

### **Stress-strain hysteresis shape estimation of different soils using deformation-history integral (DHI) model**

Different soils show different nonlinear stress-strain patterns. Hence, it is difficult to come up with a general model to predict these shapes. This study investigated the suitability of the DHI model which was not originally formulated for geomaterials. This model was applied to different loading cycles of various types of soils and the model's variables were optimized using nonlinear generalized reduced gradient (GRG) method. Up to five hysteresis springs were considered in the study. The computed error criteria indicated that the DHI model approximated the nonlinear hysteresis shapes appropriately and using three hysteresis springs presented the best estimation for almost all cases. In addition, this model approximated the initial loading cycles better than the final ones.

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Organisations: Civil Engineering, Research group: Foundation Structures, Bridgestone Corporation

Contributors: Vatanshenas, A., Mori, T., Farhadi, M., Lämsivaara, T.

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Research output: Contribution to journal > Article > Scientific > peer-review

### **Evaluation of the Preconsolidation Stress and Deformation Characteristics of Finnish Clays based on Piezocone Testing**

The design of structures and infrastructures in soft soil areas represents an important challenge in geotechnical engineering owing to the poor soil properties in terms of strength and compressibility. In this scenario, a proper geotechnical investigation plan is fundamental to evaluate geotechnical parameters for conducting stability analysis and settlement prediction. Over the past decades, in Finland, the field vane test had been widely adopted as the traditional field investigation tool.

However, recent studies conducted at Tampere University (formerly Tampere University of Technology) have revealed that this test often encounters many problems in terms of accuracy, precision, and results interpretation. The present study aims to overcome these issues and improve the quality of ground investigation data in Finnish soft clays promoting the use of piezocone testing. Although this test has proven high reliability in different soil conditions, its applicability in soft sensitive clays requires high accuracy in terms of measurement and interpretation.

Therefore, an extensive experimental program has been conducted on five soft clay sites located in Finland, aiming to build a high quality database of in situ and laboratory test data. In particular, seismic and resistivity piezocones have been adopted for field testing, whereas the laboratory program comprised index tests, one-dimensional constant rate of strain consolidation tests, and triaxial tests. As sample quality represents a key issue in soft sensitive clays, several sampling apparatuses and procedures have been tested to obtain high-quality undisturbed samples. Finally, the collected dataset has been exploited to establish correlations for evaluating the preconsolidation stress and deformation characteristics of the investigated clays. An analytical method based on a spherical cavity expansion theory and critical state soil mechanics solution has been adopted to derive simplified analytical equations for predicting the preconsolidation stress and the constrained modulus based on the piezocone test data.

Results indicate that there is a fairly good agreement between the predicted values and the experimental data. Moreover, reliable correlations between the soil compressibility and the natural water content were established while the applicability of the piezocone testing to predict the deformation characteristics turned out to be characterized by high uncertainties.

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Organisations: Civil Engineering, Research group: Foundation Structures

Contributors: Di Buo, B.

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Research output: [Book/Report](#) › [Doctoral thesis](#) › [Monograph](#)

### 3D numerical modelling of thermal shock assisted percussive drilling

A 3D numerical study on thermal shock assisted percussive drilling is presented. The governing thermo-mechanical problem is solved with the finite element method. Rock failure due to mechanical and thermal loadings is described by a damage-viscoplasticity model. The bit-rock interaction and the thermal jet heating are solved with an explicit time marching scheme. In the numerical simulations, the percussion drilling action, i.e. the dynamic indentation, on Kuru granite with a special triple-button bit is simulated. The effect of confining and down-the-hole pressures, simulating deep well drilling, are tested with an initial borehole setting. Generally, heat shock treatment enhances the performance of percussive drilling by facilitating the interaction of the damage systems induced by adjacent buttons in both shallow and deep wells. However, down-the-hole pressure severely impedes both the thermally and mechanically induced damage.

### General information

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Organisations: Civil Engineering, Research group: Structural Mechanics  
Contributors: Saksala, T.  
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Research output: [Contribution to journal](#) › [Article](#) › [Scientific](#) › [peer-review](#)

### Demolition of concrete by thermal shock spallation: a mesoscopic numerical study based on embedded discontinuity finite elements

This paper deals with 2D (plane strain) and axisymmetric numerical modelling of concrete fracture processes under mechanical and thermal loading. A mesoscopic modelling approach with an explicit representation of aggregates as Voronoi polygons is chosen while the concrete fracture model is based on rate-dependent embedded discontinuity finite elements with Rankine criterion indicating a new crack initiation. This choice enables the study of the effects of inherent crack populations on the response of concrete under mechanical and thermal loading. In the numerical examples, the performance of the present modelling approach is first demonstrated in the uniaxial compression and tension tests under plane strain conditions. Then, the problem of thermal spallation of concrete surface under dry conditions due to a high intensity, short duration heat flux is simulated under axisymmetric conditions. The underlying uncoupled thermo-mechanical problem is

solved with an explicit time marching scheme based on the staggered approach. Different heat flux intensities and heating times as well as combined effect of surface roughness and pre-stress field are tested. The simulation results suggest that demolition of concrete structures by heat shock is a viable method.

#### **General information**

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Organisations: Civil Engineering, Research group: Structural Mechanics  
Contributors: Saksala, T.  
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Research output: Contribution to journal > Article > Scientific > peer-review

#### **Lime treatment of a soft sensitive clay: A sustainable reuse option**

This paper presents the results of research aimed at studying the hydraulic and mechanical behavior of Finnish soft clays treated by quicklime. This research investigated the effect of water content and curing time on the characteristics of the compacted soil treated with 7% lime, with the aim of verifying the effectiveness of lime treatment and evaluating its possible re-use, thus avoiding landfill disposal. A laboratory-testing program was carried out both on treated and untreated soil, supported by microstructural investigation. Results have shown a general increase of the hydraulic conductivity due to the addition of lime, reduction of compressibility, and increase in the soil shear strength for a wide range of water contents (10%–40%), proving the effectiveness of the lime treatment. Lime addition to the compacted clay at high water contents (90%–130%) turned out to improve the mechanical characteristics to a lesser extent, while fractionated lime supply did not significantly improve the mechanical performance. The results of this research demonstrate that the re-use of sensitive clays, typically of high water contents, by lime addition require a drying process. Different drying procedures can be adopted (proposed in the paper) depending on the specific site conditions. However, the soil treatment is generally economically convenient in comparison to the disposal in waste landfills, which would represent the only alternative solution.

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Organisations: Civil Engineering, Research group: Foundation Structures, Universita Politecnica delle Marche  
Contributors: Di Sante, M., Di Buò, B., Fratolocchi, E., Lämsivaara, T.  
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Source: Scopus

Source ID: 85085286320

Research output: Contribution to journal > Article > Scientific > peer-review

### **Methodology to estimate ionospheric scintillation risk maps and their contribution to position dilution of precision on the ground**

Satellite-based communications, navigation systems and many scientific instruments rely on observations of trans-ionospheric signals. The quality of these signals can be deteriorated by ionospheric scintillation which can have detrimental effects on the mentioned applications. Therefore, monitoring of ionospheric scintillation and quantifying its effect on the ground are of significant interest. In this work, we develop a methodology which estimates the scintillation induced ionospheric uncertainties in the sky and translates their impact to the end-users on the ground. First, by using the risk concept from decision theory and by exploiting the intensity and duration of scintillation events (as measured by the S4 index), we estimate ionospheric risk maps that could readily give an initial impression on the effects of scintillation on the satellite-receiver communication. However, to better understand the influence of scintillation on the positioning accuracy on the ground, we formulate a new weighted dilution of precision (WPDOP) measure that incorporates the ionospheric scintillation risks as weighting factors for the given satellite-receiver constellations. These weights depend implicitly on scintillation intensity and duration thresholds which can be specified by the end-user based on the sensitivity of the application, for example. We demonstrate our methodology by using scintillation data from South America, and produce ionospheric risk maps which illustrate broad scintillation activity, especially at the equatorial anomaly. Moreover, we construct ground maps of WPDOP over a grid of hypothetical receivers which reveal that ionospheric scintillation can also affect such regions of the continent that are not exactly under the observed ionospheric scintillation structures. Particularly, this is evident in cases when only Global Positioning System (GPS) is available.

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MoE publication type: A1 Journal article-refereed

Organisations: Computing Sciences, University of Bath, Federal Institute of São Paulo

Contributors: Koulouri, A., Smith, N. D., Vani, B. C., Rimpiläinen, V., Astin, I., Forte, B.

Number of pages: 20

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URLs:

<https://github.com/AlexandraPouk/Ionospheric-Scintillation-Maps-and-PDOP> (Matlab codes)

Research output: Contribution to journal > Article > Scientific > peer-review

### **Moisture behavior of external insulated precast concrete wall panels**

Excess moisture in concrete structures is a major problem in building industry. It is claimed that degradation of the finishing materials of concrete slabs is the largest source of volatile organic compound in the building stock in the Nordic countries. Considering concrete wall panels, the choice of the insulation material influences concrete drying considerably and causes a risk for moisture accumulation on the interior surface, if vapor tight finishing materials are used or if finishing materials are installed prematurely. Mineral wool insulation, which has predominately been used in Finland, is a vapor open material. However, vapor tight plastic foam insulation materials are nowadays more commonplace. Here we show that the overall rate of drying of the concrete panel with a vapor open insulation material is higher in comparison to the concrete panel with vapor tight insulation materials. However, relative humidity distribution near the inner surface of the concrete panel at the end of the drying phase is almost identical irrespective of the insulation material and the water vapor resistance of the interior surface material has a greater impact on the relative humidity level on the inner concrete surface. Moisture behavior of concrete panel walls is studied under a certain building schedule in Finnish environment and building conditions by numerical simulation. The model for drying of concrete is calibrated based on laboratory measurements. According to our study, self-desiccation and changing diffusivity due to the hydration process of the concrete cannot be ignored when evaluating the moisture behavior of the concrete wall panel structure with a low water binder ratio ( $w/b <$

0.5). Measurements indicate that the early age humidity drop is by up to 10 percentage points.

#### **General information**

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MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering, Research group: Building Physics, Granlund Consulting Oy

Contributors: Sekki, P., Karvinen, T., Vinha, J.

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Keywords: Building envelope, concrete, drying, early age, hydration, moisture behavior, relative humidity distribution in concrete, self-desiccation, wall insulation

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#### **Bibliographical note**

EXT="Karvinen, Timo"

Source: Scopus

Source ID: 85086515517

Research output: Contribution to journal > Article > Scientific > peer-review

#### **Numerical modeling of the tool-rock penetration process using FEM coupled with SPH technique**

The numerical simulation of penetration into rock is an important tool to gain insights into rock drilling mechanisms, since it can be exploited as an alternative to the expensive field testing. This research aims to present an innovative computer simulation of rock penetration process on the basis of the finite element method (FEM) coupled with smoothed particle hydrodynamics (SPH). An advanced material model, namely the Karagozian and Case Concrete (KCC) model, was employed for this purpose. The Punch Penetration test (PPT) was carried out on a medium strength sandstone for validating the numerical method. The comparison of the numerical and experimental results obtained concluded that the FEM coupled with SPH method in conjunction with the fully calibrated KCC material model is a reliable method for the study of rock penetration due to its ability to deal with large deformations and its realistic constitutive modeling. The modeling approach was finally applied to estimate the required force to penetrate an offshore reservoir rock block under the in-situ confining pressure with a double conical tool up to 5 mm depth. The effective stresses in sedimentary basins of Agosta and Dosso Campus at a depth of 3000 m below the seabed are considered as the confining pressures of this study.

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Organisations: Civil Engineering, Research group: Structural Mechanics, Politecnico di Milano

Contributors: Mardalizad, A., Saksala, T., Manes, A., Giglio, M.

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ASJC Scopus subject areas: Fuel Technology, Geotechnical Engineering and Engineering Geology

Keywords: Coupled FEM-SPH, Drilling, KCC, Punch penetration test (PPT)

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Research output: Contribution to journal › Article › Scientific › peer-review

### **Numerical modelling of pore-fluid-enhanced thermal spallation in granitic rock**

This paper considers numerically the effect of pore-fluid on thermal spallation of granitic rock. For this end, a numerical model based on the embedded discontinuity finite element approach to rock fracture and an explicit scheme to solve the underlying thermo-mechanical problem is developed. In the present implementation, a displacement discontinuity (crack) is embedded perpendicular to the first principal direction in a linear triangle element upon violation of the Rankine criterion. In the thermo-mechanical problem, the heating due to mechanical dissipation is neglected as insignificant in comparison to the external heat flux. This leads to an uncoupled thermo-mechanical problem where the only input from the thermal part to the mechanical part is thermal strains. This problem is solved with explicit time marching using the mass scaling to speed up the solution. Finally, the fluid trapped into the micro-pores is modelled as a material that can bear only volumetric compressive stresses. A thermal spallation problem of a rock sample under axisymmetry is simulated as a numerical example.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering, Research group: Structural Mechanics

Contributors: Saksala, T.

Number of pages: 10

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#### **Publication information**

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Numerical modelling of pore-fluid-enhanced 2020

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Research output: Contribution to journal › Article › Scientific › peer-review

### **Numerical modelling of thermal drilling of rock by heating-cooling cycle**

This paper presents a numerical study on thermal drilling of rock. In this context, thermal drilling refers to the disintegration of rock surface material when exposed to a heat shock consisting of an intensive external thermal flux and consequent rapid cooling. An embedded discontinuity finite element approach is chosen for modelling the rock cracking due to the heating-cooling cycle. The underlining uncoupled thermo-mechanical problem is solved by an explicit time stepping scheme with mass scaling to increase the time critical time step. Numerical simulation of a heterogeneous rock sample under axisymmetric conditions demonstrate that the drilling by a rapid heating-cooling cycle is a feasible method at conditions where the bulk rock is at elevated temperatures.

#### **General information**

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MoE publication type: A4 Article in a conference publication

Organisations: Civil Engineering, Research group: Structural Mechanics

Contributors: Pressacco, M., Saksala, T.

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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

### Thermal shock assisted percussive drilling: A numerical study on the single-bit axisymmetric case

This paper presents a numerical study on thermal shock assisted percussive drilling. For this end, a finite element based numerical approach for solving the governing thermo-mechanical problem explicitly in time is presented.

Rock fracture is described in the continuum sense by a damage-viscoplasticity model with separate damage variables for tensile and compressive failure types. In the numerical simulations, an axisymmetric numerical rock is dynamically indented with a spherical tool in cases of intact and heat shocked heterogeneous rocks. In realistic simulations with an initial borehole, the heat shock treatment of rock enhances the mechanical breakage, increasing especially the tensile damaging, in unconfined and confined conditions with and without down-the-hole pressure. However, according to the simulations, down-the-hole pressure effectively prevents the thermal spallation phenomenon crucial for thermal jet drilling.

### General information

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MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering, Research group: Structural Mechanics

Contributors: Saksala, T.

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Research output: Contribution to journal › Article › Scientific › peer-review

### Thermal shock weakening of granite rock under dynamic loading: 3D numerical modeling based on embedded discontinuity finite elements

This paper presents a numerical study of thermal shock weakening of granite rock under dynamic loading. A fully 3D numerical scheme based on a combined continuum viscodamage-embedded discontinuity model and an explicit scheme to solve the underlying thermomechanical problem was developed and validated through numerical examples. First, the dynamic Brazilian disc test is simulated on intact numerical rock. Then, thermal shock-induced cracking due to a moving external heat flux boundary condition, mimicking experiments based on plasma jet treatment, is numerically predicted. Finally, numerical Brazilian disc test is conducted on the thermal shocked numerical samples. The predicted and experimental weakening effects are in good agreement demonstrating that the present modeling approach has good predictive capabilities. The practical significance of the results is that heat shock pre-treatment can substantially enhance rock gravel and rubble crushing.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering, Research group: Structural Mechanics, Université de Technologie Compiègne/Sorbonne Universités, Laboratoire Roberval de Mécanique Centre de Recherche

Contributors: Saksala, T., Ibrahimbegovic, A.

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Research output: Contribution to journal > Article > Scientific > peer-review

#### Variation of CPTu-based transformation models for undrained shear strength of Finnish clays

The determination of a design soil property may include multiple sources of uncertainty. One of the sources originates from transformation model used to evaluate soil parameters when they are not measured directly. This study focuses on the transformation uncertainty related to three different transformation models used in evaluation of undrained shear strength from CPTu borings. The used correlation models are common models found in literature and calibrated at Tampere University. The CPTu data used in this study was taken from Knuuti and Länsivaara [2019. Variation of Measured CPTu Data. ISGSR], and it consisted of four different soft clay sites in Finland. The transformation uncertainty was calculated for each transformation model at each site. Moreover, every CPTu boring was analysed separately. The results showed that the transformation uncertainty was lowest for models based on the net cone resistance ( $COV = 0.033-0.084$ ) and pore pressure ( $COV = 0.024-0.085$ ). For the third model, the uncertainty was little higher as it included more uncertainty in the initial parameters. This suggests that the transformation models based on net cone resistance ( $q_{NET}$ ) and pore pressure ( $u_2$ ) could be more suitable for practice.

#### General information

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MoE publication type: A1 Journal article-refereed  
Organisations: Civil Engineering  
Contributors: Knuuti, M., Länsivaara, T.  
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ASJC Scopus subject areas: Civil and Structural Engineering, Building and Construction, Safety, Risk, Reliability and Quality, Geotechnical Engineering and Engineering Geology, Geology  
Keywords: coefficient of variation, correlation models, CPTu, reliability, statistics, undrained shear strength  
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Source ID: 85074297150  
Research output: Contribution to journal > Article > Scientific > peer-review

#### Temporal variation in indoor transfer of dirt-associated environmental bacteria in agricultural and urban areas

An agricultural environment and exposure to diverse environmental microbiota has been suggested to confer protection against immune-mediated disorders. As an agricultural environment may have a protective role, it is crucial to determine whether the limiting factors in the transfer of environmental microbiota indoors are the same in the agricultural and urban environments. We explored how sampling month, garden diversity and animal ownership affected the indoor-transfer of environmental microbial community. We collected litter from standardized doormats used for 2 weeks in June and August 2015 and February 2016 and identified bacterial phylotypes using 16S rRNA Illumina MiSeq sequencing. In February, the



diversity and richness of the whole bacterial community and the relative abundance of environment-associated taxa were reduced, whereas human-associated taxa and genera containing opportunistic pathogens were enriched in the doormats. In summer, the relative abundances of several taxa associated previously with beneficial health effects were higher, particularly in agricultural areas. Surprisingly, the importance of vegetation on doormat microbiota was more observable in February, which may have resulted from snow cover that prevented contact with microbes in soil. Animal ownership increased the prevalence of genera *Bacteroides* and *Acinetobacter* in rural doormats. These findings underline the roles of season, living environment and lifestyle in the temporal variations in the environmental microbial community carried indoors. As reduced contact with diverse microbiota is a potential reason for immune system dysfunction, the results may have important implications in the etiology of immune-mediated, non-communicable diseases.

#### General information

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MoE publication type: A1 Journal article-refereed

Organisations: Architecture, University of Helsinki, Tampere University, University of Tampere

Contributors: Hui, N., Parajuli, A., Puhakka, R., Grönroos, M., Roslund, M. I., Vari, H. K., Selonen, V. A., Yan, G., Siter, N., Nurminen, N., Oikarinen, S., Laitinen, O., Rajaniemi, J., Hyöty, H., Sinkkonen, A.

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dupl=49848283

Research output: Contribution to journal › Article › Scientific › peer-review

#### Investigation and geotechnical characterization of Perniö clay, Finland

Understanding the behavior of soft sensitive clays is a key aspect of geotechnical design, especially in those regions where constructions are planned in marine clay areas. In Finland, one of the major geotechnical issues is the stability and deformation of the railway embankments located on soft soil deposits. The Tampere University of Technology (TUT) and the Finnish Transport Agency (FTA) have been carrying out a research project aiming to a better understanding of strength and deformation properties of Finnish soft clays. As a part of this project, a detailed site investigation was conducted at Perniö site in Western Finland. This paper presents the details of the geotechnical investigation, including field testing, sampling operations, and the laboratory testing program. In particular, an open drive tube sampler with 132 mm diameter, designed at TUT, was used to collect high quality samples. For comparison, samples were also taken using the conventional piston samplers and Sherbrooke Mini-block sampler. Field testing included piezocone, vane shear, and seismic piezocone. Laboratory testing consisted of index, consolidation, triaxial and simple shear tests. A comprehensive study of all these data is presented in a framework to describe Perniö soft clay.

#### General information

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Organisations: Research group: Foundation Structures, Civil Engineering, Università Politecnica delle Marche

Contributors: Di Buò, B., D'Ignazio, M., Selänpää, J., Haikola, M., Lämsivaara, T., Di Sante, M.

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<http://urn.fi/URN:NBN:fi:tuni-201910153856>  
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## Vesihuollon instituutiot vaativat taitavaa jalkapallopeleä

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Contributors: Inha, L., Katko, T. S., Rajala, R.  
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[https://www.ril.fi/media/2019/rakennustekniikka/rt-2019-3\\_low\\_linkit.pdf](https://www.ril.fi/media/2019/rakennustekniikka/rt-2019-3_low_linkit.pdf)  
Research output: Contribution to journal > Article > Professional

### Estimation of preconsolidation stress of clays from piezocone by means of high-quality calibration data

An extensive database of high-quality piezocone (CPTU) and laboratory oedometer test data on onshore and offshore clays worldwide has been established. The database covers a wide range of index parameters and overconsolidation ratios (OCR) in the range 1 to 5. The purpose is to derive general correlations to model preconsolidation stress in clays from CPTU data based on high-quality laboratory data. Several studies have already discussed such correlations for different clay types, where the preconsolidation stress is defined as a function of the cone resistance and/or the pore pressure measured in CPTU tests. Often, these correlations are characterized by high uncertainty, mainly because of the sample quality of the laboratory data. New correlations are proposed based on the new database. These correlations are meant to be used for preliminary assessment of preconsolidation stress in the absence of laboratory data or as a comparison tool when limited test data is available.

### General information

Publication status: Published  
MoE publication type: A2 Review article in a scientific journal  
Organisations: Research group: Foundation Structures, Civil Engineering, Norwegian Geotechnical Institute (NGI)  
Contributors: D'Ignazio, M., Lunne, T., Andersen, K. H., Yang, S., Di Buo, B., Lämsivaara, T.  
Number of pages: 13  
Pages: 104-116  
Publication date: 8 May 2019  
Peer-reviewed: Yes

### Publication information

Journal: AIMS Geosciences  
Volume: 5  
Issue number: 2  
ISSN (Print): 2471-2132  
Original language: English  
Electronic versions:  
geosci-05-02-104

DOIs:

10.3934/geosci.2019.2.104

URLs:

<http://urn.fi/URN:NBN:fi:tuni-201912126802>

Research output: Contribution to journal › Review Article › Scientific › peer-review

## Vesihuolto yhdyskuntien ympäristön turvaajana: uskomuksia ja todellisuuksia

### General information

Publication status: Published

MoE publication type: D1 Article in a trade journal

Organisations: Research group: Capacity Development of Water and Environmental Services CADWES, Civil Engineering

Contributors: Katko, T. S., Inha, L., Rajala, R.

Publication date: May 2019

Peer-reviewed: Unknown

### Publication information

Journal: Ympäristökasvatus

Issue number: 2

Original language: Finnish

URLs:

<https://feesuomi.fi/lehti/vesihuolto-yhdyskuntien-ympariston-turvaajana-uskomuksia-ja-todellisuuksia/>

Research output: Contribution to journal › Article › Professional

## Numerical modeling of rock failure under dynamic loading with polygonal elements

Polygonal finite elements are gaining an increasing attention in the computational mechanics literature, but their application in rock mechanics is very rare. This paper deals with numerical modeling of rock failure under dynamic loading based on polygonal finite elements. For this end, a damage-viscoplastic constitutive model for rock based on the Mohr-Coulomb criterion with the Rankine criterion as a tensile cutoff is employed and implemented with the polygonal finite element method. Moreover, the mineral mesostructure or rock is described by randomly mapping groups of polygonal elements representing the constituent minerals into a global mesh and assigning these groups with the corresponding mineral material properties. The performance of the polygonal elements is compared with that of the linear and quadratic triangular and bilinear quadrilateral elements in numerical simulations of controlled shear band formation under uniaxial compression and lateral splitting failure in the dog-bone tension test. Numerical simulations of uniaxial tension and compression tests as well as dynamic Brazilian disc test under increasing loading rates demonstrate that the present approach predicts the correct failure modes as well as the dynamic increase in strength of rock.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering, Israel Institute of Technology (Technion)

Contributors: Saksala, T., Jabareen, M.

Pages: 2056-2074

Publication date: 2019

Peer-reviewed: Yes

### Publication information

Journal: International Journal for Numerical and Analytical Methods in Geomechanics

Volume: 43

Issue number: 12

ISSN (Print): 0363-9061

Ratings:

Scopus rating (2019): CiteScore 5 SJR 1.431 SNIP 1.611

Original language: English

DOIs:

10.1002/nag.2947

Research output: Contribution to journal › Article › Scientific › peer-review

### **Numerical modelling of underground tunnel in rock under seismic loading with polygonal finite elements**

This paper deals with numerical modelling of rock failure around an underground tunnel under remote seismic loading. A continuum based numerical model consisting of a viscodamage-viscoplastic material model for rock and a polygonal finite elements scheme to model the wave propagation in rock is presented. The numerical simulations of an underground opening under a compressive stress wave demonstrate that this approach, despite the limitations of the continuum approach in modelling rock fracture, predict many important features of the rockburst (ejection) into the tunnel in computation times fractional to those of the particle methods.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Civil Engineering, Research group: Structural Mechanics

Contributors: Saksala, T.

Number of pages: 7

Pages: 4808-4814

Publication date: 2019

#### **Host publication information**

Title of host publication: Earthquake Geotechnical Engineering for Protection and Development of Environment and Constructions : Proceedings of the 7th International Conference on Earthquake Geotechnical Engineering, (ICEGE 2019), June 17-20, 2019, Rome, Italy

Publisher: CRC Press

ISBN (Electronic): 9780429031274

#### **Publication series**

Name: Proceedings in Earth and geosciences

Volume: 4

ISSN (Print): 2639-7749

ISSN (Electronic): 2639-7757

DOIs:

10.1201/9780429031274

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### **On the Strain Rate Sensitivity of Coarse-Grained Rock: A Mesoscopic Numerical Study**

A numerical study on the strain rate sensitivity of coarse-grained rock fracture under dynamic loading is presented. For this purpose, the embedded discontinuity finite element method is employed as a numerical tool. Moreover, a mesoscopic description of grain boundary-grain interior structure of rock is given. Thereby, the present approach is able to account for inter- and intragranular failure types of rock. The numerical simulations carried out here corroborate the conception that in direct tension the dynamic increase of tensile strength of rock is a real material property. Moreover, the simulations agree with the hypothesis that in uniaxial compression the dynamic increase of compressive strength is a structural effect due to lateral inertia. Finally, the numerical simulations of the dynamic Brazilian disc test suggest that structural effects also contribute to the dynamic increase in the apparent indirect tensile strength.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering

Contributors: Saksala, T.

Pages: 3229–3240

Publication date: 2019

Peer-reviewed: Yes

#### **Publication information**

Journal: Rock Mechanics and Rock Engineering

Volume: 52

Issue number: 9

ISSN (Print): 0723-2632

Ratings:

Scopus rating (2019): CiteScore 8 SJR 2.124 SNIP 2.447

Original language: English

Electronic versions:

Saksala2019\_Article\_OnTheStrainRateSensitivityOfCo-1

DOIs:

10.1007/s00603-019-01772-1

URLs:

<http://urn.fi/URN:NBN:fi:tty-201905141645>

Research output: Contribution to journal › Article › Scientific › peer-review

## **Tierakenteen rasittuminen yli 76 tonnin HCT-yhdistelmien koekuormituksissa vuosina 2015 - 2017: Liikenneviraston tutkimuksia ja selvityksiä 63/2018**

### **General information**

Publication status: Published

MoE publication type: D5 Text book, professional manual or guide or a dictionary

Organisations: Civil Engineering, Research group: Earth Constructions, Roadscanners Ltd

Contributors: Vuorimies, N., Kalliainen, A., Rossi, J., Kolisoja, P., Varin, P., Saarenketo, T.

Number of pages: 115

Publication date: Dec 2018

### **Publication information**

Publisher: Liikennevirasto

ISBN (Electronic): 978-952-317-652-2

Original language: Finnish

URLs:

<http://urn.fi/URN:978-952-317-652-2>

Research output: Book/Report › Book › Scientific

### **Numerical modelling of thermal spallation of rock**

This paper presents a numerical study on thermal spallation of rock. In the present context, thermal spallation refers to fragmentation of rock surface material when subjected to rapid external heating. For modelling the rock fracture in thermal spallation, an embedded discontinuity finite element approach is chosen. In the present implementation, a displacement discontinuity (crack) is embedded perpendicular to the first principal direction in a CST element upon violation of the Rankine criterion. The heating due to mechanical dissipation is neglected as insignificant in comparison to the external heat flux. Thereby, the underlying thermo-mechanical problem becomes uncoupled the only input from the thermal part to the mechanical part being thermal strains. This problem is solved with explicit time marching using the mass scaling to speed up the solution. A thermal spallation problem of a rock sample under axisymmetry is simulated as a numerical example. Different heat flux intensities are tested to demonstrate the capability of the method.

### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Civil Engineering, Research group: Structural Mechanics

Contributors: Saksala, T.

Number of pages: 8

Pages: 1567-1574

Publication date: Nov 2018

### **Host publication information**

Title of host publication: Proceedings of XII Argentine Congress on Computational Mechanics (MECOM2018)

### **Publication series**

Name: Mecánica Computacional

Volume: 36

No.: 48

ISSN (Electronic): 2591-3522

URLs:

<https://cimec.org.ar/~mstorti/MECOM2018/paper-6088.pdf>

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

## **Nysse tulee - Tampere3 nimittäin**

### **General information**

Publication status: Published

MoE publication type: D1 Article in a trade journal

Organisations: Civil Engineering, Research group: Earth Constructions

Contributors: Kolisoja, P.

Number of pages: 2  
Pages: 27-28  
Publication date: Oct 2018  
Peer-reviewed: Unknown

#### Publication information

Journal: Geoforum  
Issue number: 48  
Original language: Finnish  
URLs:

<https://sgy.fi/wp-content/uploads/2018/10/geoforum-nro-48-lokakuu-2018.pdf>

Research output: Contribution to journal > Article > Professional

#### A High-resolution Coupled Permafrost - Ice Sheet Model

We present the development of a high-resolution coupled permafrost - ice sheet model based on continuum thermodynamics. The model includes heat-transfer within ice, water and soil, including phase change, saturated groundwater flow, salinity transport as well as deformation and stress-distributions of ice, soil and bedrock. It further takes into account important couplings, such as effects of permafrost on glacier sliding and hydraulic conductivity of soil and bedrock, effects of solutes on the development of permafrost, and effects of ice flow and groundwater flow on heat transfer. Implemented in the Finite Element code Elmer, this package provides the possibility to couple a permafrost to a high-resolution glacier or ice-sheet model (Elmer/Ice) that accounts for all stress components (full-Stokes) and thereby - in contrast to usually deployed lower order approximations - has no limitations in spatial resolution. This makes it possible to study detailed processes at places that need high resolutions, such as ice-sheet margins where permafrost may play an important role in controlling the basal ice temperature, or geologically strongly varying bedrocks where permeability changes as a result of permafrost formation or degradation can significantly alter groundwater flow paths. The model is tested on problems of approaching and retreating ice margins using synthetic settings, and real geometries, where measurements for comparison and model constraints are available.

#### General information

Publication status: Published  
MoE publication type: Not Eligible  
Organisations: Civil Engineering, New Mexico Institute of Mining and Technology Socorro, CSC-IT Centre for Science  
Contributors: Zwinger, T., Hartikainen, J., Cohen, D.

Number of pages: 1

Pages: 123

Publication date: 19 Jun 2018

Peer-reviewed: Unknown

Event: Paper presented at POLAR2018, Davos, Switzerland.

URLs:

<http://www.professionalabstracts.com/POLAR2018/iPlanner>

Research output: Other conference contribution > Paper, poster or abstract > Scientific

#### Thermal Evolution of a Holocene Arctic Environment in Western Greenland

We present a Holocene temperature reconstruction at the arctic Greenland Analogue Project (GAP) study area near Kangerlussuaq in western Greenland. The air temperature history is obtained by combining meteorological data from (i) the GAP tundra site, (ii) Kangerlussuaq and coastal sites in South-West Greenland, and (iii) selected Greenland Ice Sheet sites, together with temperature proxy ice-core records. For the glacial stage in the early Holocene, a one-dimensional steady-state ice-sheet model is developed to reproduce the ice thickness and basal thermal conditions of the ice-sheet, and the associated isostatic adjustment. The model uses the geologically-determined ice-margin position and modelled Holocene elevation change of the ice divide. Using the temperature reconstruction and information on present-day vegetation and water bodies, a numerical model, calculating e.g. heat transfer, groundwater flow and salt transport, is used to simulate the thermal evolution of the subsurface including soil and bedrock temperatures, geothermal heat flow and the depth and distribution of permafrost and perennially frozen ground. Seasonal variations in surface processes such as the freezing and thawing of the active layer are taken into account. Comparison with measured soil temperatures and bedrock temperatures measurements down to 570 metres reveals several important factors and processes for the development of permafrost and perennially frozen ground in Greenland.

#### General information

Publication status: Published

MoE publication type: Not Eligible

Organisations: Civil Engineering, Posiva Oy, Swedish Nuclear Fuel and Waste Management Co, Geological Survey of Denmark and Greenland, CSC-IT Centre for Science

Contributors: Hartikainen, J., Claesson Liljedahl, L., Kolisoja, P., Kontula, A., Kouhia, R., Näslund, J., van As, D., Zwinger, T.

Number of pages: 1  
Pages: 122  
Publication date: 19 Jun 2018  
Peer-reviewed: Unknown  
Event:  
URLs:

<http://www.professionalabstracts.com/POLAR2018/iPlanner>

Research output: Other conference contribution › Paper, poster or abstract › Scientific

### **Vertical profiles of lung deposited surface area (LDSA) concentration measured with a drone in an urban street canyon (MP-17)**

#### **General information**

Publication status: Published

Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Research area: Aerosol Physics, Helsinki Region Environmental Services Authority (HSY), Aeromon Ltd., Atmospheric Composition Research, Finnish Meteorological Institute, Finnish Meteorological Institute, Helsinki

Contributors: Kuuluvainen, H., Poikkimäki, M., Järvinen, A., Kuula, J., Irljala, M., Dal Maso, M., Keskinen, J., Timonen, H., Niemi, J., Rönkkö, T.

Pages: 73

Publication date: 18 Jun 2018

Peer-reviewed: Unknown

Event: Paper presented at Aerosol Technology 2018, Bilbao, Spain.

#### **Bibliographical note**

Conference abstract and poster

Research output: Other conference contribution › Paper, poster or abstract › Scientific

### **Identifying criteria for environmental risk assessment models at different stage-gates of nano-material/product innovation considering requirements of various stakeholders (TH083)**

#### **General information**

Publication status: Published

Organisations: Physics, Research area: Aerosol Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group

Contributors: Sørensen, S. N., Hansen, S. F., Baun, A., Spurgeon, D., Matzke, M., Schirmer, K., Burkard, M., Dal Maso, M., Poikkimäki, M., Verschoor, A., Quik, J., Peijnenburg, W., Wigger, H., Nowack, B.

Publication date: 17 May 2018

Peer-reviewed: Unknown

Event: Paper presented at SETAC EUROPE 28th Annual Meeting, Rome, Italy.

URLs:

[https://s3.amazonaws.com/setac.static/m\\_42/abstract\\_book\\_cache/abstracts\\_presentation\\_44049.pdf](https://s3.amazonaws.com/setac.static/m_42/abstract_book_cache/abstracts_presentation_44049.pdf)

#### **Bibliographical note**

Conference abstract

Research output: Other conference contribution › Paper, poster or abstract › Scientific

### **Numerical modelling of fracture processes in thermal shock weakened rock**

This paper presents some preliminary results of a research project aiming at the simulation of thermal shock assisted percussive drilling. In the present study, a numerical model for transient thermal shock induced damage in rock is presented. This model includes a rock mesostructure description accounting for different mineral properties and a thermo-mechanical constitutive model based on embedded discontinuity finite elements. In the numerical simulations, the thermal shock induced damage process is first simulated. Then the uniaxial compression test on thermally affected numerical rock samples is carried out. The effect of thermal shock is demonstrated by comparison to uniaxial compression test simulation on intact rock. The results show that the thermal-shock assisted rock breakage is a feasible idea to be extended to percussive drilling as well.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Civil Engineering

Contributors: Pressacco, M., Saksala, T.

Pages: 883-888

Publication date: May 2018

### Host publication information

Title of host publication: Geomechanics and Geodynamics of Rock Masses, Volume 1 Proceedings of the 2018 European Rock Mechanics Symposium

Publisher: CRC Press

Editor: Litvinenko, V.

ISBN (Electronic): 9780429867729

URLs:

<https://www.crcpress.com/Geomechanics-and-Geodynamics-of-Rock-Masses-Volume-1-Proceedings-of-the-Litvinenko/p/book/9780429461774>

<https://www.taylorfrancis.com/books/9780429867729>

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### Numerical modelling of rock fracture with a Hoek-Brown viscoplastic-damage model implemented with polygonal finite elements

In the present paper, the rock mineral structure is described as a Voronoi diagram where the Voronoi cells are polygonal finite elements. The minerals constituting the rock are represented by random clusters of polygonal finite elements. Rock fracture is described in the continuum sense by using a damage-viscoplasticity model based on the Hoek-Brown criterion. Due to the asymmetry of the tension and compression behavior of rocks, separate scalar damage variables, driven by viscoplastic strain, are employed in tension and compression. The system equation of motion are solved by explicit time marching since the final aim of this research project is to model transient problems with contact loading (such as percussive rock drilling). In the numerical examples, the capabilities of the present numerical approach are demonstrated. Specifically, uniaxial

tension and compression tests of a numerical rock sample are simulated under plane strain conditions. It is shown that the present method can capture the salient features, including the stress-strain response and the failure modes, of typical rock behavior in these constitutive tests.

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Civil Engineering

Contributors: Saksala, T.

Pages: 903-908

Publication date: May 2018

### Host publication information

Title of host publication: Geomechanics and Geodynamics of Rock Masses, Volume 1: Proceedings of the 2018 European Rock Mechanics Symposium

Publisher: CRC Press

Editor: Litvinenko, V.

ISBN (Electronic): 9780429461774

URLs:

<https://www.crcpress.com/Geomechanics-and-Geodynamics-of-Rock-Masses-Volume-1-Proceedings-of-the-Litvinenko/p/book/9780429461774>

<https://www.taylorfrancis.com/books/9780429867729>

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### Vertical profiles of lung deposited surface area concentration of particulate matter measured with a drone in an urban street canyon

### General information

Publication status: Published

Organisations: Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Research area: Aerosol Physics, Faculty of Natural Sciences, Helsinki Region Environmental Services Authority (HSY), Aeromon Ltd., Aeromon Ltd, Atmospheric Composition Research, Finnish Meteorological Institute

Contributors: Kuuluvainen, H., Poikkimäki, M., Järvinen, A., Irjala, M., Dal Maso, M., Niemi, J., Timonen, H., Keskinen, J., Rönkkö, T.

Publication date: 13 Mar 2018

Peer-reviewed: Unknown

Event: Paper presented at 11th International Conference on Air Quality - Science and Application, Barcelona, Spain.

### Bibliographical note

Conference abstract and presentation

Research output: Other conference contribution > Paper, poster or abstract > Scientific



### **3D finite elements modelling of percussive rock drilling: Estimation of rate of penetration based on multiple impact simulations with a commercial drill bit**

This paper deals with assessing the rate of penetration (ROP) in percussive drilling of rock based on finite element simulations. For this end, a method to simulate the dynamic indentation in percussive drilling is developed and validated. This method includes a recently developed constitutive model to describe the rock fracture and a bit-rock interaction model. The constitutive model has a viscoplasticity part to indicate the stress states leading to rock fracture and a damage model with separate damage variables for tension and compression to quantify the rock fracture. In the numerical examples, the present approach is validated by simulations of the dynamic Brazilian disc test and dynamic indentation simulations on Kuru granite. The multiple consecutive impacts simulations carried out show that the present continuum approach is able to predict the experimental ROP. However, a close match of the experimental ROP requires that the critical damage threshold values, beyond which a damaged element contributes to the volume of removed material, are selected by the experiments. In any case, the present modelling approach, along with the procedure to convert the simulation results into ROP, provides a tool for improving the performance of percussive drilling equipment.

#### **General information**

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Civil Engineering, Materials Science  
Contributors: Saksala, T., Fourmeau, M., Kane, P., Hokka, M.  
Number of pages: 9  
Pages: 55-63  
Publication date: 2018  
Peer-reviewed: Yes

#### **Publication information**

Journal: Computers and Geotechnics  
Volume: 99  
ISSN (Print): 0266-352X  
Ratings:  
Scopus rating (2018): CiteScore 5.9 SJR 1.946 SNIP 2.201  
Original language: English  
DOIs:  
10.1016/j.compgeo.2018.02.006  
Research output: Contribution to journal › Article › Scientific › peer-review

### **Effects of Lime Stabilization on Hydraulic Behavior of Finnish Soft Sensitive Clays: Towards a Sustainable Geoenvironment**

The note presents the results of an experimental research study on the hydraulic behavior of Finnish soft clays treated by quicklime. The effect of a wide range of water contents and of curing time on hydraulic characteristics of the treated soil was studied. 7% of quicklime was identified as the optimum lime amount by means of initial consumption of lime tests and by evaluating the drying capability of different lime amounts. Soil-lime samples were prepared by wet mixing and Standard Proctor compaction. Hydraulic conductivity tests are carried out in flexible wall permeameters both on treated and untreated soil. A general increase in hydraulic conductivity due to the addition of lime is observed (2 order of magnitude at optimum conditions). For the treated specimens, a decrease of two orders of magnitude in permeability values was observed, increasing the water content of the soil. Reduction of permeability due to curing time is within 1 order of magnitude. Lime addition reduced water sensitivity and improves the draining capability of the soil.

#### **General information**

Publication status: Published  
MoE publication type: A4 Article in a conference publication  
Organisations: Civil Engineering, Research group: Foundation Structures, Universita Politecnica delle Marche  
Contributors: Di Sante, M., Giorgetti, F., Di Buo, B., Länsivaara, T., Pasqualini, E.  
Number of pages: 9  
Pages: 226-234  
Publication date: 2018

#### **Host publication information**

Title of host publication: Proceedings of the 8th International Congress on Environmental Geotechnics  
Volume: 1  
Publisher: Springer  
ISBN (Print): 978-981-13-2220-4  
ISBN (Electronic): 978-981-13-2221-1  
DOIs:

10.1007/978-981-13-2221-1\_19

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

## Evaluation of existing CPTu-based correlations for the undrained shear strength of soft Finnish clays

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Civil Engineering, Research group: Foundation Structures, Norwegian Geotechnical Institute (NGI)

Contributors: Selänpää, J., Di Buo, B., Haikola, M., Länsivaara, T., D'Ignazio, M.

Number of pages: 7

Pages: 571-577

Publication date: 2018

### Host publication information

Title of host publication: Cone Penetration Testing 2018 : Proceedings of the 4th International Symposium on Cone Penetration Testing (CPT'18)

Publisher: CRC Press

ISBN (Print): 978-1-138-58449-5

ISBN (Electronic): 978-0-429-00048-5

URLs:

<https://www.taylorfrancis.com/books/9780429000485>

### Bibliographical note

EXT="D'Ignazio, Marco"

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

## Evaluation of sample quality from different sampling methods in Finnish soft sensitive clays

The determination of reliable geotechnical parameters from laboratory testing is highly dependent on sample quality. Over the past decades, undisturbed sampling of soft sensitive clays has been performed using various apparatuses and procedures. This paper outlines details of the design and performance of a new Laval type tube sampler employed for the investigation of five soft clay sites located in Finland. The investigation was conducted using the new tube sampler and two different piston samplers. The sample quality is evaluated based on the recompression volume during reconsolidation to the in situ effective stress in constant-rate-of-strain (CRS) oedometer tests. Test results show that tube samples are generally characterized by higher quality, especially in low plastic clays. In particular, the quality of piston samples is highly affected by the apparatus condition and sampling operations. Furthermore, the influence of storage time on tube samples is investigated. In order to guarantee a proper confinement, and thus reducing swelling, a pressurized system is applied to the tube samples obtained in two soft clay sites. Results demonstrate that the sample quality is not significantly affected by storage time as long as the soil is properly stored into the tube.

### General information

Publication status: E-pub ahead of print

MoE publication type: A2 Review article in a scientific journal

Organisations: Civil Engineering, Research group: Foundation Structures, Norwegian Geotechnical Institute (NGI)

Contributors: Di Buo, B., Selänpää, J., Länsivaara, T., D'Ignazio, M.

Number of pages: 40

Publication date: 2018

Peer-reviewed: Yes

### Publication information

Journal: Canadian Geotechnical Journal

ISSN (Print): 0008-3674

Ratings:

Scopus rating (2018): CiteScore 5.1 SJR 1.753 SNIP 2

Original language: English

Electronic versions:

[evaluation\\_of\\_sample\\_quality\\_from\\_different\\_2018](#)

DOIs:

10.1139/cgj-2018-0066

URLs:

<http://urn.fi/URN:NBN:fi:tuni-201911186014>

### Bibliographical note

EXT="D'Ignazio, Marco"

## Foreword

### General information

Publication status: Published  
MoE publication type: B1 Article in a scientific magazine  
Organisations: Civil Engineering, Research group: Foundation Structures  
Contributors: Lämsivaara, T.  
Number of pages: 1  
Publication date: 2018  
Peer-reviewed: No

### Publication information

Journal: HKIE Transactions  
Volume: 25  
Issue number: 2  
ISSN (Print): 1023-697X  
Ratings:  
Scopus rating (2018): CiteScore 1.3 SJR 0.244 SNIP 0.396  
Original language: English  
DOIs:  
10.1080/1023697X.2018.1482593  
Research output: Contribution to journal › Review Article › Scientific

## Mechanical properties of recovered municipal solid waste incineration bottom ash: the influence of aging and changes in moisture content

The scarcity of non-renewable natural resources and the demand for waste recycling and utilization are steering towards increasing use of waste-derived materials in civil engineering structures. However, as the quality of different waste-derived materials can vary depending on input materials and processes in which they are generated, the utilization of these materials in civil engineering may be risky and cumbersome unless their properties are well-known. In Finland, due to the recently increased number of waste incineration plants, nearly 300 000 t of municipal solid waste incineration bottom ash (MSWI BA) is generated annually in the country. As the material is mainly landfilled or used in landfill site structures at the moment, the utilization of MSWI BA in different civil engineering applications could be increased, if the essential properties of the material were properly understood. In this study, the mechanical properties of recovered MSWI BA were investigated with cyclic load and static triaxial tests. The study focused especially on the influence of changes in moisture content and its relation to the development of recovered MSWI BA stiffness and strength properties over time. The obtained results showed that the stiffness of recovered MSWI BA was highly affected by the changes in moisture content over time but also the material aging had an influence. The resilient modulus,  $M_r$ , was at least doubled during the two months storage of test specimens. Furthermore, when the MSWI BA material dried out and the moisture content decreased 5-7 %, the resilient modulus,  $M_r$ , of the material was even quadrupled.

### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Department of Civil Engineering, Research area: Infrastructure Construction, Research group: Earth Constructions  
Contributors: Sormunen, L. A., Kolisoja, P.  
Pages: 252-270  
Publication date: 2018  
Peer-reviewed: Yes  
Early online date: 13 Nov 2016

### Publication information

Journal: Road Materials and Pavement Design  
Volume: 19  
Issue number: 2  
ISSN (Print): 1468-0629  
Ratings:  
Scopus rating (2018): CiteScore 3.3 SJR 0.963 SNIP 1.344  
Original language: English  
DOIs:  
10.1080/14680629.2016.1251960

## Otat näytteen vain kerran

### General information

Publication status: Published

MoE publication type: D3 Professional conference proceedings

Organisations: Civil Engineering, Research group: Foundation Structures, Aalto University

Contributors: Länsivaara, T., Korkiala-Tanttu, L.

Publication date: 2018

### Host publication information

Title of host publication: Geotekniikan Päivä

Publisher: SGY

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Professional

## WC-tilat ja -opasteet vain likana silmissämme?

### General information

Publication status: Published

MoE publication type: D1 Article in a trade journal

Organisations: Civil Engineering, Research group: Capacity Development of Water and Environmental Services CADWES

Contributors: Katko, T. S.

Number of pages: 1

Pages: 45

Publication date: 2018

Peer-reviewed: Unknown

### Publication information

Journal: Kuntatekniikka

Volume: 72

Issue number: 4

ISSN (Print): 1238-125X

Original language: Finnish

URLs:

<https://kuntatekniikka.fi/lehtiarkisto/>

Research output: Contribution to journal › Article › Professional

## Artificial neural networks models for rate of penetration prediction in rock drilling

Prediction of the rate of penetration (ROP) is an important task in drilling economical assessments of mining and construction projects. In this paper, the predictability of the ROP for percussive drills was investigated using the artificial neural networks (ANNs) and the linear multivariate regression analysis. The “power pack” frequency, the revolution per minute (RPM), the feed pressure, the hammer frequency, and the impact energy were considered as input parameters. The results indicate that the ANN with the regression model predicts the ROP under different conditions with high accuracy. It also demonstrates that the ANN approach is a beneficial tool that can reduce cost, time and enhance structure reliability.

### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering

Contributors: Fathipour Azar, H., Saksala, T., Jalali, S. E.

Number of pages: 4

Pages: 252-255

Publication date: 21 Aug 2017

Peer-reviewed: Yes

### Publication information

Journal: Rakenteiden mekaniikka

Volume: 50

Issue number: 3

ISSN (Print): 0783-6104

Original language: English

Electronic versions:

64969-686-76924-1-10-20170821

DOIs:

10.23998/rm.64969

URLs:

<http://urn.fi/URN:NBN:fi:tty-201708291836>

Research output: Contribution to journal › Article › Scientific › peer-review

### **Numerical modelling of rock materials with polygonal finite elements**

This article presents some preliminary results on numerical modeling of rock materials with polygonal finite elements. A method to describe the rock microstructure based on Voronoi diagrams, representing the rock grain texture, is sketched. In this method, the minerals constituting the rock are represented as Voronoi cells which themselves are polygonal finite elements. A three-point bending problem under plane stress linear elasticity condition is solved in order to compare the performance of polygonal elements to ordinary finite elements. Moreover, it is demonstrated by solving the stress state in uni-axial compression that the heterogeneity described with the present method results in short-range tensile stresses which could initiate mode-I cracks.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering

Contributors: Saksala, T.

Number of pages: 4

Pages: 216-219

Publication date: 21 Aug 2017

Peer-reviewed: Yes

#### **Publication information**

Journal: Rakenteiden mekaniikka

Volume: 50

Issue number: 3

ISSN (Print): 0783-6104

Original language: English

Electronic versions:

64643-686-76917-1-10-20170821

DOIs:

10.23998/rm.64643

URLs:

<http://urn.fi/URN:NBN:fi:tty-201708291837>

Research output: Contribution to journal › Article › Scientific › peer-review

### **Numerical modelling of dynamic spalling test on rock with an emphasis on the influence of pre-existing cracks**

This article deals with numerical modeling of rock fracture under dynamic tensile loading and the related prediction of dynamic tensile strength. A special emphasis is laid on the influence of pre-existing natural microcrack populations as well as structural (artificial) cracks. For this end, a previously developed 3D continuum viscodamage-embedded discontinuity model is employed in the explicit dynamic finite element simulations of the spalling test. This model is capable of modelling the effect of natural microcracks populations always present in rocks as well as to capture the strain rate hardening effect of quasi-brittle materials. In the numerical simulations of spalling test on Bohus granite, it is shown that the model can predict the pull-pack velocity of the free end of the intact rock sample and the effect of structural cracks with a good accuracy. According to the simulations, the effect of microcrack populations, modeled here as pre-embedded discontinuity populations, is weaker than the corresponding effect under quasi-static loading.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering

Contributors: Saksala, T.

Pages: 63-76

Publication date: 7 Aug 2017

Peer-reviewed: Yes

#### **Publication information**

Journal: Rakenteiden mekaniikka

Volume: 50  
Issue number: 2  
ISSN (Print): 0783-6104  
Original language: English  
Electronic versions:  
65303-686-76430-1-10-20170807  
DOIs:  
10.23998/rm.65303  
URLs:  
<http://urn.fi/URN:NBN:fi:tty-201708081666>  
Research output: Contribution to journal > Article > Scientific > peer-review

### **Chasing measurements for real-world emissions of city buses**

#### **General information**

Publication status: Published  
Organisations: Physics, Research area: Aerosol Physics, Research group: The Instrumentation, Emissions, and Atmospheric Aerosols Group, Atmospheric Composition Research, Finnish Meteorological Institute, Helsinki Region Environmental Services Authority (HSY), Department of Environmental Sciences, Helsinki University  
Contributors: Järvinen, A., Karjalainen, P., Bloss, M., Potila, O., Simonen, P., Kuuluvainen, H., Timonen, H., Saarikoski, S., Niemi, J. V., Keskinen, J., Rönkkö, T.  
Publication date: 2017  
Peer-reviewed: Unknown  
Event: Paper presented at European Aerosol Conference 2017, Zürich, Switzerland.  
ASJC Scopus subject areas: Automotive Engineering, Pollution, Energy (miscellaneous)  
Keywords: Exhaust emissions, bus emissions, Air quality  
Research output: Other conference contribution > Paper, poster or abstract > Scientific

### **Continuum modelling of dynamic rock fracture under triaxial confinement**

This paper deals with numerical modelling of compressive fracture behavior of granite rock under high strain rate and wide range of confining pressure. For this end, a constitutive model based on damage mechanics and viscoplasticity is formulated and implemented in explicit dynamics FEM. Rock heterogeneity is characterized with the Weibull distribution. In the numerical examples, triaxial compression tests on Kuru granite at the strain rate of 600 1/s up to 225 MPa of confining pressure were simulated. Simulations show that the model captures the correct experimental failure modes, including the transition from single-to-multiple fragmentation, as well as the dynamic compressive strengths at different confining pressures.

#### **General information**

Publication status: Published  
MoE publication type: A4 Article in a conference publication  
Organisations: Civil Engineering, Research area: Applied Mechanics, Materials Science, Research group: Materials Characterization  
Contributors: Saksala, T., Hokka, M., Kuokkala, V.  
Number of pages: 2  
Publication date: 2017

#### **Host publication information**

Title of host publication: 14th International Conference on Fracture, Proceedings of ICF 14 : Rhodes, Greece, June 18-23, 2017  
Article number: 822  
ISBN (Print): 978-1-53611-848-3  
URLs:  
<http://www.icfweb.org/>

#### **Bibliographical note**

Kysytty isbn 19.12.2017 M. K.  
Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### **Determination of remoulding energy of sensitive clays**

Energy involved in disintegrating of sensitive clays from an intact to a fully remoulded state is one of the key aspects in assessing the post failure movements of sensitive clay landslides. This energy is referred to as remoulding energy. In this paper, the energy approach is conceptualised using an analytical approach. A comprehensive review of the empirical, laboratory and field techniques to estimate remoulding energy are presented and discussed in detail.

### General information

Publication status: Published  
MoE publication type: A3 Part of a book or another research book  
Organisations: Civil Engineering, Norwegian Univ. of Sci. and Technol.  
Contributors: Thakur, V., Degago, S. A., Selänpää, J., Länsivaara, T.  
Number of pages: 11  
Pages: 97-107  
Publication date: 2017

### Host publication information

Title of host publication: Landslides in Sensitive Clays : From Research to Implementation  
Publisher: Springer  
ISBN (Print): 978-3-319-56486-9  
ISBN (Electronic): 978-3-319-56487-6

### Publication series

Name: Advances in Natural and Technological Hazards Research  
Volume: 46  
ISSN (Print): 1878-9897  
ISSN (Electronic): 2213-6959  
ASJC Scopus subject areas: Computers in Earth Sciences, Economic Geology, Global and Planetary Change, Management, Monitoring, Policy and Law, Geography, Planning and Development  
DOIs:  
10.1007/978-3-319-56487-6\_9  
Source: Scopus  
Source ID: 85020126453  
Research output: Chapter in Book/Report/Conference proceeding › Chapter › Scientific › peer-review

### Effects of sample disturbance in the determination of soil parameters for advanced finite element modelling of sensitive clays

The stress-strain response of sensitive clays tested in a laboratory setting can be significantly affected by disturbance effects caused by sampling, transport, storage and specimen preparation. Soil models for finite element analyses are commonly calibrated using the results from laboratory tests and, consequently, calibrated model parameters are likely to be affected by sample disturbance. For sensitive clays subjected to constant volume shearing, the stress-strain behavior is dependent on the direction of loading and, due to build-up of shear induced pore pressure, effective stresses will reduce with increasing strain in the post-peak regime. According to previous studies, peak strengths, strains at failure and postpeak behavior of sensitive clays are all significantly influenced by sample quality. Therefore, the relative quality of model predictions generated using a sensitive clay finite element model can also be expected to be notably affected by sample disturbance. In this study, the impact of sample disturbance on the determination of model input parameters for advanced finite element modelling of sensitive clays is addressed and critically discussed. Two advanced soil models are used for this purpose: the total stress based NGI-ADPSOFT model, which is able to predict the anisotropic strain-softening behavior of saturated sensitive clays, and the effective stress based S-CLAY1S model, which is characterized by an anisotropic yield surface and is able to simulate soil destructuration. The practical implications of a thoughtful selection of the input parameters are evaluated through FE stability analyses of a sensitive clay slope.

### General information

Publication status: Published  
MoE publication type: A3 Part of a book or another research book  
Organisations: Civil Engineering, Norwegian Geotechnical Institute (NGI), Ramboll Finland Ltd., University of Delaware  
Contributors: D'Ignazio, M., Jostad, H. P., Länsivaara, T., Lehtonen, V., Mansikkamäki, J., Meehan, C.  
Number of pages: 9  
Pages: 146-154  
Publication date: 2017

### Host publication information

Title of host publication: Landslides in Sensitive Clays : From Research to Implementation  
Publisher: Springer  
ISBN (Print): 978-3-319-56486-9  
ISBN (Electronic): 978-3-319-56487-6

### Publication series

Name: Advances in Natural and Technological Hazards Research  
Volume: 46  
ISSN (Print): 1878-9897  
ISSN (Electronic): 2213-6959  
ASJC Scopus subject areas: Computers in Earth Sciences, Economic Geology, Global and Planetary Change, Management, Monitoring, Policy and Law, Geography, Planning and Development

DOIs:

10.1007/978-3-319-56487-6\_13

Source: Scopus

Source ID: 85020127433

Research output: Chapter in Book/Report/Conference proceeding › Chapter › Scientific › peer-review

### **Failure in anisotropic sensitive clays: a finite element study of the Perniö failure test**

The railway network on coastal areas of Finland is predominantly located in soft clay areas. The undrained shear strength of such clays is generally low, highly anisotropic, rate dependent and it exhibits post-peak strain softening under undrained conditions. A full-scale failure test was performed by Tampere University of Technology in Perniö, Western Finland, in 2009. A shallow railway embankment built on a soft clay deposit was equipped with a loading structure and loaded to failure in about 30 hours. The embankment collapsed two hours after the last loading step. In this study, data collected from the experiment is used, together with laboratory test results on high quality samples, to conduct advanced finite element analysis of the Perniö failure test. The NGI-ADPSOFT model is used for this purpose, which is capable of simulating the strain-softening behavior of the clay. Even though the observed rate effect is not taken into account in the analyses, the failure load can be predicted reasonably well. Good agreement is also observed for calculated displacements and failure mechanism with experimental observations.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Research group: Foundation Structures, Civil Engineering, Norwegian Geotechnical Institute (NGI)

Contributors: D'Ignazio, M., Lämsivaara, T., Jostad, H. P.

Pages: 1013-1033

Publication date: 2017

Peer-reviewed: Yes

Early online date: 22 Feb 2017

#### **Publication information**

Journal: Canadian Geotechnical Journal

Volume: 54

Issue number: 7

ISSN (Print): 0008-3674

Ratings:

Scopus rating (2017): CiteScore 4.5 SJR 1.813 SNIP 2.082

Original language: English

DOIs:

10.1139/cgj-2015-0313

Research output: Contribution to journal › Article › Scientific › peer-review

### **Numerical 3D modelling of the effects of strain rate and confining pressure on the compressive behavior of Kuru granite**

This paper deals with numerical modeling of the compressive behavior of granite rock under high strain rate dynamic loading and wide range of confining pressure. For this end, a constitutive model based on damage mechanics and viscoplasticity for rock is formulated and implemented in explicit dynamics FEM. The viscoplastic part is based on a simple power law type yield criterion that incorporates the rate-dependency with a linear viscosity term. Moreover, a Rankine type of tensile cut-off is employed. The damage part of the model is formulated with separate scalar damage variables in tension and compression. The model is calibrated for Kuru granite and validated with the experimental data from dynamic compression tests at the strain rate of 600 1/s up to 225 MPa of confining pressure. The numerical simulations demonstrate that, despite the underlying continuum modeling approach, the model captures the correct experimental failure modes, including the transition from single-to-multiple fragmentation, as well as the dynamic compressive strengths at different confining pressures.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering, Research area: Applied Mechanics, Materials Science, Research group: Materials Characterization

Contributors: Saksala, T., Hokka, M., Kuokkala, V.

Number of pages: 8

Pages: 1-8

Publication date: 2017

Peer-reviewed: Yes

Early online date: 11 Mar 2017



## Publication information

Journal: Computers and Geotechnics

Volume: 88

ISSN (Print): 0266-352X

Ratings:

Scopus rating (2017): CiteScore 5 SJR 1.979 SNIP 2.4

Original language: English

DOIs:

10.1016/j.compgeo.2017.03.004

Research output: Contribution to journal › Article › Scientific › peer-review

## Problems related to field vane testing in soft soil conditions and improved reliability of measurements using an innovative field vane device

In Finland, undrained shear strength is commonly measured using the field vane shear test (FV). Currently, the most commonly used field vane testers are the Nilcon vane and the electrical vane with shear rotation and measuring systems located above the ground level. Vane testing is normally carried out using vanes equipped with slip coupling, while the use of casing for protecting the vane is not very common. Recent studies from Finland have shown that the undrained shear strength of clays can be significantly underestimated when casing is not used. Experimental observations suggest that the slip coupling might not always be sufficient to remove all of the rod friction effects that occur during testing. Tampere University of Technology has recently purchased an innovative field vane apparatus with a vane tester unit, where torque and rotations are measured right above the vane. In this way, the effect of rod friction is minimized and the measured stressrotation behavior is less biased. In this study, issues related to practical applications, testing devices and interpretation methods are discussed. Then, a critical comparison between test results in soft clays from both the traditional and new field vane testers is performed.

## General information

Publication status: Published

MoE publication type: A3 Part of a book or another research book

Organisations: Civil Engineering, Norwegian Geotechnical Institute (NGI)

Contributors: Selänpää, J., Buò, B. D., Länsivaara, T., D'Ignazio, M.

Number of pages: 11

Pages: 121-131

Publication date: 2017

## Host publication information

Title of host publication: Landslides in Sensitive Clays : From Research to Implementation

Publisher: Springer

ISBN (Print): 978-3-319-56486-9

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## Publication series

Name: Advances in Natural and Technological Hazards Research

Volume: 46

ISSN (Print): 1878-9897

ISSN (Electronic): 2213-6959

ASJC Scopus subject areas: Computers in Earth Sciences, Economic Geology, Global and Planetary Change, Management, Monitoring, Policy and Law, Geography, Planning and Development

Electronic versions:

problems\_related\_to\_field\_vane\_testing\_2017

DOIs:

10.1007/978-3-319-56487-6\_10

URLs:

<http://urn.fi/URN:NBN:fi:tuni-201910234045>

Source: Scopus

Source ID: 85020067264

Research output: Chapter in Book/Report/Conference proceeding › Chapter › Scientific › peer-review

## Reply to the discussion by Mesri and Wang on "Correlations for undrained shear strength of Finnish soft clays"

## General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Civil Engineering, Research group: Foundation Structures, Norwegian Geotechnical Institute (NGI), National University of Singapore

Contributors: D'Ignazio, M., Phoon, K., Tan, S. A., Länsivaara, T., Lacasse, S.  
Number of pages: 5  
Publication date: 2017  
Peer-reviewed: Yes

#### **Publication information**

Journal: Canadian Geotechnical Journal  
ISSN (Print): 0008-3674  
Ratings:  
Scopus rating (2017): CiteScore 4.5 SJR 1.813 SNIP 2.082  
Original language: English  
DOIs:  
10.1139/cgj-2017-0114#.WiUscmeXcTU

#### **Bibliographical note**

EXT="D'Ignazio, Marco"  
Research output: Contribution to journal › Article › Scientific › peer-review

### **Valkea kaupunki, mustat vedet**

#### **General information**

Publication status: Published  
MoE publication type: A2 Review article in a scientific journal  
Organisations: Civil Engineering  
Contributors: Juuti, P., Rajala, R.  
Number of pages: 3  
Pages: 15-17  
Publication date: 2017  
Peer-reviewed: Yes

#### **Publication information**

Journal: Vesitalous  
Volume: 2017  
Issue number: 1  
ISSN (Print): 0505-3838  
Original language: English  
URLs:  
<http://www.vesitalous.fi/vesitalous-lehdet/vesien-historia/>  
Research output: Contribution to journal › Review Article › Scientific › peer-review

### **Älypölkky, radan monitorointi, kreosoottipölkyn korvaavat vaihtoehdot**

#### **General information**

Publication status: Published  
Organisations: Civil Engineering, Research group: Track Structures  
Contributors: Luomala, H.  
Publication date: 29 Nov 2016

#### **Publication information**

Media of output: Rautatietekniikkaseminaari 2016, Liikennevirasto  
Year: 2016  
Original language: Finnish  
Research output: Other contribution › Scientific

### **Ballast bed**

#### **General information**

Publication status: Published  
Organisations: Civil Engineering, Research group: Track Structures  
Contributors: Luomala, H.  
Publication date: 24 Nov 2016

#### **Publication information**

Media of output: Presentation at Nordisk Banteknisk Ingenjörutbildning (NBIU), Espoo

Year: 2016  
Original language: English  
Research output: Other contribution › Scientific

### **Näkökulma-kolumni: Putkiremontit kestävät aivan liian kauan**

#### **General information**

Publication status: Published  
Organisations: Civil Engineering  
Contributors: Saari, A.  
Publication date: 24 Nov 2016

#### **Publication information**

Publisher: Sanoma Talotekniikkajulkaisut Oy  
Year: 2016  
Original language: Finnish  
URLs:  
<http://www.rakennuslehti.fi/kirjoittajat/arto-saari/>  
Research output: Other contribution › Scientific

### **Sleepers**

#### **General information**

Publication status: Published  
Organisations: Civil Engineering, Research group: Track Structures  
Contributors: Luomala, H.  
Publication date: 24 Nov 2016

#### **Publication information**

Media of output: Presentation at Nordisk Banteknisk Ingenjörutbildning (NBIU), Espoo  
Year: 2016  
Original language: English  
Research output: Other contribution › Scientific

### **Tutkimusohjelma Elinkaaritehokas RAta (TERA): Kokonaisvaltainen ote ratarakennetutkimukseen**

#### **General information**

Publication status: Published  
Organisations: Civil Engineering, Research group: Track Structures  
Contributors: Luomala, H.  
Publication date: 15 Nov 2016

#### **Publication information**

Media of output: Rakennustekniikan vuosiseminaari 2016  
Year: 2016  
Original language: Finnish  
Research output: Other contribution › Scientific

### **Editorial to "The best papers from the 32nd International Symposium on Automation and Robotics in Construction and Mining (ISARC 2015)"**

#### **General information**

Publication status: Published  
MoE publication type: B1 Article in a scientific magazine  
Organisations: Department of Civil Engineering, Research group: Responsible Construction, Univ of Oulu  
Contributors: Malaska, M., Heikkilä, R.  
Number of pages: 1  
Pages: 1  
Publication date: 1 Nov 2016  
Peer-reviewed: No

#### **Publication information**

Journal: Automation in Construction

Volume: 71  
ISSN (Print): 0926-5805  
Ratings:

Scopus rating (2016): CiteScore 7.8 SJR 1.395 SNIP 2.754

Original language: English

ASJC Scopus subject areas: Control and Systems Engineering, Civil and Structural Engineering, Building and Construction

DOIs:

10.1016/j.autcon.2016.08.045

Source: Scopus

Source ID: 84988322453

Research output: Contribution to journal › Editorial › Scientific

### **Comparison of community managed projects and conventional approaches in rural water supply of Ethiopia**

This study aimed to compare Community Managed Projects (CMP) approach with the conventional approaches (Non-CMP) in the case of Ethiopia. The data collection methods include a household survey (n=1806), community representative interviews (n=49), focus group discussions with district water experts (n=48) and observations of water systems (n=49). The data were collected from seven districts of two regions of Ethiopia. The study shows that CMP have a better platform to involve the community than non-CMP. In terms of reducing distances to water points, all approaches succeeded. However, the intended amount of water supplied is not achieved in all the cases: only 25% of CMP users and 18% of non-CMP users are able to get water according to the national standard, 15 L per capita per day. Fee collection in the approaches has a high disparity in favour of CMP. To keep long-lasting services, three requirements need to be particularly fulfilled: quantity, quality and accessibility.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Civil Engineering, Community-Led Accelerated WASH (COWASH) Project

Contributors: Behailu, B. M., Suominen, A., Katko, T. S., Mattila, H., Yayehyirad, G.

Number of pages: 15

Pages: 292-306

Publication date: 30 Sep 2016

Peer-reviewed: Yes

#### **Publication information**

Journal: African Journal of Environmental Science and Technology

Volume: 10

Issue number: 9

Article number: 04AF23059936

ISSN (Print): 1996-0786

Original language: English

Electronic versions:

04AF23059936

DOIs:

10.5897/AJEST2016.2132

URLs:

<http://urn.fi/URN:NBN:fi:tty-201608164415>

URLs:

<http://www.academicjournals.org/journal/AJEST/article-full-text-pdf/04AF23059936>

Research output: Contribution to journal › Article › Scientific › peer-review

### **Undrained shear strength of Finnish clays for stability analyses of embankments**

The thesis deals with the undrained shear strength ( $s_u$ ) of Finnish clays. The research study focuses on the evaluation and modelling of undrained shear strength for total stress stability analyses of embankments and it studies some special features of sensitive clays.

Firstly, a multivariate database of Finnish clay data points is compiled in order to derive correlations for undrained shear strength specific to Finnish clays. For each data point, information on  $s_u$  from field vane, consolidation stresses and other physical properties is available. The dependency of  $s_u$  on overconsolidation ratio (OCR) and index parameters is studied. The new correlations are derived through regression analyses. Results show that the dependency of  $s_u$  on index parameters is more marked when the uncorrected field vane measurements are considered. On the other hand, when measured  $s_u$  is corrected for strain rate and converted into mobilized  $s_u$ , such dependency becomes negligible. The new correlations are validated through comparison with existing correlations from the literature. Bias and uncertainties of the new transformation models are evaluated through an independent database consisting of clay data points from Sweden

and Norway. The main result is that the new correlations are characterized by lower uncertainty than the other commonly used correlation models.

In order to study some of the special characteristics of soft sensitive clays, the Perniö failure test is analyzed through the finite element method (FEM) using the advanced NGIADPSoft model, which includes anisotropy and strain-softening behavior of sensitive clays. A series of laboratory and in-situ tests are used to determine the anisotropic shear strength of Perniö clay and Perniö dry crust. Stability analyses are performed using the software PLAXIS 2D and the influence of stress path dependency and post-peak strength reduction on the failure load is evaluated. Calculated displacements are compared to field measurements from the experiment. A good agreement is observed between field observations and calculation results. The study indicates that both  $s_u$  anisotropy and strain-softening have a notable impact on the undrained behavior of the Perniö embankment. Furthermore, it was shown how the modelling of post-peak properties influences the computed failure mechanism.

The issue of undrained shear strength increase in clayey layers under old embankments due to consolidation is studied through CPTU and field vane test results from Murro test embankment. Previous test results suggested a decrease of shear strength under the embankment after a few years of consolidation. The new test results show that the strength has increased and the soil has reached its normally consolidated state. Undrained shear strength and preconsolidation pressure are assessed using existing as well as calibrated transformation models. Data from the Murro test site shows that  $s_u$  has increased by over 50% in the uppermost part of the deposit.

Engineering aspects related to the topics object of study are discussed and some complex issues are addressed from a practical point of view. Firstly, some indications on the use of the new correlations for  $s_u$  of Finnish clays are provided. Secondly, suggestions about how to derive soil parameters for FE total stress soil models are given. Finally, a simplified methodology is proposed to model strength increase in total stress analyses.

#### **General information**

Publication status: Published

MoE publication type: G4 Doctoral dissertation (monograph)

Organisations: Department of Civil Engineering

Contributors: D'Ignazio, M.

Number of pages: 178

Publication date: 21 Sep 2016

#### **Publication information**

Publisher: Tampere University of Technology

ISBN (Print): 978-952-15-3804-9

ISBN (Electronic): 978-952-15-3806-3

Original language: English

#### **Publication series**

Name: Tampere University of Technology. Publication

Volume: 1412

ISSN (Print): 1459-2045

Electronic versions:

d'ignazio 1412

URLs:

<http://urn.fi/URN:ISBN:978-952-15-3806-3>

Research output: Book/Report > Doctoral thesis > Monograph

#### **Combining mineral fractions of recovered MSWI bottom ash: improvement for utilization in civil engineering structures**

In real-life construction projects, the utilization of different types of waste derived aggregates can often be falsely considered as utilization, but in fact, it is merely dumping the potentially high value material from one site to another. For example, building highway noise barriers with waste derived aggregates cannot be considered as utilization. In this study, a more advanced approach was chosen in order to create aggregate like products from recovered municipal solid waste incineration (MSWI) bottom ash (BA) and thus potentially increase their value and image in civil engineering applications. MSWI BA from one waste incineration plant in Finland was first treated with a Dutch dry treatment technology called ADR (Advanced Dry Recovery). This process separates non-ferrous and ferrous metals from MSWI BA and generates mineral fractions of different grain sizes. These mineral fractions may not be used separately, for example, in the unbound structural layers of roads due to the strict grain size distribution requirements of these civil engineering structures. Hence, different combinations were designed from these BA mineral fractions using the mathematical proportioning of aggregates. The aim was to create aggregate like products from this waste material for different structural layers (filtration, sub-base and base) of, for example, road and field structures. Three mixtures were chosen based on their correspondence to the grain size distribution requirements of natural aggregates and further analyzed in the laboratory from their technical, mechanical and environmental point of view. The leaching of chrome (Cr) and chloride (Cl-) exceeded the Finnish emission boundary values for utilization of certain types of ashes in civil engineering. On the other hand, the technical and mechanical properties of these mixed bottom ash products were considered suitable to be used, for example, in the

unbound structural layers of the interim storage field in a waste treatment center. In such location, also the leaching potential of harmful substances can be further studied and verified in a larger scale.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Civil Engineering, Research group: Earth Constructions, Research area: Infrastructure Construction, Suomen Erityisjäte Oy

Contributors: Sormunen, L. A., Kalliainen, A., Kolisoja, P., Rantsi, R.

Number of pages: 12

Publication date: 22 Aug 2016

Peer-reviewed: Yes

#### Publication information

Journal: Waste and Biomass Valorization

ISSN (Print): 1877-2641

Ratings:

Scopus rating (2016): CiteScore 2.1 SJR 0.451 SNIP 0.668

Original language: English

DOIs:

10.1007/s12649-016-9656-4

URLs:

[http://www.readcube.com/articles/10.1007/s12649-016-9656-](http://www.readcube.com/articles/10.1007/s12649-016-9656-4)

[4?author\\_access\\_token=NZQ\\_65zpzvVOVrBLEzMHEve4RwIQNchNByi7wbcMAY7GR4IWocqPWPkZkNDQXRz7x\\_qbW1ahjf7kWiQeH17QihXQ2Mi1WmHqe\\_CBIFMwbY\\_lgt4SeoDhDFf1GD-qyVAD6lZs6oA2j6mNx9V6woW5Gw%3D%3D](http://www.readcube.com/articles/10.1007/s12649-016-9656-4?author_access_token=NZQ_65zpzvVOVrBLEzMHEve4RwIQNchNByi7wbcMAY7GR4IWocqPWPkZkNDQXRz7x_qbW1ahjf7kWiQeH17QihXQ2Mi1WmHqe_CBIFMwbY_lgt4SeoDhDFf1GD-qyVAD6lZs6oA2j6mNx9V6woW5Gw%3D%3D)

Research output: Contribution to journal > Article > Scientific > peer-review

### A laboratory listening experiment on subjective and objective rating of impact sound insulation of concrete floors

#### General information

Publication status: Published

MoE publication type: B3 Non-refereed article in conference proceedings

Organisations: Department of Civil Engineering, Research group: Building Acoustics, Turku University of Applied Sciences

Contributors: Kylliäinen, M., Hongisto, V., Oliva, D., Rekola, L.

Number of pages: 9

Pages: 894-902

Publication date: Aug 2016

#### Host publication information

Title of host publication: Proceedings of the INTER-NOISE 2016, 45th International Congress on Noise Control Engineering : Towards a Quieter Future, August 21-24, 2016, Hamburg, Germany

Place of publication: Hamburg

Publisher: German Acoustical Society (DEGA)

Article number: 193

ISBN (Electronic): 978-3-939296-11-9

URLs:

<http://pub.dega-akustik.de/IN2016/data/articles/000193.pdf>

<http://www.internoise2016.org/>

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific

### A method for design of sound insulation of glazed balconies against traffic noise

#### General information

Publication status: Published

MoE publication type: B3 Non-refereed article in conference proceedings

Organisations: Department of Civil Engineering, Research group: Building Acoustics, A-Insinöörit Suunnittelu Oy

Contributors: Kovalainen, V., Kylliäinen, M., Huhtala, T.

Number of pages: 8

Pages: 3834-3841

Publication date: Aug 2016

#### Host publication information

Title of host publication: Proceedings of the INTER-NOISE 2016, 45th International Congress and Exposition on Noise Control Engineering : Towards a Quieter Future, August 21-24, 2016, Hamburg, Germany

Place of publication: Hamburg  
Publisher: German Acoustical Society (DEGA)  
Article number: 503  
ISBN (Electronic): 978-3-939296-11-9  
ASJC Scopus subject areas: Acoustics and Ultrasonics  
URLs:  
<http://pub.dega-akustik.de/IN2016/data/articles/000503.pdf>  
<http://www.internoise2016.org/>  
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific

### **Problems with Railway Track Drainage in Finland**

Several studies have shown that water plays a significant role in phenomena that weaken track geometry. For instance, water may cause frost heave, thaw softening, attrition of ballast, and weakening of the load bearing capacity of a track. Functioning drainage can prevent water damage, but no researched data on the magnitude of the impacts exist.

Most of the Finnish rail network has been built in times when earthworks were kept to a minimum. Drainage generally functions well along new and renovated rail sections, but the situation is quite different with old tracks. If unevenness problems can be dealt with adequately by improving drainage, it is considerably more advantageous compared to massive renovation. The aim is to find out whether systematic improvement of drainage can produce significant savings in rail network maintenance.

The study examines the unevenness problems discovered along the Finnish rail network where the functioning of drainage is thought to be a major factor, while seeking solutions to the problems. This article presents the technical and administrative problems related to drainage in the Finnish rail network. Based on observations made so far, even basic drainage solutions are beset with problems since e.g. ditches are not cleaned with sufficient regularity.

The on-going study aimed to determine the impact of drainage on track unevenness at monitored sites. However, the method did not work as expected since no suitable sites, where other significant measures had not been carried out in connection with drainage renovation, could be found along the rail network. Moreover, it was difficult to get information about earlier renovation measures.

It can be said already at this phase of the study that drainage maintenance should be improved. There are also problems with drainage assessment methods which consist mainly of visual inspection instead of more sophisticated methods. Subjective assessment methods and maintenance contracts that call for maintenance 'as required' easily lead to postponement of maintenance measures.

### **General information**

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Department of Civil Engineering, Research group: Track Structures  
Contributors: Latvala, J., Nurmikolu, A., Luomala, H.  
Number of pages: 7  
Pages: 1051-1058  
Publication date: 13 Jul 2016  
Peer-reviewed: Yes

### **Publication information**

Journal: Procedia Engineering  
Volume: 143  
ISSN (Print): 1877-7058  
Ratings:  
Scopus rating (2016): CiteScore 0.9 SJR 0.286 SNIP 0.725  
Original language: English  
Electronic versions:  
Problems with Railway Track Drainage in Finland  
DOIs:  
10.1016/j.proeng.2016.06.098  
URLs:  
<http://urn.fi/URN:NBN:fi:tyy-201608244438>  
Research output: Contribution to journal › Article › Scientific › peer-review

### **The effect of climate change on freeze-thaw durability of concrete structures in Finland**

Lahdensivu presented in his Doctoral Thesis (Durability Properties and Actual Deterioration of Finnish Concrete Facades and Balconies, 2012) that without proper air-entrainment outdoor concrete structures have needed average of 307 freeze-

thaw cycles (threshold value:  $t \leq -5$  °C) after a rain event in southern Finland and 388 cycles in inland for incipient freeze-thaw damage to occur. The difference between figures can be explained by the greater amount of wind-driven rain (WDR) before the freeze-thaw cycle on coastal areas.

As a consequence of climate change it has been shown that by the end of the century, the amount of WDR is going to increase 30 % at southern Finland and 40 % at inland. At the same time the amount of freeze-thaw cycles after a rain event are decreasing significantly at both locations which indicates freeze-thaw durability-wise longer service life for outdoor concrete structures. However, the latest studies show that while the amount of freeze-thaw cycles is decreasing, the amount of WDR before the cycles is also increasing significantly.

The WDR at winter time in Finland is highly orientated on west to south-east directions which can be seen also by the degradation rate observations of concrete facades and balconies based on condition assessments. In this study, the changes at WDR before the freeze-thaw events and the effect of climate change on them depending on the structure orientation are calculated to estimate the changes of climatic stress level on outdoor concrete structures.

### General information

Publication status: Published

Organisations: Department of Civil Engineering, Research group: Service Life Engineering of Structures, Tampere University of Technology

Contributors: Pakkala, T., Lemberg, A., Lahdensivu, J.

Number of pages: 1

Pages: 53

Publication date: Jun 2016

Peer-reviewed: Unknown

Event: Paper presented at OCEANEXT : Interdisciplinary Conference, .

ASJC Scopus subject areas: Civil and Structural Engineering

Keywords: Freeze/thaw, Concrete, Wind-driven rain, Service life

URLs:

<https://oceanext.sciencesconf.org/?lang=en>

<https://oceanext.sciencesconf.org/93828/document>

### Bibliographical note

INT=rak,"Lemberg, Antti-Matti"

Research output: Other conference contribution > Paper, poster or abstract > Scientific

### Deterioration mechanisms and life cycle of concrete monoblock railway sleepers in Finnish conditions

Thirty eight sleepers aged 30 to 40 years old were removed from Finnish railway lines and were loaded. Twelve new sleepers were also tested. The old sleepers fulfilled most of the requirements specified for the new ones. The old sleepers were also much more resistant to loading than predicted by structural calculations. The purpose of field tests was to establish the role of traffic loads in the life-cycle of sleepers: the actual stresses and moments in sleepers due to traffic loads; the distribution of the load through the underside of the sleeper to the ballast; and the variation in ballast-sleeper reaction on different sections of track in different seasons. Strain changes at the top surfaces of sleepers were measured on tracks while the rail was loaded by passing trains. Ballast-sleeper reactions tended to be concentrated under the rail along a length of sleeper of approximately 350 mm towards the centre of the track. The mean bending moments determined at the rail seat and centre of sleepers were about  $\pm 2.5$  kNm, and the maximum moments were up to  $\pm 10$  kNm. The purpose of fatigue loading tests was to analyse the long term properties of the sleepers and the effect of fatigue on the stiffness of sleepers. Several load levels were chosen in order to estimate the significance of the fatigue in a real operating situation. The fatigue limit determined based on the loading tests and the computational limit state of crack formation were clearly higher than the bending moments measured in the field tests.

### General information

Publication status: Published

MoE publication type: D3 Professional conference proceedings

Organisations: Department of Civil Engineering, Research group: Vaativat rakenteet, Research group: Concrete and Bridge Structures, Research group: Track Structures

Contributors: Kerokoski, O., Rantala, T., Nurmikolu, A.

Publication date: 31 May 2016

### Host publication information

Title of host publication: WCRR 2016 Proceedings : 11th World congress on railway research, 29.5-2.6.2016, Milano

URLs:

<http://www.wcrr2016.org/>

### Bibliographical note

ei isbn 8.12.16

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Professional



## Betonirakenteiden korjausohjeet 2016, by 41

### General information

Publication status: Published

MoE publication type: D5 Text book, professional manual or guide or a dictionary

Organisations: Department of Civil Engineering, Research group: Service Life Engineering of Structures, Research area: Structural Engineering

Contributors: Köliö, A., Pakkala, T., Lahdensivu, J., Pentti, M.

Number of pages: 115

Publication date: May 2016

### Publication information

Publisher: Suomen Betoniyhdistys r.y.

ISBN (Print): 978-952-68068-7-7

Original language: Finnish

URLs:

<https://www.rakennustietokauppa.fi/by-41-betonirakenteiden-korjausohjeet-2016-/101127/dp?nosto=alsobought>

Research output: Book/Report > Book > Professional

## Preliminary results from a study aiming to improve ground investigation data

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Civil Engineering, Research group: Foundation Structures, Research area: Infrastructure Construction

Contributors: Di Buo, B., D'Ignazio, M., Selänpää, J., Länsivaara, T.

Number of pages: 11

Pages: 187-197

Publication date: May 2016

### Host publication information

Title of host publication: Proceedings of the 17th Nordic Geotechnical Meeting : Challenges in Nordic Geotechnic 25th-28th of May

Place of publication: Reykjavik

Publisher: Icelandic Geotechnical Society

ISBN (Electronic): 978-9935-24-002-6

URLs:

[http://www.ngm2016.com/uploads/2/1/7/9/21790806/022-072-ngm\\_2016\\_-\\_preliminary\\_results\\_from\\_a\\_study\\_aiming\\_to\\_improve\\_ground\\_investigation\\_data\\_dibuo\\_d%E2%80%99ignazio\\_sel%C3%A4np%C3%A4\\_l%C3%A4nsivaara.pdf](http://www.ngm2016.com/uploads/2/1/7/9/21790806/022-072-ngm_2016_-_preliminary_results_from_a_study_aiming_to_improve_ground_investigation_data_dibuo_d%E2%80%99ignazio_sel%C3%A4np%C3%A4_l%C3%A4nsivaara.pdf)

URLs:

<http://britishgeotech.org/the-17th-nordic-geotechnical-meeting/>

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

## Strength increase below an old test embankment in Finland

### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Civil Engineering, Research group: Foundation Structures

Contributors: D'Ignazio, M., Länsivaara, T.

Pages: 357-366

Publication date: May 2016

### Host publication information

Title of host publication: The 17th Nordic Geotechnical Meeting : Conference proceedings

Place of publication: Reykjavik

Publisher: Icelandic Geotechnical Society

ISBN (Electronic): 978-9935-24-002-6

URLs:

<http://britishgeotech.org/the-17th-nordic-geotechnical-meeting/>

### **3D Finite Element Model as a Tool for Analyzing the Structural Behavior of a Railway Track**

The rising public and commercial demands on railway network increases the need to improve systems that comprise the railway network. Especially in case of mixed corridors, the demands for track smoothness and load carrying capacity increase simultaneously. From this perspective, the optimization of track design creates efficiency and reduction of life-cycle costs. Hence, there is a great need for a tool which enables designing the load-carrying capacity of a railway track structure as a whole and simultaneously evaluates the stress and/or strain levels of each track component such that the life cycle of the track structure is optimized. The main focus of this study was to create a three dimensional structural model in which the stress-strain behavior of different railway track components could be evaluated realistically. The created model is based on finite element method using PLAXIS 3D software which is specialized in geotechnical problems. Differing from most of the traditional methods, which are based on a theory of linear elasticity, Finite Element Method-based approach with the chosen tool provides a non-linear solution and a three dimensional stress state. As features, the created structural model enables variation in structural layer thickness, rail size, sleeper type (wood/concrete) and material properties of rail pad, ballast, subballast layers and subgrade.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Civil Engineering, Research group: Earth Constructions, Research area: Infrastructure Construction, Research group: Track Structures

Contributors: Kalliainen, A., Kolisoja, P., Nurmikolu, A.

Number of pages: 8

Pages: 820-827

Publication date: 2016

Peer-reviewed: Yes

#### **Publication information**

Journal: Procedia Engineering

Volume: 143

ISSN (Print): 1877-7058

Ratings:

Scopus rating (2016): CiteScore 0.9 SJR 0.286 SNIP 0.725

Original language: English

ASJC Scopus subject areas: Engineering(all)

Keywords: 3D Finite Element Method, Load Carrying Capacity, Mechanical Behavior, Modelling, Railway Track

Electronic versions:

3D Finite Element Model as a Tool for Analyzing

DOIs:

10.1016/j.proeng.2016.06.133

URLs:

<http://urn.fi/URN:NBN:fi:ty-201608244437>

Source: Scopus

Source ID: 84982993434

Research output: Contribution to journal › Article › Scientific › peer-review

### **Acceptability of contaminated soils and waste materials in landfill structures**

#### **General information**

Publication status: Published

Organisations: Civil Engineering, Research group: Earth Constructions

Contributors: Leppänen, M. M., Kuula, P.

Publication date: 2016

Peer-reviewed: Unknown

Event: Paper presented at Nordrocs, .

URLs:

<http://nordrocs.org/wp-content/uploads/2016/09/kompendium08282016.pdf>

Research output: Other conference contribution › Paper, poster or abstract › Professional

### **Back-calculation of the Saint-Alban A test embankment with a new modelling approach in LEM**

To facilitate the continued use of limit equilibrium method (LEM) in stability design of embankments on soft clays, the new calculation method "Hybrid su" (HSU) has been developed. It is used to derive undrained shear strength from effective strength parameters, or to predict the excess pore pressure at failure. The HSU method uses an anisotropic effective stress soil model with volumetric hardening, from which a closed form solution for the effective mean stress at failure  $p_f$  is

derived. This in turn is used to derive the anisotropic undrained shear strength (for use in total stress analyses), or excess pore pressure (for use in undrained effective stress analyses). The model accounts for factors such as anisotropy, consolidation state, volumetric hardening and to some extent, rate effects. An advantage of the model over traditional undrained effective stress calculations is that the overestimation of shear strength at  $F > 1$  is avoided.

#### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Civil Engineering, Research group: Foundation Structures

Contributors: Lehtonen, V., Lämsivaara, T.

Number of pages: 9

Pages: 691-699

Publication date: 2016

#### Host publication information

Title of host publication: Proceedings of the The 17th Nordic Geotechnical Meeting, Reykjavik Iceland : 25th - 28th of May 2016

ISBN (Electronic): 978-9935-24-002-6

URLs:

[http://www.ngm2016.com/uploads/2/1/7/9/21790806/076-024-ngm\\_2016\\_-\\_back-calculation\\_of\\_the\\_saint-alban\\_a\\_test\\_embankment\\_with\\_a\\_new\\_modelling\\_approach\\_in\\_lem\\_lehtonen\\_lansivaara.pdf](http://www.ngm2016.com/uploads/2/1/7/9/21790806/076-024-ngm_2016_-_back-calculation_of_the_saint-alban_a_test_embankment_with_a_new_modelling_approach_in_lem_lehtonen_lansivaara.pdf)

<http://www.ngm2016.com/>

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### Characterization of fine fraction mined from two Finnish landfills

A fine fraction (FF) was mined from two Finnish municipal solid waste (MSW) landfills in Kuopio (1- to 10-year-old, referred as new landfill) and Lohja (24- to 40-year-old, referred as old landfill) in order to characterize FF. In Kuopio the FF (<20mm) was on average  $45 \pm 7\%$  of the content of landfill and in Lohja  $58 \pm 11\%$ . Sieving showed that  $86.5 \pm 5.7\%$  of the FF was smaller than 11.2mm and the fraction resembled soil. The total solids (TS) content was 46-82%, being lower in the bottom layers compared to the middle layers. The organic matter content (measured as volatile solids, VS) and the biochemical methane potential (BMP) of FF were lower in the old landfill (VS/TS  $12.8 \pm 7.1\%$  and BMP  $5.8 \pm 3.4 \text{ m}^3 \text{ CH}_4/\text{t TS}$ ) than in the new landfill (VS/TS  $21.3 \pm 4.3\%$  and BMP  $14.4 \pm 9.9 \text{ m}^3 \text{ CH}_4/\text{t TS}$ ), and both were lower compared with fresh MSW. In the Kuopio landfill materials were also mechanically sieved in the full scale plant in two size fraction <30mm (VS/TS 31.1% and  $32.9 \text{ m}^3 \text{ CH}_4/\text{t TS}$ ) and 30-70mm (VS/TS 50.8% and BMP  $78.5 \text{ m}^3 \text{ CH}_4/\text{t TS}$ ). The nitrogen ( $3.5 \pm 2.0 \text{ g/kg TS}$ ), phosphorus (<1.0-1.5g/kg TS) and soluble chemical oxygen demand (COD) ( $2.77 \pm 1.77 \text{ kg/t TS}$ ) contents were low in all samples. Since FF is major fraction of the content of landfill, the characterization of FF is important to find possible methods for using or disposing FF mined from landfills.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Chemistry and Bioengineering, Research group: Industrial Bioengineering and Applied Organic Chemistry

Contributors: Mönkäre, T. J., Palmroth, M. R. T., Rintala, J. A.

Number of pages: 6

Pages: 34-39

Publication date: 2016

Peer-reviewed: Yes

#### Publication information

Journal: Waste Management

Volume: 47A

ISSN (Print): 0956-053X

Ratings:

Scopus rating (2016): CiteScore 6.4 SJR 1.407 SNIP 2.191

Original language: English

ASJC Scopus subject areas: Waste Management and Disposal

Keywords: Biochemical methane potential, Characterization, Fine fraction, Landfill mining, Municipal solid waste

Electronic versions:

Mönkäre et al. 2016. Embargo ended: 1/12/17

DOIs:

10.1016/j.wasman.2015.02.034

URLs:

<http://urn.fi/URN:NBN:fi:tty-201903261332>. Embargo ended: 1/12/17

Source: Scopus

Source ID: 84958845557

Research output: Contribution to journal > Article > Scientific > peer-review

### **Commercialising reclaimed materials in earthworks – guidelines for productization and the process of appending these materials in the Finnish national code of practice**

To decrease the use of non-renewable natural resources as well as environmental effects of earth-works, natural aggregate materials can be replaced with recycled materials acquired from surplus soil, industrial by-products and waste, etc. When wishing to increase the usage of these reclaimed materials (=“UUMA”-material), the usage must be straightforward for developers, designers and constructors alike. To make this possible, the materials must have design guidelines for their appropriate applications. They must be productized and CE marked or otherwise authorized, and the construction guidelines for the materials must be included in the Finnish general specifications for in-frastructural construction works (InfraRYL). As productization is especially important in increasing the usage of UUMA materials, guidelines for vendors are being drawn that present information on commercializing reclaimed materials to be used in earthworks. The guidelines for productization are being prepared in the Finnish national UUMA2 programme (2013-2017, [www.uuma2.fi](http://www.uuma2.fi)), which was created to promote the use of recycled materials in earthworks.

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Civil Engineering, Research area: Infrastructure Construction, Research group: Earth Constructions, Research group: Track Structures, Ramboll Finland Ltd.

Contributors: Koivisto, K., Forsman, J., Ronkainen, M., Lahtinen, P., Kolisoja, P., Kuula, P.

Number of pages: 10

Publication date: 2016

#### **Host publication information**

Title of host publication: Proceedings of the 17th Nordic Geotechnical Meeting Reykjavik Iceland : Challenges in Nordic Geotechnic 25th - 28th of May

Place of publication: Reykjavik

Publisher: Icelandic Geotechnical Society

ISBN (Electronic): 978-9935-24-002-6

Electronic versions:

Commercialising reclaimed materials in earthworks 2016

URLs:

<http://urn.fi/URN:NBN:fi:tuni-202005205536>

URLs:

<http://www.ngm2016.com/>

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

### **Correlations for undrained shear strength of Finnish soft clays**

The study focuses on the derivation of transformation models for undrained shear strength ( $s_u$ ) of Finnish soft sensitive clays. Specific correlation equations for  $s_u$  of Finnish clays are presented in this work for the first time. Field and laboratory measurements from 24 test sites in Finland are exploited for this purpose and a multivariate database is constructed. The multivariate data consists of  $s_u$  from field vane, preconsolidation stress, vertical effective stress, liquid limit, plastic limit, natural water content and sensitivity. The main objective is to evaluate the interdependence of  $s_u$ , consolidation stresses and index parameters and provide a consistent framework for practical use. The new correlations are established through regression analyses. The constructed framework is further validated by another independent multivariate database of clays from Sweden and Norway as well as by empirical equations for Swedish and Norwegian clays. Existing correlations are evaluated for Finnish and Scandinavian clays. Finally, bias and uncertainties of the new correlations are presented.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Civil Engineering, Research group: Foundation Structures, National University of Singapore

Contributors: D'Ignazio, M., Phoon, K. K., Tan, S. A., Lämsivaara, T.

Pages: 1628-1645

Publication date: 2016

Peer-reviewed: Yes

#### **Publication information**

Journal: Canadian Geotechnical Journal

Volume: 53

Issue number: 10

ISSN (Print): 0008-3674

Ratings:

Scopus rating (2016): CiteScore 3.8 SJR 1.93 SNIP 2.111

Original language: English

DOIs:

10.1139/cgj-2016-0037

Research output: Contribution to journal › Article › Scientific › peer-review

### **Modelling of plastic culvert and road embankment interaction in 3D**

A series of 3D Finite Element simulations was performed to investigate the effect of different factors influencing the distortions undergone by a plastic culvert tube while subject to external loading from a heavy truck. The applied simulation model was verified by full-scale loading tests carried out on a number of actual culvert installation sites. Based on the results of the study, it can be concluded that both installation depth and quality of the material surrounding the culvert have a dominant effect on culvert distortions while the effects of material quality above the culvert and the type of tyre configuration transmitting the wheel load are much less pronounced.

#### **General information**

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Civil Engineering, Research area: Infrastructure Construction, Research group: Earth Constructions

Contributors: Kolisoja, P., Kalliainen, A.

Number of pages: 8

Pages: 427-434

Publication date: 2016

Peer-reviewed: Yes

#### **Publication information**

Journal: Procedia Engineering

Volume: 143

ISSN (Print): 1877-7058

Ratings:

Scopus rating (2016): CiteScore 0.9 SJR 0.286 SNIP 0.725

Original language: English

Electronic versions:

Kolisoja & Kalliainen Procedia Engineering Copy

DOIs:

10.1016/j.proeng.2016.06.054

URLs:

<http://urn.fi/URN:NBN:fi:tyy-201608164416>

Research output: Contribution to journal › Article › Scientific › peer-review

### **Spatial variability of reed bed spectra in Olkiluoto Island**

#### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Pori Department, Research group: Data-analytics and Optimization

Contributors: Tuominen, J., Lipping, T.

Number of pages: 4

Pages: 7188-7191

Publication date: 2016

#### **Host publication information**

Title of host publication: 2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), : July 10-15, Beijing, China

Publisher: IEEE

ISBN (Electronic): 978-1-5090-3332-4

#### **Publication series**

Name: IEEE International Geoscience and Remote Sensing Symposium Proceedings

ISSN (Electronic): 2153-7003

DOIs:

**Teräsrumpujen uudet korjausmenetelmät: Halkaistu sisäputki, puolipohjaus ja pohjan betonointi**

Tässä tutkimuksessa arvioitiin uudentyyppisten korjausmenetelmien soveltuvuutta teräksestä valmistettujen tierumpujen käyttöön pidentämiseksi. Tutkimuksessa rajauduttiin tarkastelemaan sellaisia korjausmenetelmiä, joita käyttämällä rumpuputken aukon koko pienenee mahdollisimman vähän. Rumpujen korjaaminen on kannattavinta kohteissa, joissa rummun asennussyvyys on suuri tai tien aukikaivaminen aiheuttaa suuret liikenteenjärjestelykustannukset.

Tutkimuksessa on tarkasteltu kolmea uutta menetelmää: halkaistu sisäputki, puolipohjaus ja pohjan betonointi. Näistä kahta ensinnä mainittua kokeiltiin verraten matalalla peitesyvyydellä olevissa rummuissa, mistä johtuen niistä oli mielekästä mitata myös rumpurakenteen mekaanista toimintaa raskaan ajoneuvoyhdistelmän ajaessa mittaushetken yli. Pohjan betonointimenetelmän koekohteena toimineella rummulla peitesyvyys on sitä vastoin niin suuri, että rumpuputkeen ylittävistä ajoneuvosta mobilisoituvat muodonmuutokset jäävät oletettavasti merkityksettömän pieniksi. Tästä johtuen kyseiseltä koekohteelta kerätyt havainnot rajoittuvat pelkästään korjausrakenteen periaatteen ja toteutuksen dokumentointiin. Niitä kahta koekohteita, joilla tehtiin mittauksia, tarkasteltiin myös tarkemmin elementtimenetelmään perustuvien mallien avulla.

Kaikki tutkimukseen valikoituneet korjausmenetelmät osoittautuivat rakennettujen koekohteiden perusteella toteuttamiskelpoisiksi. Kahdessa kohteessa kuormituskokeiden perusteella saatujen mittaustulosten perusteella korjausmenetelmät arvioitiin myös rummun mekaanisen toiminnan kannalta toimiviksi ratkaisuksi. Mittausten avulla todennetut jännitys- ja muodonmuutostasot jäivät verrattain maltillisiksi, vaikka rummun peitesyvyys oli koekohteissa melko pieni.

Aiemmissä rumpuputken mekaanisen toiminnan mallinnuksissa käytetyn PLAXIS 3D-ohjelmiston rinnalla mallinnettiin tässä tutkimuksessa rumpuputken syntyviä rasituksia tarkemmin myös ANSYS-ohjelmistolla. Tämän osalta todettiin, että korjatun rumpuputken mekaanista käyttäytymistä ei saatu verifioitua uskottaviksi arvioituilla materiaaliparametreilla. Suurin yksittäinen laskennallista virhettä aiheuttava tekijä oli ANSYS-ohjelmistossa käytössä ollut materiaalimalli, joka mahdollisesti vetojännitysten syntyminen sitomattomiin tien rakennekerroksiin. Tällöin liikennekuormitus ei vaikuta etenkään tierakenteen syvyysuunnassa tarpeeksi suurena, ja myös rummun yläpintaa rasittava puristusjännitys jää laskentamalleissa liian pieneksi. Tulevia korjausratkaisuja ei siis tutkimuksen tulosten perusteella pystytä verifioimaan pelkästään laskennallisesti tässä tutkimuksessa käytetyllä lähestymistavalla, mikäli rajaudutaan uskottaviksi arvioituihin materiaaliparametreihin tien rakennekerrosten ja pohjamaan osalta. Näin ollen laskennallisten parametrien määrittämisen tueksi tarvitaan tarkempia tietoja joko rumpuputken käyttäytymisestä tai rumpu ympäröivistä maakerroksista.

**General information**

Publication status: Published

MoE publication type: D5 Text book, professional manual or guide or a dictionary

Organisations: Department of Civil Engineering, Research group: Earth Constructions, Research group: Structural Mechanics, Research area: Infrastructure Construction

Contributors: Kalliainen, A., Haakana, V., Korhonen, M., Mäkinen, J., Kolisoja, P.

Number of pages: 70

Publication date: 2016

**Publication information**

Publisher: Liikennevirasto

ISBN (Electronic): 978-952-317-268-5

Original language: English

**Publication series**

Name: Liikenneviraston tutkimuksia ja selvityksiä

ISSN (Electronic): 1798-6656

URLs:

[http://www2.liikennevirasto.fi/julkaisut/pdf8/lts\\_2016-26\\_terasrumpujen\\_uudet\\_web.pdf](http://www2.liikennevirasto.fi/julkaisut/pdf8/lts_2016-26_terasrumpujen_uudet_web.pdf)

Research output: Book/Report > Book > Professional

**The effects of improved energy efficiency on indoor environmental quality in multi-family buildings****General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Research group: Concrete and Bridge Structures, Research area: Structural Engineering, Department of Civil Engineering, Research group: Building Physics, Natl Inst Hlth & Welf, Finland National Institute for Health & Welfare, Dept Environm Hlth, Kaunas Univ Technol, Kaunas University of Technology, Dept Environm Technol

Contributors: Du, L., Prasauskas, T., Leivo, V., Turunen, M., Kiviste, M., Martuzevicius, D., Haverinen-Shaughnessy, U.  
Publication date: 2016

#### Host publication information

Title of host publication: Indoor Air 2016 : The 14th international conference of Indoor Air Quality and Climate Ghent, Belgium July 3-8 2016

Article number: 737

ISBN (Electronic): 978-0-9846855-5-4

URLs:

<http://www.indoorair2016.org/>

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

#### Vesihuollon strateginen kehittäminen haltuun: Ydin- ja tukitoiminnon tarpeen hahmottaa selkeästi

##### General information

Publication status: Published

MoE publication type: D1 Article in a trade journal

Organisations: Department of Civil Engineering

Contributors: Katko, T. S., Hukka, J. J.

Number of pages: 2

Pages: 12-13

Publication date: 2016

Peer-reviewed: Unknown

##### Publication information

Journal: Kuntatekniikka

Volume: 70

Issue number: 2

ISSN (Print): 1238-125X

Original language: Finnish

URLs:

<http://kuntatekniikka.fi/lehtiarkisto/022016/kansi-6>

URLs:

<http://kuntatekniikka.fi/lehtiarkisto/022016/vesihuollon-strateginen-kehittaminen>

Research output: Contribution to journal › Article › Professional

#### Tien ja radan sitomattomissa rakennekerroksissa käytettävien kiviainesten lujuuden ja hienontumisen tutkiminen : kirjallisuusselvitys

##### General information

Publication status: Published

MoE publication type: D4 Published development or research report or study

Organisations: Department of Civil Engineering, Research group: Track Structures

Contributors: Kuula, P.

Number of pages: 115

Publication date: 18 Nov 2015

##### Publication information

Place of publication: Helsinki

Publisher: Liikennevirasto

Volume: 68

Edition: 2015

ISBN (Electronic): 978-952-317-181-7

Original language: Finnish

##### Publication series

Name: Liikenneviraston tutkimuksia ja selvityksiä

Publisher: Liikennevirasto

Volume: 2015

No.: 68

ISSN (Electronic): 1798-6664

URLs:

[http://www2.liikennevirasto.fi/julkaisut/pdf8/lts\\_2015-68\\_tien\\_radan\\_web.pdf](http://www2.liikennevirasto.fi/julkaisut/pdf8/lts_2015-68_tien_radan_web.pdf)

Research output: Book/Report › Commissioned report › Professional

**Arsenic in bedrock, soil and groundwater - The first arsenic guidelines for aggregate production established in Finland**  
Concern over arsenic (As)-rich drinking water has gained worldwide attention since the 1990s, when the problem was discovered in West Bengal in India and in Bangladesh. Since then, authorities and research institutes have focused on risk assessment and management for As in Finland. Nationwide geochemical mapping projects determined background levels and revealed regions with a higher than average As content in bedrock and soil. Approximately 10% of the citizens in Finland use drinking water from private wells. Groundwater, especially from drilled bedrock wells, may contain As concentrations higher than 10 µg/L, the European Union quality guideline for As in drinking water. Here, we present the outcome of two European Union projects, RAMAS and ASROCKS, which based their conclusions on nationwide databases and thousands of samples. Both RAMAS and ASROCKS focused on the Tampere-Häme region of Southern Finland, where bedrock and soil contain more As than in other parts of Finland on average. Over 1000 groundwater samples revealed that drilled bedrock wells may contain As-rich water in certain geological units. Naturally occurring As in bedrock and soil may also cause the mobilization of As during rock aggregate production and construction activities, potentially impacting on groundwater aquifers, surface waters, and biota. Arsenic concentrations in aggregate production and construction exceeded the regional background levels in some bedrock and aggregate product samples, but during leaching tests As concentrations were found to be low. Based on the results, risk management tools were revised and guidelines for the rock aggregate industry were established in cooperation with authorities, companies, and other stakeholders. To our knowledge, the guidelines established were the first in the world. The guidelines for As for the aggregate and construction industries can be applied in other countries and adapted to local conditions.

#### General information

Publication status: Published

MoE publication type: A1 Journal article-refereed

Organisations: Department of Civil Engineering, Research group: Earth Constructions, Research group: Track Structures, Aalto University, Geologian tutkimuskeskus, Finnish Environment Institute

Contributors: Parviainen, A., Loukola-Ruskeeniemi, K., Tarvainen, T., Hatakka, T., Härmä, P., Backman, B., Ketola, T., Kuula, P., Lehtinen, H., Sorvari, J., Pyy, O., Ruskeeniemi, T., Luoma, S.

Number of pages: 15

Pages: 709-723

Publication date: 1 Nov 2015

Peer-reviewed: Yes

#### Publication information

Journal: Earth-Science Reviews

Volume: 150

ISSN (Print): 0012-8252

Ratings:

Scopus rating (2015): CiteScore 11.3 SJR 3.692 SNIP 3.143

Original language: English

ASJC Scopus subject areas: Earth and Planetary Sciences(all)

Keywords: Arsenic, Bedrock, Construction, Groundwater, Risk management, Rock aggregates, Soil, Surface water

DOIs:

10.1016/j.earscirev.2015.09.009

URLs:

<http://www.scopus.com/inward/record.url?scp=84943781121&partnerID=8YFLogxK> (Link to publication in Scopus)

Source: Scopus

Source ID: 84943781121

Research output: Contribution to journal › Article › Scientific › peer-review

#### Kapillaaristen vedenmuominaisuuksien määrittämiseen sopivan vapaan vedenimukoelaitteiston kehittäminen

##### General information

Publication status: Published

MoE publication type: B3 Non-refereed article in conference proceedings

Organisations: Department of Civil Engineering, Research group: Building Physics

Contributors: Tuominen, E., Vinha, J.

Number of pages: 6

Pages: 233-238

Publication date: 20 Oct 2015

##### Host publication information

Title of host publication: Rakennusfysiikka 2015. Uusimmat tutkimustulokset ja hyvät käytännön ratkaisut. 20.-22.10.2015, Tampere

Place of publication: Tampere



Publisher: Tampereen teknillinen yliopisto, rakennustekniikan laitos, rakennetekniikka  
Editors: Vinha, J., Ruuska, T.  
ISBN (Print): 978-952-15-3580-2  
Keywords: Double skin facade, Energy efficiency, New renovation concepts, Innovative HVAC, Earth to air heat exchanger

#### **Bibliographical note**

AUX=rak,"Tuominen, Eero"

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific

### **Laastien vedenimukertoimen määrittämisen virhelähdekokeet**

#### **General information**

Publication status: Published  
MoE publication type: B3 Non-refereed article in conference proceedings  
Organisations: Department of Civil Engineering  
Contributors: Tuominen, E., Vinha, J.  
Number of pages: 6  
Pages: 239-244  
Publication date: 20 Oct 2015

#### **Host publication information**

Title of host publication: Rakennusfysiikka 2015. Uusimmat tutkimustulokset ja hyvät käytännön ratkaisut. 20.-22.10.2015, Tampere  
Place of publication: Tampere  
Publisher: Tampereen teknillinen yliopisto, rakennustekniikan laitos, rakennetekniikka  
Editors: Vinha, J., Ruuska, T.  
ISBN (Print): 978-952-15-3580-2  
Keywords: Double skin facade, Energy efficiency, New renovation concepts, Innovative HVAC, Earth to air heat exchanger

#### **Bibliographical note**

AUX=rak,"Tuominen, Eero"

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific

### **Laastin ja betonin lämmönjohtavuuden ja ominaislämpökapasiteetin määrittäminen lämpövirtalevyllä**

#### **General information**

Publication status: Published  
MoE publication type: B3 Non-refereed article in conference proceedings  
Organisations: Department of Civil Engineering, Research group: Building Physics  
Contributors: Ruuska, T., Vinha, J.  
Number of pages: 6  
Pages: 227-232  
Publication date: 20 Oct 2015

#### **Host publication information**

Title of host publication: Rakennusfysiikka 2015. Uusimmat tutkimustulokset ja hyvät käytännön ratkaisut. 20.-22.10.2015, Tampere  
Place of publication: Tampere  
Publisher: Tampereen teknillinen yliopisto, rakennustekniikan laitos, rakennetekniikka  
Editors: Vinha, J., Ruuska, T.  
ISBN (Print): 978-952-15-3580-2  
Keywords: Double skin facade, Energy efficiency, New renovation concepts, Innovative HVAC, Earth to air heat exchanger  
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific

### **Betonisten ratapölkkyjen väsytytkuormituskokeet**

In fatigue load tests, unused Finnish concrete railway sleepers B97 and BP99 were loaded. The purpose of the loading tests was to analyse the fatigue properties of the sleepers and the effect of the fatigue on the stiffness of the sleeper. Furthermore, the significance of cracks was estimated in the study. The load levels were chosen so that it was possible to estimate the significance of the fatigue in a real operating situation. The fatigue limit that has been determined based on the loading tests and the calculatory limit state of crack formation are distinctly higher than the bending moments that have been measured in the field tests. Consequently, the deterioration of the railway sleepers under the traffic load and due to the fatigue is very unlikely.

#### **General information**

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Department of Civil Engineering, Research group: Track Structures  
Contributors: Rantala, T., Kerokoski, O., Nurmikolu, A.  
Number of pages: 16  
Pages: 18-33  
Publication date: 3 Jun 2015  
Peer-reviewed: Yes

#### Publication information

Journal: Rakenteiden mekaniikka  
Volume: 48  
Issue number: 1  
ISSN (Print): 0783-6104  
Original language: Finnish  
Keywords: betoniratapölkky, kuormituskoee, väsyminen  
URLs:  
[http://rmseura.tkk.fi/rmlehti/2015/nro1/RakMek\\_48\\_1\\_2015\\_2.pdf](http://rmseura.tkk.fi/rmlehti/2015/nro1/RakMek_48_1_2015_2.pdf)  
Research output: Contribution to journal › Article › Scientific › peer-review

#### Test in scala reale su argille sensibili: l'esperienza finlandese

##### General information

Publication status: Published  
MoE publication type: D3 Professional conference proceedings  
Organisations: Department of Civil Engineering, Research group: Foundation Structures  
Contributors: D'Ignazio, M.  
Publication date: May 2015

##### Host publication information

Title of host publication: 5 IAGIG, Incontro Annuale dei Giovani Ingegneri Geotecnici  
Place of publication: Rome  
URLs:  
[http://www.iagig.unisa.it/iagig\\_2015/iagig2015atti](http://www.iagig.unisa.it/iagig_2015/iagig2015atti)  
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Professional

#### A proposal for some modifications of EN 1997-1 design approaches

All Eurocodes are currently under a critical review, while the work for a second generation of codes are about to start in 2015. For the geotechnical design EN 1997-1 is facing high demands for harmonization and simplification of the present code.

The paper presents some proposals for improving the code regarding ultimate limit state (ULS) design. The goal is to make the

code better in accounting for uncertainties involved in the design and possible consequences of an ultimate limit state.

When

applying a material factor approach (MFA), the partial safety factors are suggested to depend on both the uncertainty of the

material and the consequence of failure. Such an approach is well suited for slope stability analysis. However, the authors suggest that also the uncertainties involved with loads should be placed on the material factors. For retaining wall design and

load factor approach (LFA) is suggested in addition to MFA similar to present Design Approach (DA) 1 in the Eurocode.

This

approach gave the most consistent design for all cases in a comprehensive study performed. Some modifications are though

suggested also for DA1 to make the design simpler and even more consistent.

##### General information

Publication status: Published  
MoE publication type: A4 Article in a conference publication  
Organisations: Department of Civil Engineering, Research group: Foundation Structures  
Contributors: Länsivaara, T., Knuuti, M.  
Number of pages: 6  
Pages: 486-491  
Publication date: 2015

##### Host publication information

Title of host publication: Fifth International Symposium on Geotechnical Safety and Risk (ISGSR) : Rotterdam, The Netherlands 13-16 October 2015

Publisher: IOS Press

ISBN (Print): 978-1-61499-579-1

ISBN (Electronic): 978-1-61499-580-7

URLs:

<http://www.isgsr2015.org/>

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

## Kiviaines- ja luonnonkiviteollisuuden kehitysnäkymät

### General information

Publication status: Published

MoE publication type: D4 Published development or research report or study

Organisations: Department of Civil Engineering, Research group: Track Structures, Työ- ja elinkeinoministeriö, Infra ry, Suomen ympäristökeskus SYKE - Finnish Environment Institute, Kiviteollisuusliitto ry, Geologian tutkimuskeskus, Aalto University, Geological Survey of Finland

Contributors: Loukola-Ruskeeniemi, K. (ed.), Lonka, H. (ed.), Ehrukainen, E., Gustafsson, J., Honkanen, M., Härmä, P., Jauhiainen, P., Kuula, P., Nenonen, K., Pellinen, T., Rintala, J., Selonen, O., Martikainen, M., Aalto, M.

Number of pages: 72

Publication date: 2015

### Publication information

Place of publication: Helsinki

Publisher: Työ- ja elinkeinoministeriö

Volume: 2015

ISBN (Print): 978-952-327-047-3

ISBN (Electronic): 978-952-327-048-0

Original language: Finnish

### Publication series

Name: Työ- ja elinkeinoministeriön julkaisuja

Publisher: Työ- ja elinkeinoministeriö

Volume: 2015

No.: 54

ISSN (Print): 1797-3554

ISSN (Electronic): 1797-3562

URLs:

[https://www.tem.fi/files/44123/TEMjul\\_54\\_2015\\_web\\_28102015.pdf](https://www.tem.fi/files/44123/TEMjul_54_2015_web_28102015.pdf)

Research output: Book/Report › Commissioned report › Professional

## Konvektiivinen lämmönsiirtyminen ratapenkereessä

Modern track evenness demands are high which is why frost heave causes considerable problems in Finland. Nowadays railway ballast and sub-ballast are often of crushed rock whose thermal performance differs from that of the traditional gravel. Many studies around the world have found that convective heat transfer may occur in very coarse crushed rock aggregate. This can lead to increased heat transfer from the embankment which allows frost to penetrate deeper than normal calculation methods predict.

Many studies have been conducted on free convection internationally, and there is a calculation model for estimating its probability. However, the calculation involves problems because the calculation model considers intrinsic permeability, which is difficult to define for coarse materials. Intrinsic permeability can be calculated from water permeability. Unfortunately, water permeability is difficult to determine for coarse materials. The results of research conducted abroad are not as such applicable in determining convection in Finnish railway embankments because of different grain sizes. Therefore, new laboratory test apparatus was built. Three materials of different gradation were tested in the lab: 31.5/63 mm ballast aggregate, 5/16 mm crushed rock aggregate, and 0/63 mm sub-ballast material.

Strong natural convective heat transfer via air occurred in the railway ballast tested in the lab. If the medium was moist air or water, convection could occur at smaller temperature differences. No significant convection occurred in the crushed rock and sub-ballast material via convection, but when water was added to the sample, thermal conductivity of the material increased significantly due to convection. The same phenomenon was observed in the case of 5/16 mm crushed rock, but adding of water

did not increase thermal conductivity significantly.

Two actual railway embankments on which temperature data was available were also tested. The data allowed estimating the temperature differences in the embankments. Based on the results from the test embankments in Seinäjoki, Finland, the thermal performance of the gravel embankment and crushed rock embankment differed, but the possibility of natural convection could not be proved nor completely excluded. The study showed that crushed rock ballast and sub-ballast material may allow natural convection to occur if its grain size distribution is close to the most coarse and even-grained materials allowed by the current guidelines. Sorting of the material in the building phase can increase this susceptibility to convection.

#### General information

Publication status: Published

MoE publication type: D4 Published development or research report or study

Organisations: Department of Civil Engineering

Contributors: Latvala, J.

Number of pages: 115

Publication date: 2015

#### Publication information

Publisher: Liikennevirasto

Volume: 20/2015

ISBN (Print): 78-952-317-081-0

ISBN (Electronic): 78-952-317-081-0

Original language: Finnish

#### Publication series

Name: Liikenneviraston tutkimuksia ja selvityksiä

Publisher: Liikennevirasto

Keywords: Convective heat transfer, Frost depth, Railway track structures

URLs:

[http://www2.liikennevirasto.fi/julkaisut/pdf8/lts\\_2015-20\\_konvektiivinen\\_lammonsiirtyminen\\_web.pdf](http://www2.liikennevirasto.fi/julkaisut/pdf8/lts_2015-20_konvektiivinen_lammonsiirtyminen_web.pdf)

Research output: Book/Report > Commissioned report > Professional

#### Selvitys UUMA-materiaalien teknisen kelpoisuuden arviointiin liittyvistä testausstandardeista ja -menetelmistä (1. vaihe), 29.12.2014

#### General information

Publication status: Published

MoE publication type: D4 Published development or research report or study

Organisations: Department of Civil Engineering, Research group: Track Structures, Research group: Earth Constructions

Contributors: Kuula, P., Kolisoja, P., Sjöberg, M., Ketola, T., Koivisto, K., Forsman, J., Dettenborn, T., Jyvära, H.

Publication date: 2015

#### Publication information

Publisher: Ramboll

Original language: Finnish

#### Publication series

Name: UUMA 2, Uusiomateriaalit maarakentamisessa ohjelma 2013-2015

Publisher: Ramboll

URLs:

<http://www.uuma2.fi/>

#### Bibliographical note

Contribution: organisation=rak,FACT1=1<br/>Portfolio EDEND: 2015-01-13

Source: researchoutputwizard

Source ID: 14

Research output: Book/Report > Commissioned report > Professional

#### Shear bands in soft clays: strain-softening behavior in finite element method

Strain-softening behavior of soft sensitive clays is very often neglected in geotechnical design. During undrained loading, such materials show a dramatic loss of strength after the peak stress, until residual strength is reached at large strain. As a consequence, local failure occurs and plastic strains localize in a shear band. Shear band modeling in Finite Element Method requires a regularization technique to overcome mesh dependency. NGI-ADPSof2 model is able to simulate the post-peak softening behavior of sensitive clays. In this study, the influence of

strain softening on the stability of sensitive clay slopes is studied using the NGI-ADPSoft2 model. The analyses are conducted using the finite element software PLAXIS 2D AE. The advantages of using a strain-softening soil model are discussed.

#### General information

Publication status: Published  
MoE publication type: A1 Journal article-refereed  
Organisations: Department of Civil Engineering, Research group: Foundation Structures  
Contributors: D'Ignazio, M., Lämsivaara, T.  
Number of pages: 16  
Pages: 83-98  
Publication date: 2015  
Peer-reviewed: Yes

#### Publication information

Journal: Rakenteiden mekaniikka  
Volume: 48  
Issue number: 1  
ISSN (Print): 0783-6104  
Original language: English  
Electronic versions:  
RakMek\_48\_1\_2015\_6  
URLs:  
<http://urn.fi/URN:NBN:fi:tty-201605033915>  
URLs:  
[http://rmseura.tkk.fi/rmllehti/2015/nro1/RakMek\\_48\\_1\\_2015\\_6.pdf](http://rmseura.tkk.fi/rmllehti/2015/nro1/RakMek_48_1_2015_6.pdf)

#### Bibliographical note

xa ei tarkistettu  
Research output: Contribution to journal > Article > Scientific > peer-review

### Varmuuden kohdentaminen geotekniikassa, miten Eurokoodeja voisi kehittää?

#### General information

Publication status: Published  
MoE publication type: D3 Professional conference proceedings  
Organisations: Department of Civil Engineering, Research group: Foundation Structures  
Contributors: Lämsivaara, T.  
Publication date: 2015

#### Host publication information

Title of host publication: Geotekniikan päivä 2015  
Publisher: SGY  
URLs:  
<http://www.getunderground.fi/web/page.aspx?refid=38>  
Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Professional

### Anisotropic total and effective stress stability analysis of the Perniö failure test

#### General information

Publication status: Published  
MoE publication type: A4 Article in a conference publication  
Organisations: Department of Civil Engineering, Life Cycle Effectiveness of the Built Environment (LCE@BE)  
Contributors: D'Ignazio, M., Mansikkamäki, J., Lämsivaara, T.  
Number of pages: 6  
Pages: 609-614  
Publication date: 2014

#### Host publication information

Title of host publication: Numerical Methods in Geotechnical Engineering : Proceedings of the 8th European Conference on Numerical Methods in Geotechnical Engineering NUMGE2014, Delft, The Netherlands, 18-20 June 2014  
Publisher: CRC Press Taylor & Francis Group; A Balkema book  
Editors: Hicks, M. A. ..., Brinkgreve, R. B. ... J. ..., Rohe, A.  
ISBN (Print): 978-1-138-00146-6

ISBN (Electronic): 978-1-315-75182-5

DOIs:

10.1201/b17017-109

URLs:

<http://www.crcnetbase.com/doi/pdf/10.1201/b17017-109>

#### **Bibliographical note**

Contribution: organisation=rak,FACT1=1<br/>Portfolio EDEND: 2014-12-31

Source: researchoutputwizard

Source ID: 245

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

#### **ASROCKS-Hankkeen heikkouuttomenetelmien vertailu**

##### **General information**

Publication status: Published

MoE publication type: D4 Published development or research report or study

Organisations: Department of Civil Engineering

Contributors: Tarvainen, T., Hatakka, T., Backman, B., Ketola, T., Härmä, P.

Number of pages: 13

Publication date: 2014

##### **Publication information**

Publisher: GEOLOGIAN TUTKIMUSKESKUS

Original language: Finnish

URLs:

[http://projects.gtk.fi/export/sites/projects/ASROCKS\\_ENG/project/GTK\\_Arkistoraportti\\_77\\_2014.pdf](http://projects.gtk.fi/export/sites/projects/ASROCKS_ENG/project/GTK_Arkistoraportti_77_2014.pdf)

##### **Bibliographical note**

Contribution: organisation=rak,FACT1=1<br/>Portfolio EDEND: 2014-12-30

Source: researchoutputwizard

Source ID: 1607

Research output: Book/Report › Commissioned report › Professional

#### **Condition-Based Track Maintenance and Rehabilitation Design Using Combined Data Analysis**

##### **General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Civil Engineering

Contributors: Silvast, M., Nurmikolu, A., Wiljanen, B., Mäkelä, E.

Number of pages: 8

Pages: 649-656

Publication date: 2014

##### **Host publication information**

Title of host publication: GEORAIL 2014 : 2nd International symposium - Railway geotechnical engineering, 6-7 November 2014, France

Place of publication: Ranska

Publisher: IFSTTAR

ISBN (Print): 978-2-7208-2621-4

##### **Bibliographical note**

Contribution: organisation=rak,FACT1=1<br/>Portfolio EDEND: 2014-12-30<br/>Publisher name: IFSTTAR

Source: researchoutputwizard

Source ID: 1513

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

#### **Finnish mine waste disposal areas**

In 2013, a total of forty-six mines and quarries were operating in Finland, and several new mining projects were in progress. Both mining and environmental legislation and dam safety regulations have been developed and renewed during recent years, and the mining and permitting authorities have changed.

Due to problems at the Talvivaara Mine in 2013, the Finnish government decided to implement a voluntary stress test for Finnish mines. The method was developed based on the stress test designed for nuclear power plants by the European Nuclear Safety Regulators Group (ENSREG). Altogether twenty-

one mines or concentrating plants were chosen to be tested, and twenty responded. In the stress test questionnaire there were fifteen questions on seven risk scenarios that the nominated expert group assessed to be both potential and significant. There are sixty-seven tailings dams in Finland. Nine of them have been classified as Class 1 ("consequence class"), that is, dams which could cause loss of life in the event of dam failure. The study showed that the hydrological design of tailings dams has to be reconsidered. One finding of the stress test was that the dam safety legislation and the guidelines do not define criteria for the closure of tailings dams. Based on the results, mining companies are monitoring their dams quite well and are aware of dam safety risks, probably thanks to the detailed dam safety legislation. However, the base of the waste areas is typically ignored. Old mining waste areas are mainly built on natural soil layer without any liners. New mining waste areas require an environmental permit, which contains requirements for the bottom liners as well.

#### General information

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Civil Engineering, Research group: Earth Constructions

Contributors: Leppänen, M., Laasonen, J., Välisalo, T.

Publication date: 2014

#### Host publication information

Title of host publication: Geosynthetics Mining Solutions 2014

Publisher: Infomine

ISBN (Print): 978-0-9917905-5-5

Keywords: mining, waste, liner, geosynthetics

URLs:

<http://www.geosyntheticssolutions.com/>

Research output: Chapter in Book/Report/Conference proceeding > Conference contribution > Scientific > peer-review

#### Kiviainesten otto arseenialueilla - opas kiviainesten tuottajille, maarakentajille ja viranomaisille.

#### General information

Publication status: Published

MoE publication type: D4 Published development or research report or study

Organisations: Department of Civil Engineering

Contributors: Härmä, P., Tarvainen, T., Backman, B., Hatakka, T., Ketola, T., Kuula, P., Luoma, S., Pyy, O., Sorvari, J., Loukola-Ruskeeniemi, K.

Number of pages: 71

Publication date: 2014

#### Publication information

Place of publication: Espoo

Publisher: GEOLOGIAN TUTKIMUSKESKUS

ISBN (Print): 978-952-217-288-4

ISBN (Electronic): 978-952-217-289-1

Original language: Finnish

URLs:

[http://tupa.gtk.fi/julkaisu/opas/op\\_059.pdf](http://tupa.gtk.fi/julkaisu/opas/op_059.pdf)

<https://www.gtk-kauppa.fi/products/view/14373>

#### Bibliographical note

Contribution: organisation=rak,FACT1=1<br/>Portfolio EDEND: 2014-09-22

Source: researchoutputwizard

Source ID: 414

Research output: Book/Report > Commissioned report > Professional

#### Liite 6: Yleistä kaivannaisjätealueista ja patoturvallisuudesta

#### General information

Publication status: Published

MoE publication type: D2 Article in professional manuals or guides or professional information systems or text book material

Organisations: Department of Civil Engineering, Research group: Earth Constructions

Contributors: Leppänen, M., Välisalo, T. (ed.), Laasonen, J.

Publication date: 2014

**Host publication information**

Title of host publication: Kaivosten stressitesti 2013

Publisher: Ympäristöministeriö

ISBN (Electronic): 978-952-11-4269-7

**Publication series**

Name: Ympäristöministeriön raportteja

URLs:

[http://www.ym.fi/fi-FI/Ajankohtaista/Julkaisut/YMra\\_22014\\_Kaivosten\\_stressitestit\\_2013%2828221%29](http://www.ym.fi/fi-FI/Ajankohtaista/Julkaisut/YMra_22014_Kaivosten_stressitestit_2013%2828221%29)

Research output: Chapter in Book/Report/Conference proceeding › Chapter › Professional

**Stiffmaster - A continuous track stiffness measurement device****General information**

Publication status: Published

MoE publication type: A4 Article in a conference publication

Organisations: Department of Civil Engineering

Contributors: Luomala, H., Peltokangas, O., Nurmikolu, A.

Number of pages: 10

Pages: 109-118

Publication date: 2014

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Contribution: organisation=rak,FACT1=1<br/>Portfolio EDEND: 2014-12-30<br/>Publisher name: IFSTTAR

Source: researchoutputwizard

Source ID: 980

Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review