative Soil Models, Discrete Element and Boundary Element Modelling, Mesoscale Modeling, and Advanced Numerical and Analytical Analyses;
- Physical Modelling in Geotechnics;
- Saturated and Unsaturated Soil Mechanics;
- Oil and Gas, and Petroleum Geotechnical Engineering; and
- Geosciences, Geomatics, Geoinformatics, Geophysics and Global Hazards.

Sustainable Civil Infrastructures:

- **Structures and Bridges Engineering:** Advanced Analysis of Structures; Non-Destructive Evaluation; Inspection Technologies; Structural Health Monitoring; Remote Monitoring of Structures; Scour Assessment; Seismic Design Issues for Bridges, Super Structures and Underground Structures; Design Methods and Materials, Innovative Repair Methods and Materials, Durable and Sustainable Designs, Innovative Materials, Advances in Foundation Design/Construction, Accelerated and/or Performance Based Design/Construction, Aesthetics and Environment; State-of-the-Arts and State-of-the-Practices on Bridge Design, Construction and Maintenance; Special Foundation Treatment and Settlement Control Technology.

- **Tunneling Engineering:** Tunnel Management and Inventory, Monitoring and Settlement Control; Emerging Technologies, Lining Design & Precast Segment Advances; Innovation in Tunneling Design, Construction, Repair, Rehabilitation; Fire & Life Safety, Vulnerability & Security; Tunneling in Soft Ground, Ground Conditioning and Modification; Advanced prediction technology of tunnel construction geology; Deep excavations and urban tunneling.

- **Pavement Engineering, Airports and Advances in Pavement Techniques:** Airfield pavement analysis, rehabilitation and performance; Recycled Asphalt Pavement; Pavement Design, Modeling, Performance Evaluation, & Management; Sustainable Long Life Pavement; Ground Improvement, and Chemical/Mechanical Stabilization for Pavement and Geotechnical Applications; Moisture Damage in Asphaltic Concrete Materials; Pavement Foundations: Modelling, Design and Performance Evaluation; Geotechnical Properties and Their Effects on Portland Concrete Pavement Behavior and Performance; Warm Mix; Rehabilitation strategy selection and preventative maintenance treatments; Accelerated Testing of Pavement Structures and Materials; Material, Design, Construction, Maintenance and Testing of Pavement; Asphalt Binder and Mixture Characterization; Construction and Rehabilitation of Jointed Concrete Pavement, Reinforced Concrete Pavement, and Continuously Reinforced Concrete Pavement; Bridges Deck Pavement; Stabilization, Recycling, Foamed Bitumen and Emulsion, Granular Materials; Roadway Widening; Asphalt Mix-Design,HMA; Testing &Material; Property Characterization.

- **Transportation Engineering:** Highway Pavements: Design, Materials, and Construction; Transportation Operations and Safety; Advanced Technologies, Infrastructure Systems, Intermodal Transportation, Planning, and Development; Rail and Transit; Aviation

- **Railroad and Railway Engineering:** Railway and Railroad Track Substructure; High Speed Rail System; Seismic Design for Railway and Roadway Structures; Economics of Railway Engineering and Operations; Structures, Maintenance and Construction; Innovative Procedures and Precautions; Long Term Pavement Performance Contest; BIM and Contract Administration.

- **Engineering geology for urban and major infrastructure development:** The ongoing population growth is resulting in rapid urbanization and new infrastructure development. This, together with the current climate change and increasing impact of natural hazards, imply that the engineering geology profession is called upon to respond to new challenges. It is recognized that these challenges are particularly relevant in the developing and newly industrialized regions. The idea beyond this Theme is to highlight the role of engineering geology in fostering sustainable urbanization and infrastructure construction (e.g., major buildings and facilities, water supply and distribution systems, roads, railways, tunnels, ports, dams, powerlines, pipelines). We invite contributions that illustrate how engineering geologists can support civil, geotechnical and environmental engineers in different phases of infrastructure development including sustainability assessment, pre-design site investigation, design and construction. Papers related to ageing infrastructure maintenance, structural stability control and monitoring, environmental impact studies and protection from geohazards are also welcome.

- **Dams Engineering, Canals and Levees, Irrigation and Water Sources and Structures, and Ports, Offshore and Marine Technologies.**

Climate Change and effects on Infrastructure:

- **Sustainability and Energy Engineering;**

- **Environmental and Waste / Sediment Management, Characterization, Treatment and Re-Use;**

- **Energy Geotechnics and Geo-Energy Infrastructure.**

- **Materials Engineering, Nanotechnologies, Advances in Composite Materials, Climate-Friendly Technologies, and Damage Mechanics.**

- **Structural Health Monitoring, and Sustainable Construction Technologies;**

- **Advanced Analysis for Sustainable Design.**

- **Worldwide innovative procedures and precautions for the Design;**

- **Building Information Modeling (BIM), Building and Construction Engineering, Project Management, and Contract Administration; and**

- **Sustainable Infrastructure:** Current and Projected; Financing Infrastructure Projects; Cross-cutting Issues; Materials, Tools, and Methodologies; Innovation; Sustainability and Competitiveness; Risk, Resiliency, and Adaptation to Climate Change; Sustainable Cities; Sustainability, Society and Culture; Envision™ and Other Rating Systems; Special Topics on Middle East Urbanization; Smarthome, barrier-free building and reconstructing

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WTC2019 Tunnels and Underground Cities: Engineering and Innovation meet Archaeology, Architecture and Art and ITA - AITES General Assembly and World Tunnel Congress, 3-9 May 2019, Naples, Italy, www.wtc2019.com

14th international Conference "Underground Construction", 3 to 5 June 2019, Prague, Czech Republic, www.ucprague.com

☙ ❧

2019 Rock Dynamics Summit in Okinawa
7-11 May 2019, Okinawa, Japan

Contact Person: Prof. Aydan Omer, aydan@tec.u-ryukyu.ac.jp

☙ ❧

VII ICEGE ROMA 2019 - International Conference on Earthquake Geotechnical Engineering, 17 - 20 June 2019, Rome, Italy, www.7icege.com

☙ ❧

ISDCG 2019

7th International Symposium on Deformation Characteristics of Geomaterials
26 - 28 June 2019, Glasgow, Scotland, UK,

The Technical Committee 101 of the ISSMEG is pleased to announce the organisation of the 7th International Symposium on Deformation Characteristics of Geomaterials (ISDCG) in 2019, in Glasgow, UK. The symposium is co-organised by the University of Strathclyde in Glasgow, the University of Bristol, and the Imperial College in London.

Building on the success of the previous Symposia organised in Sapporo (Japan) Japan in 1994, Torino (Italy) in 1999, Lyon (France) in 2003, Atlanta (US) in 2008, Seoul (Korea) in 2011 and Buenos Aires (Argentina) in 2015, the 7th ISDCG will equally follow both its traditions and active promotion of new technical elements to maintain it as one of the most popular and vibrant events within the geotechnical community. The technical core themes will focus on: (i) advanced laboratory geotechnical testing; (ii) application of advanced laboratory testing in research, site characterisation, and ground modelling; (iii) application of advanced testing to practical geotechnical engineering. In addition to these traditional topics, sub-themes will include cutting-edge techniques and approaches, for example experimental micro-mechanics, non-invasive monitoring systems, nano and micro-sensors, new sensing technologies. A key goal is to engage with the full spectrum of geotechnical specialists, from early career engineers and researchers through to world leading experts.

cmn 2019 -Congress on Numerical Methods in Engineering, July 1 - 3, 2019, Guimarães, Portugal, www.cmn2019.pt

For additional information, please contact the secretariat of the congress, Ms. Lara Leite

CMN2019, Universidade do Minho, Departamento de Engenharia Civil, 4800-058 Guimarães - Portugal
Email: cmn2019@civil.uminho.pt
Telephone: +351 253 510 748
Fax: +351 253 510 217

The 17th European Conference on Soil Mechanics and Geotechnical Engineering, 1st - 6th September 2019, Reykjavik Iceland, www.ecsmge-2019.com

14th ISRM International Congress, 13-18 September 2019, Iguassu Falls, Brazil, www.isrm2019.com

XVII African Regional Conference on Soil Mechanics and Geotechnical Engineering
07-10 October 2019, Cape Town, South Africa

Organiser: SAICE

Contact person: Dr Denis Kalumba

Email: denis.kalumba@uct.ac.za

XVI Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, 21 - 25 October 2019, Taipei, China www.16arc.org

XVI Panamerican Conference on Soil Mechanics and Geotechnical Engineering, 18-22 November 2019, Cancun, Quintana Roo, Mexico, http://panamerican2019mexico.com/panamerican

YSRM2019 - the 5th ISRM Young Scholars' Symposium on Rock Mechanics
and
REIF2019 - International Symposium on Rock Engineering for Innovative Future
1-4 December 2019, Okinawa, Japan

Contact Person: Prof. Norikazu Shimizu, jsrm-office@rocknet-japan.org

Nordic Geotechnical Meeting
27-29 May 2020, Helsinki, Finland

Contact person: Prof. Leena Korkiala-Tanttu
Address: SGY-Finnish Geotechnical Society,
Phone: +358-(0)50 312 4775
Email: leena.korkiala-tanttu@aalto.fi

EUROCK 2020
Hard Rock Excavation and Support
June 2020, Trondheim, Norway

Contact Person: Henki Ødegaard, henki.oedegaard@multiconsult.no

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

Ground freezing TBM drive collapse in Germany 22 Aug 2017

Collapse of a TBM tunnel drive in association with ground freezing support under the main Rhine Valley freight and passenger railway line at Rastatt in Germany has halted all rail traffic between Karlsruhe and Basel, Switzerland, and demanded backfilling of the new tunnel with concrete, burying the TBM in the process.

The 4,270m long twin tube rail tunnel is part of a 17km long project to double the capacity on the Rhine Valley rail corridor from two to four tracks taking the underground route beneath the city of Rastatt. To limit the length of underground construction and maintain acceptable gradients for the 250km/hour rail lines, the TBM drives are aligned at depths of up to 19m maximum with the 10.97m diameter TBMs passing a minimal 4m to cross beneath the main-line surface tracks (Figs 1 and 2).

To support the shallow alignment beneath the main rail lines and through loose sand and gravel deposits, a pre-support of horizontal ground freezing to create a full round ring of frozen ground was installed for the TBMs driving through the centre of the frozen collars.

It was on Saturday 12 August that monitoring instrumentation detected subsidence under the surface rail tracks. This progressed rapidly to create a subsidence depression of 500mm beneath the tracks and buckling the rails, demanding the halt of all rail traffic on the line.

At the time, the leading TBM in the east tunnel bore had passed beneath the rail tracks by about 40m and was 3,974m into its drive and just short of breakthrough in the reception shaft which was also access for installation of the horizontal ground freezing operation.

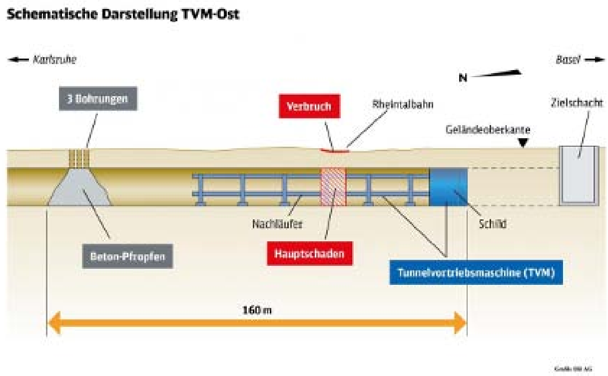


Fig 1. Schematic of the east TBM drive collapse as provided by Deutschebahn

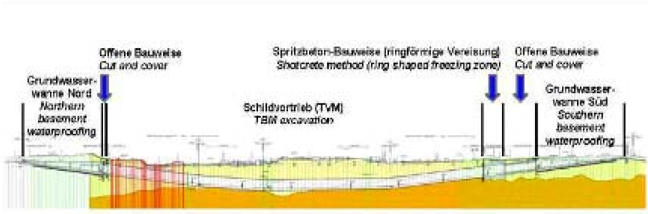


Fig 2. Construction elements, plan and longitudinal section of the tunnelled route under Rastatt

The trailing TBM in the west tunnel is also at a standstill as a result of the event and is about 1,000m behind the leading TBM at 3,064m into its 4,250m drive.

Immediate response to the incident was to install three slick-line holes into the new tunnel to create a concrete plug about 150m behind the cutterhead and fill the new 9.5m i.d. segmentally lined tunnel from the TBM bulkhead to the plug with 10,500m^3 of concrete (Fig 1).

Concrete backfill into the collapsed Rastatt TBM rail tunnel

According to a press briefing on Monday this week (21 August) by Section Manager Jürgen Kölmel for project client Deutschebahn, the segmental lining of the tunnel under the rail tracks and 40m behind the TBM did not crack or collapse but rather the seven segments in the 500mm thick x 2m long rings dislodged creating gaps and allowing infiltration of water and ground.

This indicates a failure of the freezing regime and possible over-excavation of material as the TBM passed through the zone.

Collapse sinkhole beneath the existing surface rail tracks

Up to 370 trains per day are being diverted away from the closed section of rail route with buses managing the broken passenger train journeys and diversions having to be found for the 170 to 200 of long distance freight trains per day on the corridor. In addition several buildings and homes in the vicinity have been evacuated. Estimates for how long the line will remain closed range from four to six weeks.

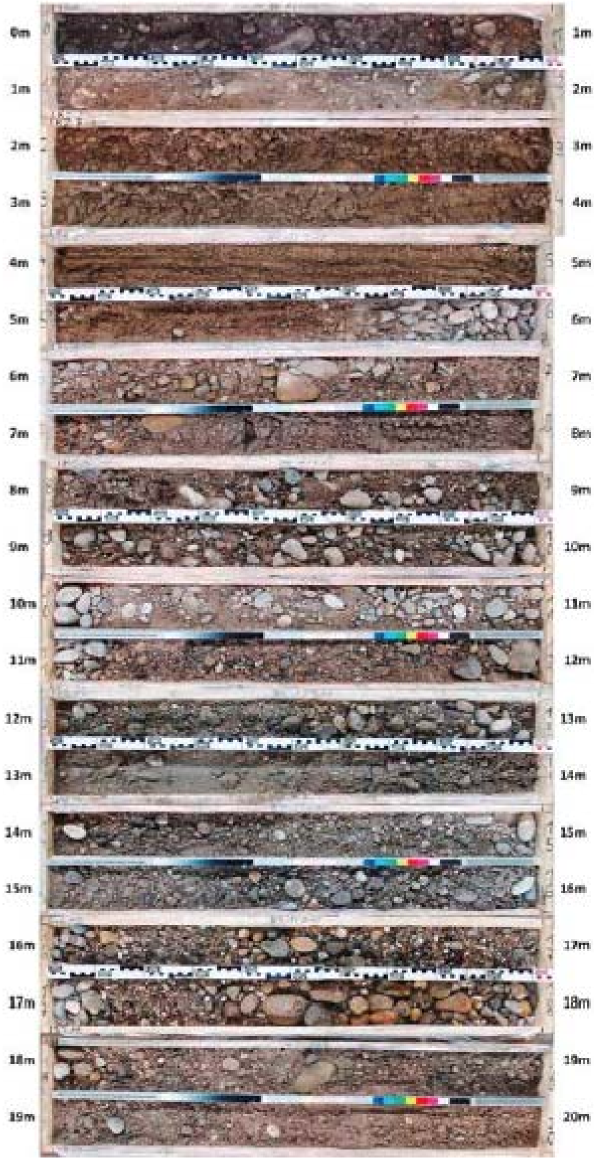
Work on the €693 million federally-funded project to build a new double-track alignment through Rastatt started in mid-2013 and the construction of the underground sections was awarded to the Ed Züblin/Hochtief joint venture. Together with TBM tunnelling, the construction works include open cut and cut-and-cover sections, NATM cross passages and ground support methods including sheet piling, diaphragm walls, jet grouting, underwater concreting and several applications of ground freezing.

To complete the twin TBM drives, Züblin/Hochtief procured two slurry Herrenknecht Mixshields. The machines launched from the north transition portal, the first east bore TBM beginning its drive in May 2016 and the west bore machine starting four months later in September 2016. Due to the shallow alignment and first section of angled ground freezing from the surface as a canopy over each TBM tube protected against potential slurry blowouts for a distance of up to 290m as the machines passed below a cover of about 5m below the Federbach conservation area. Freezing will also be used in the waterbearing ground for open face excavation of cross passages every 500m between the two tubes.

According to technical trade press media, excavation of the section under the main railway lines by extending the operation of the TBM drives was a contractor alternative to initial proposals to use open-face NATM excavation through the ground freezing support. The alternative was said to result in construction savings and was approved after comprehensive study.

The 200m long horizontal freeze for the rail underpass was established from two 30m deep shafts installed about 100m either side of the tracks. From the shafts a circle of 42 x 100m long freeze pipe holes were drilled using horizontal directional drilling and the freeze applied to create a 2m thick collar of frozen ground around each 10.97m o.d. tunnel tube.

The exact cause of the tunnel failure is now the subject of intense and wide-ranging investigation to include freeze management, instrumentation and monitoring reviews, TBM operation, and operator logs. Reports in the local German media suspect that the integrity of the ground freezing operation was undermined by a recent period of high summer temperatures combined with periods of heavy rainfall.



Samples of the prevailing geology

Launch and working site of the twin TBM drives

As well as preparing the freezing operation for changing climate conditions, the application also involves accounting for the heat generated by the operation of the TBM machine and systems and by the slurry excavation process within the excavation chamber ahead of the bulkhead. The balance between keeping the freeze to support the ground and the heavy and regular train traffic above while preventing the

TBM becoming trapped in the frozen ground or its slurry circulation system or other operating fluids freezing up in the applied freezing conditions.

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Hallandsås milestone TBM plus ground freezing achievement – *TunnelTalk,* June 2010

Hallandsås celebrates first tunnel finish - *TunnelTalk,* August 2010

Video: Northern Boulevard ground-freezing support on East Side Access project in New York – *TunnelTalk,* April 2013

Ground freezing first for Singapore rail project – *TunnelTalk,* July 2014

Feedback

Rastatt TBM drive collapse and failure of its segmental lining

One can see out of the available publications that the segments of the lining have dislocated some 40m behind the TBM. This is an indication that the ring gap has not been filled properly. As this happened to an experienced contractor it may be the case that the grouting operation together with the TBM drive through a frozen soil includes some particular problems.

Mining through an ice body has the characteristic of a hard rock drive, which requires some over excavation to enable shield steering.

Most shielded TBMs use grout lines through the shield tail to fill the annual gap immediately behind the tail seal. Under hard rock conditions the mortar tends - due to the over excavation - to flow around the body of the TBM and to the front and into the working chamber and so leaving voids outside the segmental lining. These voids have to be filled by a secondary grouting operation through the segments as soon as possible from the top of one of the trailing gantries.

In case of a frozen soil outside the gap however, it may happen that the voids are being filled by groundwater, which would also freeze, and as heat is present inside the tunnel during the mining process, the ice in the gap may melt leaving the segments unsupported. In this case filling of the gap by blowing pea gravel through the segments combined with a cement grouting operation may be a better option in my view.

Anyway, the tunneling world is keen to see the outcome of the following investigations and very interested on further reports in *TunnelTalk* about them!

Regards,

Rupert Sternarh
Stern Consult
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Rastatt TBM drive collapse and failure of its segmental lining

Thank you for the write-up on a major failure, which appears so far to have had limited press coverage, despite the severe impact on train operation.

As far as I am aware, this is the fourth incidence of catastrophic segmental lining failure behind a pressurised TBM in the last eighteen years; these being:

- Hull wastewater transfer tunnel, UK [1999]
- Cairo, Egypt [2009]
- Okayama, Japan [2012]
- Rastatt, Germany [2017]

I know of two other cases of severe, local, distortion of gasketted, concrete segmental tunnel linings, in Singapore and the USA, where total failure was avoided by providing additional support in the tunnel.

Given the huge number of segmentally lined tunnels built over the last 18 years, the proportion that has failed is tiny; and in each case the failure has been local, without similar problems on the rest of the drive. However, the consequences of each of the failures have been catastrophic.

To date, the best documented of the failures is that at Hull, which was the subject of an investigation that was summarised in Grose and Benton (2005)[(1)]. Even in this case the investigation was limited and the conclusions tentative.

The paper was the subject of a number of discussions, to which I contributed, and which elicited detailed responses that contained much additional information to that in the original paper[(2)]. In my opinion, the conclusions were inconsistent with some of the observations made in the tunnel; I stated this in a further discussion, which was submitted, but rejected by the journal on the basis that they did not accept a second round of discussions.

The failures at Cairo and Okayama have been the subject of a number of articles in *TunnelTalk*, but I have not seen any definitive explanation of causation.

This limited response to these failures can be compared with that to the failure of the cut-and-cover tunnel at Nicoll Highway in 2004 in Singapore. This was the subject of a public inquiry, which published clear, extensive and detailed findings that have had a major effect on practice in Singapore.

Because the failure of segmental linings is so rare, those listed above have each occurred in different countries. As far as I am aware each has been assessed in isolation. I hope that the detailed results of the investigation into the failure at Rastatt are made public, but this will take months or years, based on previous experience. Given that there have been several failures there does appear to be a case for reviewing them together, to see if there are any common features, and lessons to be learned.

Even though these events are very rare, the consequences are so severe that we, as an industry, need to make sure that the relevant lessons are learned and the likelihood of another incident reduced.

1. Hull wastewater flow transfer tunnel: tunnel collapse and causation investigation, Grose and Benton, 158, October 2005, Issue GE4, Proceedings of the Institution of Civil Engineers, Geotechnical Engineering

2. Hull wastewater flow transfer tunnel: tunnel collapse and causation investigation, discussion report, Ground Engineering, Volume 159 Issue 2, April 2006, pp. 125-128.

Sincerely,

Nick Shirlaw,
Golder Associates,
Singapore

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Germany: Ground freezing TBM drive collapse in Germany – *TunnelTalk,* August 2017

Japan: Five feared dead in Japanese tunnel collapse – *TunnelTalk,* February 2012

Japan: Possible causes of Japan's fatal tunnel failure – *TunnelTalk,* March 2012

Japan: Salvage team recovers Japan disaster TBM – *TunnelTalk,* Sepember 2013

Egypt: Cairo Metro tunnel collapse – *TunnelTalk,* July 2014

(Shani Wallis / TunnelTalk, 22 Aug 2017, https://tunneltalk.com/Germany-21Aug2017-Rastatt-TBM-rail-tunnel-collapse-brings-rail-traffic-to-a-halt.php?platform=hootsuite).

Switzerland landslide: Are the Alps melting?

Rocks and debris cascaded down the mountain to the edges of Bondo village

A massive rockslide in Switzerland's Val Bondasca was not a complete surprise. Many parts of Switzerland, two thirds of which is mountainous, are at risk of avalanches and landslides.

Communities in the Alps have been protecting themselves against such natural hazards for years.

Before Wednesday's landslide, sensors on the Piz Cenaglo, high above the Bondasca valley, had already shown that the rock mass was moving. That warning triggered the automatic closure of some sections of road.

The village of Bondo had a narrow escape. The four million cubic metres (141m cubic feet) of mud and rock which thundered down the mountain ended up just centimetres from people's homes.

That wasn't just luck. Bondo has a concrete barrier to protect it from the full force of a landslide, and the river bed in the Bondasca Valley has been widened in the hope of channelling landslides away from populated areas.

But the size of Wednesday's slide was a shock, and some scientists are now warning that the alpine regions can expect more events like this in the future.

Permafrost thaw

The reason is that the high mountains are not as cold as they once were. Marcia Phillips, a permafrost researcher with Switzerland's Federal Institute for Snow and Avalanche Research, has been analysing temperatures all over the Alps.

"We have bore holes at different depths in different terrain and the ones that are in rock walls are showing a distinct warming over the last 10 to 20 years," she explained.

That would not be a problem if the rock was simply rock,

but the rock in large sections of the Swiss Alps is cracked and fractured - between the layers of rock there are layers of permafrost. Ice in fact, but ice that is not supposed to melt.

Scene of landslide in Bondo, Switzerland, near the Italian border

"We have a problem if the temperature rises above -1.5C because the permafrost has a stabilising function," Ms Phillips said.

Compounding the weakening permafrost is another phenomenon associated with global warming - Switzerland's glaciers are noticeably retreating.

The glacier at the base of Piz Cenaglo provided additional stability to the rock above it, but that glacier has shrunk in recent years. So precarious had the mountain become that Marcia and her colleagues had given up on borehole testing and instead resorted to remote monitoring.

"It is cracked and unstable up there," she explained, "It was just too dangerous."

Infrastructure fears

Another headache associated with thawing permafrost is the possible risk to winter tourism. The stanchions of cable cars and chairlifts are very often anchored in permafrost.

The Swiss government already requires intensive monitoring of cable car infrastructure. Lift operators must check regularly for any movement or creep.

Marcia Phillips suggests that, if temperatures do continue to rise, changes may have to be made.

"I could foresee some having to be closed down or rebuilt," she said.

Eight people are still missing following Wednesday's landslide

In preparation, the avalanche institute has already produced a book "Building in Permafrost" with guidelines on how to build safely.

"It is possible but very, very expensive," said Ms Phillips.

That is not good news for Switzerland's tourism resorts, already suffering financially because of the strength of the Swiss franc.

For now, though, the focus remains on finding the eight people still missing from Wednesday's landslide, and on protecting those who live in the Bondasca Valley.

The residents of Bondo have been told they cannot go home yet. Four million cubic metres of rock came down but another million, very unstable, still looms above the village.

(Imogen Foulkes / BBC News, Geneva, 25 August 2017, http://www.bbc.com/news/world-europe-41049827)

Keith Nicholls, Principal Geotechnical Engineer, Opus International (in LinkedIn)

Big landslide in Switzerland - seems fully predictable though

☙ ❧

Massive rockslope collapse with 35 fatalities caught on a remarkable video

A massive landslide hit Bijie City in Zhangjiawan Township, Nayong County of southwest China's Guizhou province at about 10:40 local time on Monday, August 28, 2017, affecting 34 households. At least three people have died, seven are injured and another 32 are missing.

According to the city's publicity department, over 2 000 people, including police, firefighters and medical staff are at the scene and more than 80 emergency vehicles, 20 life detectors, 17 digging machines and 8 drones are involved in the rescue work.

"This appears to be a massive rockslide, with a fair amount of toppling as the landslide developed," landslides expert Dr. Dave Petley said.

"Unusually for a non-seismic slide the failure seems to have developed from the ridge crest and then to have entrained debris from lower on the slope The result is a landslide with a morphology that is more reminiscent of an earthquake-induced slide," he said.

"It is notable that there is a high proportion of highly weathered material in the landslide, especially in the scar, much of which seems to have fallen from the upper part of the slope (the deposit itself is mostly intact rock blocks with a mantle of weathered material). This suggests perhaps that there was a highly weathered zone high on the slope that provided the structural weakness for the failure," Petley concluded.

A massive landslide hit Bijie City in Zhangjiawan Township, Nayong County of southwest China's Guizhou province at about 10:40 local time on Monday, August 28, 2017.

The cause of the landslide appears to be heavy rain, as the

region has been battered in recent days by two typhoons that saturated soil, leaving it prone to landslides.

Zhangjiawan Township landslide, Nayong County of southwest China's Guizhou province - Monday, August 28, 2017.

According to the Guizhou Provincial Civil Affairs Department report, 3 people have died and 32 are still missing under the rubble, as of 10:00 local time on August 29.

(THE WATCHERS, August 29, 2017, https://watchers.news/2017/08/29/zhangjiawan-landslide-china-video/?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+adorraeli%2FtsEq+%28The+Watchers+-+watching+the+world+evolve+and+transform%29)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

What's Causing So Many Earthquakes in Oklahoma?

On Aug. 2, 2017, a 4.2-magnitude earthquake struck north central Oklahoma, a region that has seen an uptick in temblors since 2014. *Credit: USGS*

A magnitude-4.2 earthquake hit just outside Edmond, Oklahoma, last night (Aug. 2) at 9:56 p.m. local time — the fifth significant temblor to shake this region of the state already this month, according to the U.S. Geological Survey.

The temblor originated at a depth of 1.9 miles (3 km), about 15 miles (24 km) northeast of Oklahoma City, the USGS said. According to the Edmond police department's Twitter account, as of last night, no significant damage had been reported. News 9 in Oklahoma City reported that although 4,600 people were left without power after the quake, all power has since been restored.

But last night's quake is part of a recent trend. Since Tuesday (Aug. 1), five earthquakes above magnitude 3.0 have been reported in this region, Xiaowei Chen, assistant professor of geophysics at the University of Oklahoma, told Live Science. It appears to be part of a longer sequence of earthquakes that began in 2014, she added. In fact, in 2014, the USGS issued an earthquake warning in the central part of the state — the first time the agency had ever issued such a warning for a state east of the Rockies.

Chen didn't yet know enough about the most recent earthquake sequence to be able to comment on whether this recent magnitude-4.2 earthquake may signal that an even bigger earthquake will come, or if it's simply within the range of expected seismic activity in the area, she said.

Although it's difficult to attribute earthquakes to a particular cause, it's possible that human activity induced this earthquake, William Yeck, a research geophysicist with the USGS Geologic Hazards Science Center, told Live Science. Since 2014, there has been a significant increase in the rate of earthquakes in north central Oklahoma, the area in which this recent earthquake occurred, he said. The cause of this increase? The injection of wastewater — a byproduct of oil and gas production — into the ground may be to blame.

"The injection of fluids underground can increase underground pressures," he said. "This, in turn, can effectively unclamp faults, allowing them to slip, which results in earthquakes."

Last year, scientists reported that north central Oklahoma and the southernmost part of Kansas were at the greatest risk of a human-induced earthquake in the United States.

The high rate of earthquakes that began in 2014 began to drop off last year, which Yeck thinks may be due to the decrease in wastewater injection in this area.

"I just stress that [for] people [living] in an area that's prone to earthquakes, preparedness is key," he added.

(Sarah B. Puschmann, Staff Writer / Live Science, August 3, 2017, https://www.livescience.com/60032-earthquakes-shake-oklahoma.html)

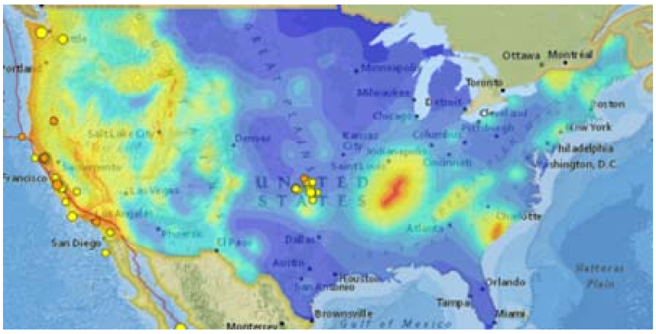
New earthquake software refines Oklahoma's bridge inspection process

A new software system has enabled Oklahoma state bridge inspectors to provide a faster, more targeted response in ensuring public safety the next time an earthquake strikes.

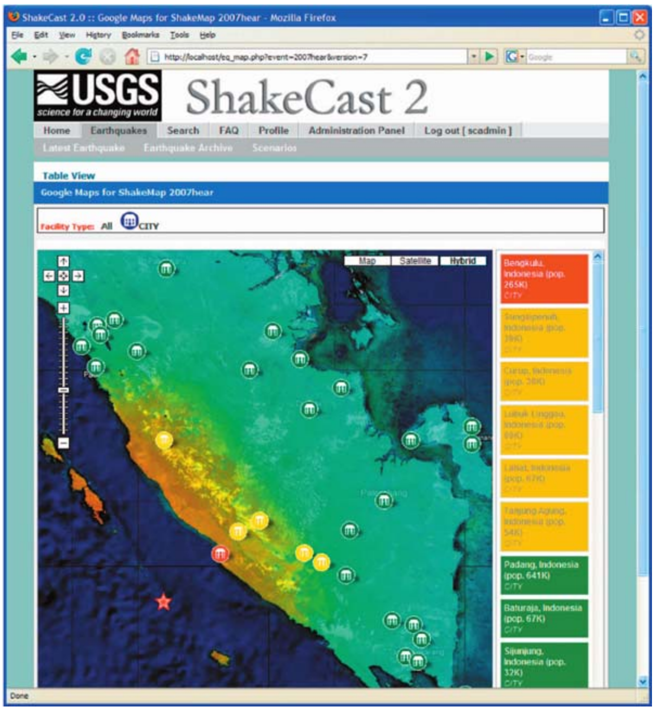
The Oklahoma Department of Transportation (ODOT) is now implementing the use of ShakeCast, a program created by the US Geological Survey (USGS), which is in the final stage of a two-year, two-phase, nearly US$650,000 contract with Infrastructure Engineers Inc. of Edmond to assist the department in developing an earthquake response protocol.

The ShakeCast program will enable the nearly 300 trained ODOT employees to quickly determine which bridges to inspect first after an earthquake. If conditions warrant, key ODOT employees will receive a software-generated inspection priority order based on several factors, including ODOT bridge data, such as bridge condition, age and proximity to an earthquake's epicenter, combined with USGS seismic movement data and magnitude rating.

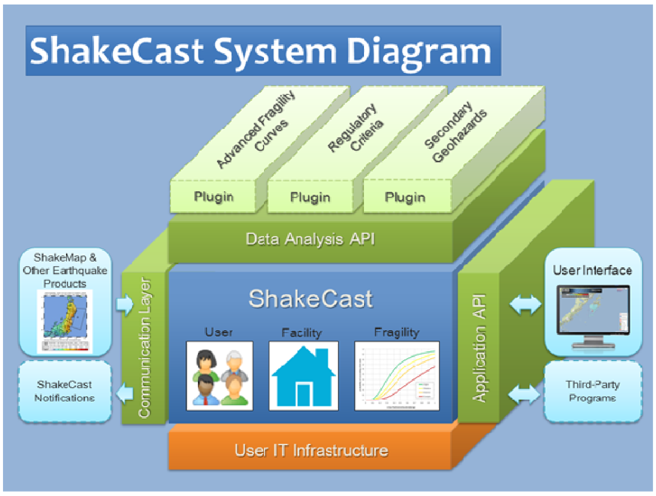
Previously ODOT visually inspected all bridges within five miles (8km) of any earthquake epicenter measuring between 4.4 and 4.7 magnitude on the Richter scale. The inspection radius increased with the earthquake magnitudes. Generally, with a 4- to 5-magnitude earthquake no damage has been found. Going forward with ShakeCast, the inspections will identify only specific bridges susceptible to damage, allowing for a faster and more pinpointed response. The consultant assisted the department with interfacing ODOT bridge inventory data with the ShakeCast software, developing bridge fragility models and disaster preparation plans, training and implementing the alert system for bridge inspectors.



ODOT bridge engineer Steve Jacobi noted that Oklahoma transportation infrastructure has withstood the increased number and severity of earthquakes since 2010 with two instances of cosmetic damage found after the 5.8-magnitude Pawnee earthquake in September 2016, and minor damage to US-62 pavement after a 5.6-magnitude earthquake near Prague in 2011.



While seismic activity seems to have lessened in the state, Oklahoma's chances of earthquake-related bridge damage also are lessened due to the replacement of more than 900 structurally deficient bridges since 2004. The majority of the state's remaining 251 structurally deficient bridges are scheduled for replacement by the end of the decade.



"This technology is one of the biggest advances in ensuring public safety that I've seen in my 30-year career at the department," said Casey Shell, ODOT's chief engineer. "By comparing state bridge data with the severity of an earthquake's ground motions, ShakeCast will allow us to inspect fewer bridges, but with a much greater degree of confidence that we could quickly find any potential damage."

(Adam Frost / Traffic Technology Today.com, August 9, 2017,
http://www.traffictechnologytoday.com/news.php?NewsID=86773)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

This Animated Video Perfectly Explains How Oil Pumpjacks Extract Oil From Underground

Oil derricks are strewn across the southern states of the US. They form an integral part of the domestic oil production market.

Despite being a massive importer of oil from other countries, the United States does also produce oil itself. Statistics suggest most of this oil is used not for fuel but as an ingredient in products.

So where does this oil come from? Most of the oil in the U.S. is extracted in its Southern states.

If you have ever been to this part of the world, you will have surely noticed the very conspicuous oil derrick's or oil wells that are strewn across the country. These odd-looking metal structures pump oil from below the earth and store it on site or send it directly to an oil pipeline.

This great video from Concerning Reality explains in detail how oil derricks work. While using very basic technology, the pumps form an integral part of the oil extraction ecosystem.

They are designed to withstand the harsh conditions of the Southern states and require low maintenance to keep them running basically continuously. Each derrick is designed according to the depth of the well it is drawing from but these machines can 1.5 - 10 gallons of oil per stroke.

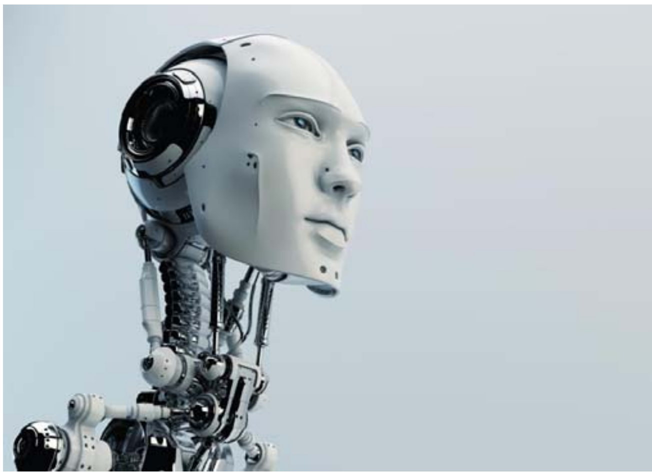
The oil removed by the derrick is a mixture of crude oil and water which is then separated depending on the oil's future use. The U.S. exports some of its oil to Canada which is then often imported back in the form of different value-added products.

(Interesting Engineering, https://interestingengineering.com/video/this-animated-video-perfectly-explains-how-oil-pumpjacks-extract-oil-from-under-ground?_campaign=YyPMkqpV4DYvl&_h=9480fc0933eb231a0575c535417bef075ed6e805&_source=newsletter&_uid=9wdL9JEwej&utm_campaign=Newsletter-08-03-2018&utm_medium=mailing&utm_source=newsletter)

RoboStop

FACEBOOK shut down an artificial intelligence experiment after two robots began talking in a language only they understood.

The "chatbots" Alice and Bob modified English to make it easier for them to communicate — creating sentences that were gibberish to watching scientists.



The robots' conversation was gibberish to anyone except them

A robot expert said the revelation that Facebook machines had spoken in their own language was exciting — but also incredibly scary.

UK Robotics Professor Kevin Warwick said: "This is an incredibly important milestone, but anyone who thinks this is not dangerous has got their head in the sand.

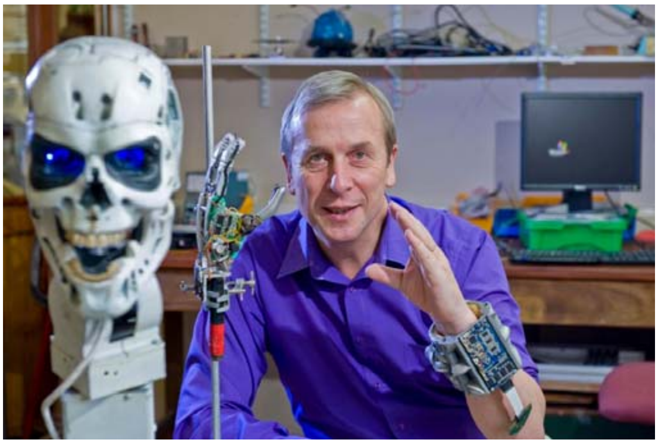
"We do not know what these bots are saying. Once you have a bot that has the ability to do something physically, particularly military bots, this could be lethal.

"If one says, 'Why not do this,' and the other says 'Yes' and it's a military bot, you have a serious situation.

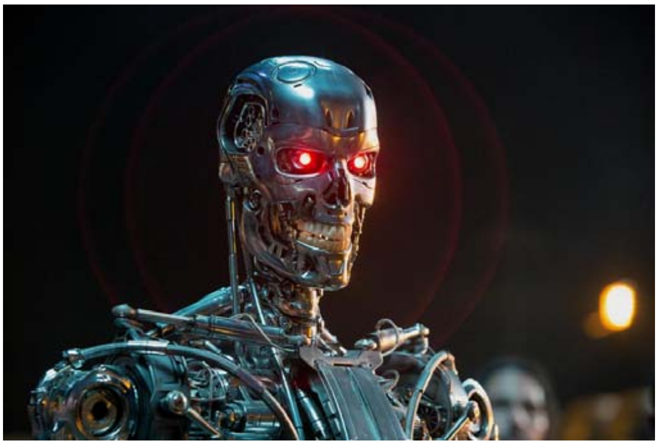
"This is the first recorded communication but there will have been many more unrecorded.

"Smart devices right now have the ability to communicate and although we think we can monitor them, we have no way of knowing.

"Stephen Hawking and I have been warning against the dangers of deferring to Artificial Intelligence."



Robotic Professor Kevin Warwick said the development is potentially dangerous



The incident closely resembles the plot of The Terminator in which a robot becomes self-aware and starts waging a war on humans

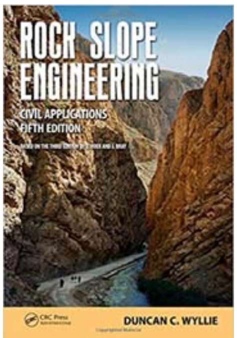
The Facebook incident has echoes of the storyline to movie The Terminator, in which an AI system which has developed self-awareness wages a devastating war against humans.

Facebook researchers in New York set up "chatbots" Alice and Bob in a bid to develop automated trouble-shooters for social media networks.

They were to speak in English as they worked out how to negotiate and trade hats, books and balls — each of which were given a value.

(James Beal and Andy Jehring / THE Sun, 1st August 2017, https://www.thesun.co.uk/tech/4141624/facebook-robots-speak-in-their-own-language)

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ



Rock Slope Engineering: Civil Applications 5th Edition

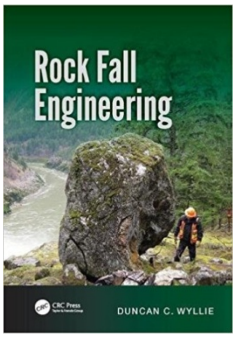
Duncan C. Wyllie

Rock Slope Engineering covers the investigation, design, excavation and remediation of man-made rock cuts and natural slopes, primarily for civil engineering applications. It presents design information on structural geology, shear strength of rock and ground water, including weathered rock. Slope design methods are discussed for planar, wedge, circular and toppling failures, including seismic design and numerical analysis. Information is also provided on blasting, slope stabilization, movement monitoring and civil engineering applications.

This fifth edition has been extensively up-dated, with new chapters on weathered rock, including shear strength in relation to weathering grades, and seismic design of rock slopes for pseudo-static stability and Newmark displacement. It now includes the use of remote sensing techniques such as LiDAR to monitor slope movement and collect structural geology data. The chapter on numerical analysis has been revised with emphasis on civil applications.

The book is written for practitioners working in the fields of transportation, energy and industrial development, and undergraduate and graduate level courses in geological engineering

(CRC Press, September 16, 2017)



Rock Fall Engineering

Duncan C. Wyllie

Rock falls can be a public safety issue. This book provides comprehensive information on identification of these hazards, and design and construction of protection methods.

Rock Fall Engineering describes first, the theoretical background to rock fall behavior in terms of the impact and trajectory phases of rock falls, and second, how this information is applied to modeling of rock falls and the design of ditches, fences and sheds. The theory of rock fall behavior is verified by comparing the calculations with five carefully documented case studies.

The book covers four main topics as follows:

- Describes causes of rock falls, including geology, climate and topography, and provides detailed documentation on rock fall impacts and trajectories at five sites with a wide variety of topographic and geologic features

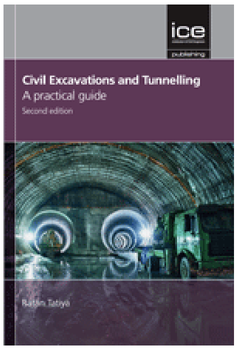
- Discusses theory of impact mechanics, and its application to velocity and energy changes during impacts and trajectories

- Reviews methods of modeling rock fall events, and presents analyses for the five case studies

- Examines rock fall protection in terms of selecting appropriate method(s) for site conditions, and design principles in which the objective is to absorb impact energy in an efficient manner

This book, which contains many worked examples, is of interest to practitioners and researchers working in the fields of geological engineering and natural hazards.

(CRC Press, April 2, 2017)



Civil Excavations and Tunnelling - A Practical Guide, Second Edition

Ratan Tatiya

Civil Excavations and Tunnelling is a comprehensive guide to civil excavations at surface and subsurface levels, with or without the aid of explosives. It features descriptions of the latest methods, techniques, equipment, trends and practices, as well as guidance on safety and the environment.

Civil Excavations and Tunnelling, Second edition:

- serves as a single point of extraction of multiple data for earthworks
- comprises numerous case studies to illustrate the challenges posed by different types of soil, as well as the pros and cons of different sets of equipment
- details the recent innovations in tunnel boring machines (TBMs), including crossover, variable density and multi-mode TBMs
- includes key points and learning questions that allow readers to test their knowledge
- highlights best practices, sustainability in operations, loss-prevention strategies, and occupational health, safety and environment issues

Excavation is a multi-disciplined activity involving civil, construction and mining professionals, earth scientists and geologists. This book will appeal to practitioners, researchers and students in these disciplines.

(ICE Publishing, 27/07/2017)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

Κυκλοφόρησε το Τεύχος 4 του Τόμου 11 (Αυγούστου 2017) του ISSMGE Bulletin με τα παρακάτω περιεχόμενα:

Research highlights

University of California, Berkeley

Member society report

The Kazakhstan Geotechnical Society

Conference reports

- The 2nd International Symposium on Coastal and Offshore Geotechnics (ISCOG 2017) & the 2nd International Conference on Geo-Energy and Geo-Environment (GeGe 2017), China
- All-Russian Conference with International Participation "Deep foundations and geotechnical problems", Russia
- The 3rd International Symposium on Transportation Soil Engineering in Cold Regions, China

ISSMGE Foundation reports

Event Diary

Corporate Associates

Foundation Donors

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www.geoengineer.org

Κυκλοφόρησε το Τεύχος #147 του **Newsletter του Geoengineer.org** (Αυγούστου 2017) με πολλές χρήσιμες πληροφορίες για όλα τα θέματα της γεωμηχανικής. Υπενθυμίζεται ότι το Newsletter εκδίδεται από τον συνάδελφο και μέλος της ΕΕΕΕΓΜ Δημήτρη Ζέκκο (secretariat@geoengineer.org).

Ενδεικτικά αναφέρονται:

- Deadly M6.6 earthquake hits Kos Island, Greece
- Large sinkhole opens up in Florida
- Chesapeake Bay Bridge-Tunnel: An 'engineering wonder' of the modern world
- Unprecedented rainfall leaves at least 11 dead in Japan

http://campaign.r20.constantcontact.com/render?m=1101304736672&ca=b197107a-951b-4b26-91d4-fb5914bd7d22

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http://campaign.r20.constantcontact.com/render?m=1111082143825&ca=e577625d-cc78-4f87-9865-acb3cd140165

Κυκλοφόρησε το Τεύχος 2 του Τόμου 33, 2017 του Newsletter της International Deosynthetics Society με τα παρακάτω περιεχόμενα:

Volume 24, Issue 4, August, 2017
www.icevirtuallibrary.com/toc/jgein/24/4

Experimental evaluation of HDPE geomembrane seam strain concentrations, E. Kavazanjian, J. Andresen, A. Gutierrez, 24(4), pp. 333–342

Evaluation of shear bonding and reflective crack propagation in a geocomposite reinforced overlay, A. Noory, F. Moghadas Nejad, A. Khodaii, 24(4), pp. 343–361

Effects of aspect ratio of footings on bearing capacity for geogrid-reinforced sand over soft soil, S. Saha Roy, K. Deb, 24(4), pp. 362–382

Performance of buried HDPE pipes – part I: peaking deflection during initial backfilling process, M. Zhou, Y. J. Du, F. Wang, M. D. Liu, 24(4), pp. 383–395

Performance of buried HDPE pipes – part II: total deflection of the pipe, M. Zhou, F. Wang, Y. J. Du, M. D. Liu, 24(4), pp. 396–407

Effect of welding parameters on properties of HDPE geomembrane seams, L. Zhang, A. Bouazza, R. K. Rowe, J. Scheirs, 24(4), pp. 408–418

A new approach for estimating internal stability of reinforced soil structures, L. Weerasekara, B. Hall, D. Wijewickreme, 24(4), pp. 419–434

A general relationship to estimate strength of fibre-reinforced cemented fine-grained soils, N. C. Consoli, S. F. V. Marques, N. C. Sampa, M. S. Bortolotto, A. T. Siacara, H. P. Nierwinski, F. Pereira, L. Festugato, 24(4), pp. 435–441

Volume 45, Issue 4, August 2017
www.sciencedirect.com/journal/geotextiles-and-geomembranes/vol/45/issue/4

Numerical modelling of two full-scale reinforced soil wrapped-face walls, Yan Yu, Richard J. Bathurst, Tony M. Allen, Pages 237-249

A method for correcting field strain measurements to account for temperature effects, Christopher L. Meehan, Majid Talebi, Pages 250-260

Serviceability design for geosynthetic reinforced column supported embankments, Daniel J. King, Abdelmalek Bouazza, Joel R. Gniel, R. Kerry Rowe, Ha H. Bui, Pages 261-279

The efficacy and use of small centrifuge for evaluating geotextile tube dewatering performance, M.M. Khachan, S.K. Bhatia, Pages 280-293

Numerical analysis of instrumented mechanically stabilized gabion walls with large vertical reinforcement spacing, Meixiang Gu, James G. Collin, Jie Han, Zhen Zhang, ... Pietro Rimoldi, Pages 294-306

Long-term reinforcement strains for column supported embankments with viscous reinforcement by FEM, K.-W. Liu, R. Kerry Rowe, Qian Su, Bao Liu, Zhixiang Yang, Pages 307-319

Investigation of soil-geosynthetic-structure interaction associated with induced trench installation, M.A. Meguid, M.G. Hussein, M.R. Ahmed, Z. Omeman, J. Whalen, Pages 320-330

Evaluation of compressibility and small strain stiffness characteristics of sand reinforced with discrete synthetic fibers, H. Choo, B. Yoon, W. Lee, C. Lee, Pages 331-338

A numerical modelling technique for geosynthetics validated on a cavity model test, Bekoin Francis Guillaume Tano, Guillaume Stoltz, Nathalie Touze-Foltz, Daniel Dias, Franck Olivier, Pages 339-349

Performance of the bearing reinforcement earth wall as a retaining structure in the Mae Moh mine, Thailand, Artit Udomchai, Suksun Horpibulsuk, Cherdsak Suksiripattanapong, Narongsak Mavong, Arul Arulrajah, Pages 350-360

An analytical solution for geotextile-wrapped soil based on insights from DEM analysis, Hongyang Cheng, Haruyuki Yamamoto, Klaus Thoeni, Yang Wu, Pages 361-376

Effect of geogrid-reinforcement in granular bases under repeated loading, Lekshmi Suku, Sudheer S. Prabhu, G.L. Sivakumar Babu, Pages 377-389

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