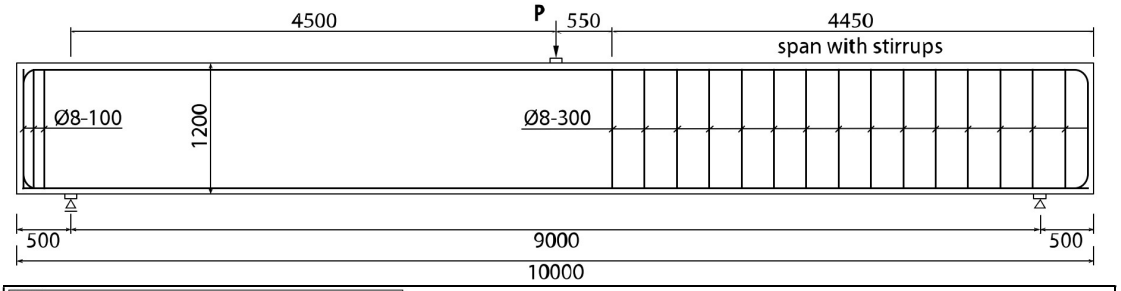
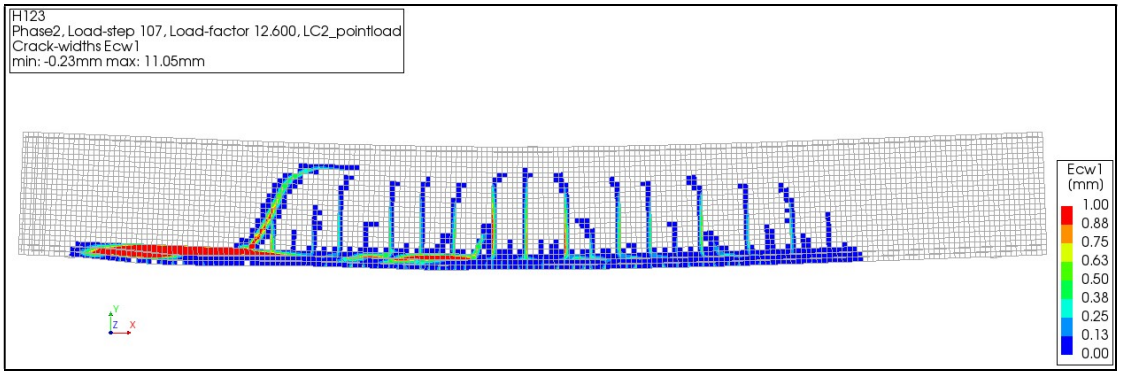
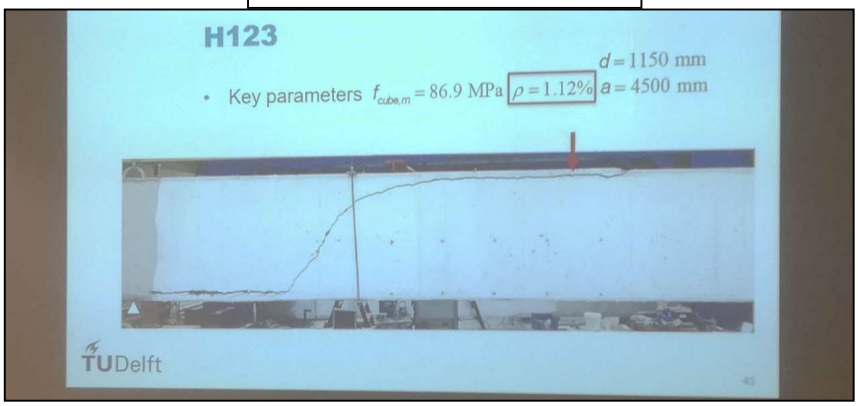
DIANA Users Association

Annual report 2018





Experimental result



Dr.ir. Ane de Boer
Chairman DIANA User's Association

Annual Report 2018

Contents

1 Aim of the Association

The members of the Association are all users of the DIANA software package of DIANA FEA BV.
In this capacity, they have a considerable interest in gaining knowledge in the Finite Element Method and (numerical) mechanics, as well as in the further development and extension of DIANA.

To achieve this, the Association fulfils a coordinating role by taking stock of the members' needs in terms of research and development, and initiating new projects.

The Association is also a meeting place for the exchange of experiences with the software package.

Furthermore, DIANA FEA BV utilizes the Association to inform the Users on the DIANA package development progress.

2 Executive Committee 2018

During this reporting year, the Executive Committee consisted of:

Chairman:	Dr.ir. Ane de Boer, Ane de Boer Consultancy
Treasurer/ Secretary:	ir. Coen v.d. Vliet, Arcadis Nederland BV
Committee member:	ir. Henco G. Burggraaf, TNO Structural Reliability

The Executive Committee has mainly dealt with the following:

1. Discussion on continuing new research projects on the basis of a national and international user's wish list.
2. Organizing of the 12th International DIANA Users Meeting in Porto, Portugal.
3. Continuing contributing to the set-up a database with publications related to DIANA or FEA.
4. Extending the existing e-mail database with foreign users in the fields of concrete, concrete mechanics, bridges and tunnels.
5. Extending the examples for validation of the NLFEA Guideline version 2.1
6. Preparation of general and technical meetings.
7. Association finance.
8. Progress in an international response/discussion forum around developments now and in the future related to Users Wishes.

3 Actitivities

3.1 General

The Association holds a general meeting of members twice a year, followed if possible by a technical meeting (lectures). In 2018 there have been held one general meeting and one technical meeting (lecture evening).

3.2 Technical lectures February 7th, 2018

Defining maintenance intervals for an orthotropic steel deck

Sjoerd Hengeveld (TNO)

Many steel bridges with a long span from the seventies are bridges with an orthotropic steel deck. In general the impact of the traffic load is changed over the years. Therefor it is becoming increasingly important to gain insight in the fatigue strength of these bridges. An orthotropic bridge deck consists of a number of longitudinal girders, transversal girders, troughs and a deck plate. In order to determine the fatigue strength**,** several critical locations are determined. The connection between the trough and the deckplate are the most critical locations. The fatigue strength is among other things a function of the stresses at these locations. Therefore a finite elements model is created in order to gain insight in detail at these locations.
Within the total number of steel bridges there are differences in the amount of longitudinal girders, transversal girders and troughs. That is reason to setup a parametric FE model. By using the python-DIANA interface, the generation of different types of geometries can be automated. The complete geometry, modelled with quadratic shell elements, will be automatically generated, where the different structural components will be located at the right spot.

The traffic load is modelled by moving a surface load over the deck plate. The global and local effect at the structure has been determined by means of different load cases. By using influence lines, critical locations can be determined, after which insight is gained into the fatigue strength of the bridge deck.

The huge amount of input and output data, it has been decided to automatize as much as possible in both the pre- and post-processing stages of the analysis.

Geomechanical modelling to minimize the risk of induced seismicity during underground gas storage operations in a depleted gas field in the Netherlands

B. Orlic, B.B.T. Wassing (TNO, Applied Geosciences)

A geomechanical modelling study was conducted to investigate stability of major geological faults during past gas production and future underground gas storage operations in a depleted gas field in the Netherlands. The field experienced induced seismicity during gas production, which was most likely caused by the reactivation of an internal Central fault separating the two reservoir blocks. A 3D field scale finite

element geomechanical model of the gas field was developed using DIANA. The model was calibrated to match the subsidence data and the approximate location of the critically stressed, reactivated part of the fault in agreement with the seismological localization of the hypocentres of the past major seismic events. The model predicted a maximum shear slip of up to 2 cm associated with gas production. Additional, but a smaller, fault slip of up to 0.5 cm could be expected during the subsequent phase of cushion gas injection. During annual cycles of gas injection and production, the Central fault is not critically stressed and the predicted stress changes lie in the elastic region. Although the fault slip is unlikely, continuous monitoring of induced seismicity is essential.

Crack pattern observations to finite element simulation, an exploratory study for detailed assessment of existing reinforced concrete structures

Saurabh Dhanmeher TU Delft, Civil Engineering and Geosciences; TU Delft, Engineering Structures)

Uncertainties regarding structural safety of reinforced concrete structures may warrant a need for a detailed assessment. A detailed assessment using nonlinear finite element analysis is one of the alternatives which could help in decision-making about maintaining, upgrading or even demolishing and rebuilding of the structure. A reliable assessment should account for the existing damage in the structure, which may cause re-distribution of stresses within the structure, giving rise to unexpected failure modes. The existing approaches in nonlinear finite element analysis which account for the effect of already undergone damage in concrete, pose a number of limitations which either makes structural analysis ambitious or the uncertainty of concrete damage is not effectively accounted for. An alternative approach is adopted in this thesis, which is phenomenological and probabilistic in nature. Existing damage in concrete is conceived as a statistical field, which can be input into a finite element model, such that the existence of damage is taken as the starting point of the structural analysis. Focusing on indications of damage on the surface of concrete, i.e. crack patterns, an exploratory methodology based on image analysis is developed, to account for information obtained from crack pattern observation into nonlinear finite element analysis of reinforced concrete structures. The methodology is implemented on MATLAB and validated on damaged experimental specimens. Results of the computational analyses indicate good efficiency in predicting residual load carrying capacities and failure modes, alongside insightful numerical crack patterns. Through a critical examination of the obtained results and reflection upon the assumptions and simplification made in the methodology, recommendations for future research are provided.

The spalling mechanism of fire exposed concrete

Bas Lottman (Witteveen+Bos)

The spalling damage observed to concrete structures after severe fire exposure has been the topic of scientific research for the past decades. This phenomenon is commonly characterised by the sudden and in some cases violent breaking off of concrete pieces from the cross-section. In this thesis the derivation and the numerical results of a finite element based model are presented, using a coupled pore pressure

and fracture mechanics approach. The crack patterns obtained are found to be sufficient to reduce the pore pressure to a level representing only a minor contribution. The fracture behaviour during severe fire exposure also revealed that the continued compression of the heated surface layer promotes the formation of thermal instabilities. Based on simulated results, observations from full-scale tests and a conceptual model, a philosophy is argued proposing thermal buckling as the spalling mechanism of fire exposed concrete.

3.3 Technical lectures June 7th, 2018

Extra bearing capacity beam grid bridge deck

Kees Jan van der Wilt, IV-Infra BV

It concerns a concrete beam grid bridge deck. Prior to this, it was determined on the basis of a slab re-examination that there is insufficient bearing capacity in the transverse direction. With the use of a nonlinear analysis, it has been proven that the deck does comply.

Generic Python Script for Analysing Experimental RC Beams

Jonna Manie, DIANA FEA BV

A generic python script is being developed to model, analyse, and report experimental reinforced concrete beams in the DIANA Interactive Environment (DianaIE). Based on the user input, cross-sectional properties, web openings, and locations of the reinforcement bars and stirrups, either a two-dimensional curved shell model, or three-dimensional solid model is prepared. Further, the user provides information on the supports and loading, force or prescribed displacements, and the basic material properties for the concrete, i.e. Young's modulus, compressive and tensile strength, and the reinforcements, i.e. Young's modulus, yielding strength, and hardening properties. From the results of the structural nonlinear analysis, which is also set-up by the python script, output result screenshots, a basic report, and convergence overview is generated. Feedback from the users is being used to extend and enhance the python script.

Modelling an entire skew girder bridge with shell elements

Maciej Kraczla, Arcadis

A common engineering practice to assess structural resistance of existing structures is executed through the so-called Quick Scan tools. Besides the ULS values, these tools are often used to determine the most detrimental loading situation.
The presentation concerns a NLFEA of a skew bridge, previously assessed with the Quick Scan. The "actual" capacity of the bridge was investigated by means of a "2,5D" shell element model. The bridge is constructed with 11 prefabricated post-tensioned T-shaped girders, concrete joints and end cross beams. The bridge was statically loaded with the loading configurations from a Quick Scan deemed to result in the lowest shear capacity.
In the presentation, the adopted modelling technique and obtained results are discussed. The primary points of interest are: pros and cons of the method i.e. encountered problems and software issues, applicability of the method to investigate

shear failure and qualitative comparison of the results with the outcome from the Quick Scan.

Workflow DIANA

Gerd-Jan Schreppers, DIANA FEA BV

In response to the wishes of the DIANA users, attention will be given to the idea behind the partly implemented workflow concerning analyzes. Moreover, a short overview will be given about what is still to come in the future and finally a live demo will be shown based on the current DIANA version.

3.4 International DIANA Users Meeting 11-12 October 2018, University of Porto, Porto, Portugal

Thursday, 11th October

Workshop 'Monitoring'

Lectures:

Asset management supported by Finite Element models devoted to the short- and long-term assessment of prestressed concrete bridges

Helder Sousa, HS Consulting, Portugal

Summary

Over the past century, European countries have developed mature and extensive transport infrastructure networks, in which bridges play a vital role. Their design is increasingly influenced by life-cycle multi-objective performance criteria, which integrate economic, environmental and social factors. On the other hand, the growth of traffic and climatic changes are already placing an increasing demand on ageing and deteriorating on these networks, for which emphasis has shifted from new build to maintenance & rehabilitation.

In this context, new paradigms are needed to better support asset management towards an efficient utilization of the available, and steadily more limited, resources. Indeed, and mainly since the beginning of the XXI century, a significant effort has been made on structural performance, which indeed has been enabling a more accurate assessment of the load-carrying capacity of key assets (e.g. bridges) through refined and more comprehensive models, as compared to their simplified counterparts used in design.

In this context, this lecture aims to show how those refined and more comprehensive Finite Element models are being addressed and developed as a key component of a new paradigm in asset management. These comprehensive models differ from their counterparts at the design phase, mainly from the point of view of:

(i) an accurate modelling of the geometry with special attention to the type of finite elements used (e.g. beam elements, shell elements),
(ii) a better modelling of the in-situ material properties with particular focus on those with higher uncertainty,
(iii) a precise time-phased analysis since early stage of the construction and
(iv) the real operational loading conditions along the lifecycle of the bridge.

Focusing on prestressed concrete bridges, this will be made by means of a unique and very interesting case study available in the literature – the Lezíria Bridge. A *story* (that started in 2006 and keep ongoing) will be shared with the audience mainly by depicting along the three main phases of the bridge lifecycle: (i) construction, (ii) load test and (iii) operational lifetime.

Structural response of a concrete cable-stayed bridge under thermal loads

Emanuel de Sousa Tomé, Mário Pimentel and Joaquim Figueiras
CONSTRUCT-LABEST, Faculty of Engineering (FEUP), University of Porto, Portugal

Summary
Daily and seasonal temperature variations have a significant influence on the structural response of bridges, inducing strains, displacements or rotations of the same order of magnitude, or even larger, than those due to dead or live loads.
Besides understanding the structural behaviour under the operational loads, the characterization of the structural response induced by the daily and seasonal temperature variations is mandatory for the critical assessment of the bridge structural condition and when proactive conservation is envisaged.
In this study, a methodology is proposed for the simulation of the structural response of large concrete bridges under the effects of realistic temperature variations, aiming at the optimum compromise between accuracy and simplicity of the involved procedures.
The methodology is applied to a concrete cable-stayed bridge equipped with a permanent structural monitoring system. The measured and calculated hourly temperatures, deflections, bearing displacements, rotations and stay-cable forces are compared during a period of 17 months.
Good agreement is generally found, providing the validation of the developed methodology and related models. The behaviour of the bridge is discussed and the relative contribution of each temperature component to a given structural response is disclosed.
A discussion on the optimal deployment location of the embedded temperature sensors in order to have better estimators of the temperature components using the temperature readings is also presented.

KEYWORDS: Structural health monitoring; Cable-stayed bridges; Long-term effects; Thermomechanical analysis; Temperature effects; Radiative heat transfer

Workshop ‘Soil-Structure Interaction’

Lectures:

Introduction of Soil-Structure Interaction

Coen van der Vliet, Arcadis, the Netherlands

Summary
Every structure is somehow connected to the earth. This foundation transfers the loads on the structures to the subsoil, but also implies soil deformations on the structure.

This ongoing mutual communication between structure and soil is what we mean with soil-structure interaction (SSI).
With respect to SSI we distinguish different situations:
1. Loads dependent on displacements (e.g. sheet pile wall, laterally loaded piles);
2. Strength dependent on loads (e.g. tension piles);
3. Soil deformations impacting structures (e.g. excavations, vibrations).

Before exploring the DIANA possibilities with respect to SSI, the lecture briefly describes the different aspects of SSI, touches SSI-approaches from simple to advanced and gives several examples of SSI in daily engineering practice.

FE Modelling approaches for soil-bridge systems towards better emergency response planning

Wazeer Ali[1], Paolo Bocchini[2], Helder Sousa[1]
[1] University of Surrey, Guilford, United Kingdom
[2] Lehigh University, USA

Summary
The management of bridges in transportation networks located in seismic areas encompasses seismic risk assessments as a critical input in emergency response plans. For this, bridge managers usually rely on the concept fragility curves, which is a robust input for assessing the seismic vulnerability of bridges.

These fragility curves estimate the likely damage a bridge might sustain when it experiences seismic event. Nevertheless, these likely damages are highly dependent on the soil-structure system is modelled and therefore, quite different results might be achieved for these fragility curves. In the context of emergency response planning, this plays a vital role.

In this context, this presentation presents the modelling of a typical bridge by using different FE approaches for the analysis of soil-bridge systems and how these affect the derived fragility curves. In order to better assess these approaches, two different site profiles are considered to quantify the differences between the results from the different approaches used.

This work aims to contribute for a better assessment, on the basis of fragility curves, towards optimal emergency response plans in the context of seismic events.

Discussion & hands on workshop

Friday, 12th October

Lectures:

Theme: UHPFRC & Multiscale

Anisotropic tensile behaviour of UHPFRC: experiments, multi-scale modelling and non-destructive assessment

Mario Pimentel, University of Porto, Portugal

Summary
The commonly designated Ultra-High Performance Fibre-Reinforced cementitious Composites (UHPFRC) belong to a family of materials constituted by an extremely compact cementitious matrix reinforced with short high-strength steel fibres. This combination provides distinctly high compressive and tensile strengths and excellent durability properties. The material finds application in the rehabilitation and strengthening of existing reinforced concrete structures or in innovative designs of slender structures that take advantage of its outstanding mechanical properties.
The tensile behaviour of UHPFRC is decisive in many applications and strongly depends on the fibre orientation, which may vary throughout the structure and differ from that of the laboratory specimens. The influence of the fibre orientation on the tensile behaviour of UHPFRC, particularly for a wide range of fibre orientation profiles, needs to be investigated and the resulting anisotropic behaviour characterized in order to enable the efficient design of structural UHPFRC elements.
In the first part of the presentation the experiments conducted at the University of Porto to disclose the dependency of the tensile response with respect to the amount and orientation of the fibres is described. A model based on a meso-level description of the involved mechanics is then presented which is capable of simulating the full tensile response of the material.
In the second part of the presentation a non-destructive test method currently under development based on the magnetic properties of the steel fibres is described. This method is shown to provide indicators of the fibre content and orientation which can be used as inputs of the mechanical model.
It is demonstrated that the relative magnetic permeability of thin UHPFRC elements can be well approximated by a 2nd order tensor, providing the means to determine the relevant orientation parameters along any direction of interest based on a minimum number of measurements.
Finally, an outlook is given on how the meso-mechanical model and the NDT method can be combined to provide the necessary inputs for a macro-scale model of the material that is suitable for nonlinear analysis of real scale UHPFRC structures.

Finite element modelling of UHPFRC elements

Eduardo J. Mezquida-Alcaraz, Juan Navarro-Gregori, Pedro Serna Ros
Institute of Science and Concrete Technology, ICITECH, Universitat Politècnica de València, Spain

Summary
Nowadays the characterization of Ultra-High Performance Fibre-Reinforced Concrete (UHPFRC) tensile behaviour still remains a challenge for researchers. For this purpose, a simplified closed-form nonlinear hinge model based on the Three Point Bending Test (TPBT) was developed by the research group. This model has been used

as the basis of a simplified inverse analysis methodology to derive the tensile material properties from load-deflection response obtained from TPBT experimental tests.

The aim of this work is the numerical validation of the simplified inverse analysis method to characterize the tensile properties of UHPFRC. To get this objective a Finite Element Model (FEM) is carried out in DIANA software.
The parameters to characterize the concrete properties from the simplified inverse analysis method by means of TPBT are used in the numerical modelling. The constitutive model for UHPFRC is modelled using two assumptions.
One is based on the smeared cracking approach where a fixed total strain crack model, expressed as function of a crack opening fibre-reinforced concrete fib curve, is used.
The other is based on a discrete cracking model for the macrocrack position.
Numerical validation accuracy is reasonable for the smeared crack case and good for the discrete crack approach.

Moreover, an application of the model in uniaxial tensile UHPFRC elements has been carried out with the objective of study, not only the particular cracking process of UHPFRC, but the interaction between the different types of reinforcement and the matrix of this concrete.

Multiscale modelling of concrete material: micro- and nano-structure of cement paste

H. Mazaheripour[1], R. Faria[1], M. Azenha[2]
[1] University of Porto, Portugal
[2] ISISE, School of Engineering, University of Minho, Portugal

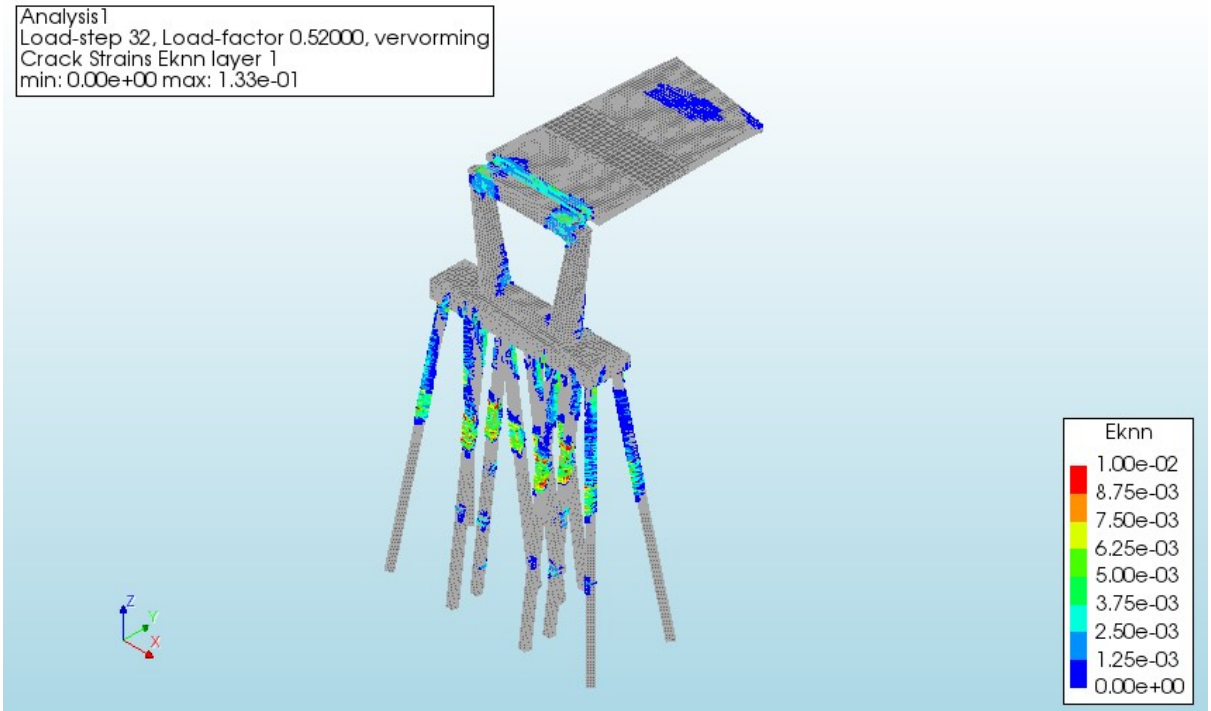
Summary
Development of a numerical multiscale modelling platform is purposed under the scope of our research project.
The modelling focuses on concrete material, or generally cement-based material (CBM). It includes simulation of the individual components of cement paste hydration products (e.g. Calcium-Silicate-Hydrate globules) at nano (×10-9 m) and micro scales (×10-6 m).
These models will provide the input data for the modelling in greater length scale for concrete and reinforced concrete structure.
The modelling deals with fundamental cement paste characterization including elasticity, thermal properties, fracture behaviour, transport properties, etc.
The concept of Representative Elementary Volume (REV) is used in our multiscale simulations. Cubic REVs are constructed using a recently developed hydration software available in the literature.
The constructed REVs are then discretised and exported as Finite Element Models (FEM) to DIANA.
All linear and nonlinear analysis are performed in DIANA.
The models deal with mostly the structural solid finite elements as well as the beam elements as a form of a lattice (combination of nodes and linear elements).
The current work presents some already done simulations and discusses some advantages and shortages of the models in DIANA.

THEME: Dynamics I

Robustness cycle bridge damaged by a ship

Ricky Tai, Arcadis, the Netherlands

Summary
In this presentation a project from the engineering practice will be discussed. Our client provided us with a third-party design of a bicycle bridge crossing a river with ship traffic. According to local design standards the bridge has to be able to withstand the accidental load of a ship collision. One of the possible scenarios is that a ship will collide into the river bank near the bridge pier. This would lead to tremendous deformations of the pier, which possibly results in the collapse of the bridge due to structural instability. To prevent this, a protection system has been engineered in the design which was provided to us by the client. In the expectance of hidden margins, our client asked us to review the design of the bridge pier protection system, and to evaluate the deformation capacity of the bridge pier against the design standards.
In case of an insufficient design, we were asked to provide a solution to guarantee the structural integrity of the bridge.
To achieve this, several analyses have been made with DIANA and PLAXIS (software for geotechnical analysis). PLAXIS has been used to determine the soil behaviour due to the ship collision, while DIANA has been used to determine the deformation capacity of the bridge pier.
The application of nonlinear material models for concrete and reinforcement in DIANA made it possible to prove extra deformation capacity for the bridge pier.
A special point of attention was to correctly describe the soil-structure interaction caused by the use of two different software packages, hence models, to schematize the situation.



Typical crack pattern bridge pier due to ship collision.

Heated Reinforced Concrete Slabs Subjected to Blast Load: Configuring Experiments by Numerical Analyses

Assis Arano[1], Jiangpeng Shu[1], Jan Arve Øverli[1], Max Hendriks[1,2], and Terje Kanstad[1]
[1] Norwegian University of Science and Technology , Trondheim, Norway
[2] Delft University of Technology, Delft, Netherlands

Summary
Ferry-free coastal route E39 is a project by the Norwegian Public Roads Administration that aims to design a coastal highway route between Kristiansand and Trondheim without ferry connections. Wide and deep fjords along the Norwegian coast make submerged floating tunnels (SFT) an alternative to conventional structures, such as large span bridges, significantly reducing the environmental impact to the landscape.
This type of structure has, however, never been built before. The evaluation of its feasibility taking into account safety aspects represents, therefore, an engineering challenge.
In the unfortunate situation of accidental events, the SFT reinforced concrete (RC) structure may become damaged, affecting its load carrying capacity.
RC shells can be a representative component of the SFT concrete structure and it is relevant to study if the RC shells can carry the combination of fire and blast load. In order to evaluate these two phenomena, a shock tube is a useful equipment to perform experimental tests on heated RC slabs. The number of experiments is usually limited due to the high cost and, therefore, conclusions are generally obtained with the contribution of numerical simulations.
This study presents a preliminary numerical study of RC slabs subjected to fire and blast loads. First, different models (3D solid and shell model) have been developed and compared, in order to find the best strategy in terms of results and computational time.
Then, nonlinear analyses for both static and dynamic tests have been performed, in combination with standard fire curve load effects. Temperature-dependent material properties have been used, in order to evaluate the influence of high temperature in the blast load carrying resistance. Load-deflection curve, crack pattern and temperature distribution along the slab thickness, are the main variables used to compare the results.
This study aims to assess future experiments performed on heated RC slabs subjected to blast loading.
Determining the most influencing material parameters will define relevant experiments to perform and, therefore, help to develop a better-calibrated numerical model. The numerical simulations will assess the risk analysis of SFT and its feasibility in the E39 project.

Numerical Modelling of Masonry-infilled RC Frame

Christiana Filippou, Cyprus University of Technology, Cyprus

Summary
The behaviour of masonry-infilled reinforced concrete (RC) frame structures during an earthquake, has attracted the attention by structural engineers since 1950's. Experimental and analytical studies have been carried out to investigate the performance of masonry-infilled RC frames under in-plane lateral loadings.

My study is to create a numerical model of the behaviour of existing masonry-infilled RC frame that was studied experimentally at the University of Patra for a PhD study.
The objective of this study was to identify suitable numerical constitutive models of each component of the structural system to create a numerical tool to represent the masonry infill's in-plane behaviour by accounting the frame-infill separation.
In DIANA finite element analysis (FEA) software, a 2D masonry-infilled RC frame was developed and a structural linear, eigenvalue and nonlinear cyclic analysis were performed.
It is a 2:3 scale three-story structure with non-seismic design and detailing, subjected to in-plane cyclic loading through displacement control analysis.
The proposed meso-model for masonry-infilled RC frame was implemented in DIANA using available materials, sections and elements commands.
The material models that were selected for the concrete and steel reinforcement were the Maekawa–Fukuura Concrete Model and Menegotto–Pinto model.
In addition the material models that were selected for the masonry infill wall and for the interface between the wall and the RC frame were the New Engineering Masonry model and the Coulomb Friction model respectively.
The numerical model results were compared and represented an agreed correlation to the experimental ones through a cyclic nonlinear analysis. It was found that the numerical model has the capability to predict the initial stiffness, the ultimate stiffness, the maximum shear-force capacity, cracking patters and the possible failure mode of masonry-infilled RC frame.
The study concludes that this model is a reliable model of the behaviour of masonry-infilled RC frame including the frame-infill separation (gap opening).

Vibration control in industry

Wouter Meijers, Royal HaskoningDHV, the Netherlands

Summary
For the refurbishing of an industrial facility, several new machines will be placed on an existing concrete frame. The existing concrete frame was initially not designed for these new machines. To avoid dynamic issues such as nuisance vibrations, malfunction of the machines, damage or even failure of the production hall's structural elements, the new situation was analysed in the frequency domain with DIANA 10.2. Both the concrete frame and the machines were modelled.
Each machine has several rotating elements that can exert a dynamic load on the structure if there is a small eccentricity. In total, there are 58 rotating elements, which vibrate in a different frequency depending on the operating speed of the machine. Each dynamic load is thus unique and was analysed with a separate direct response analysis. This led to a large data set, which was combined and analysed with Python.
Results from the direct response analysis combined with eigenfrequency analysis showed that resonance occurs in the structure, resulting in vibrations that are a factor 2.5 above the specified limit of 1.12 mm/s RMS. Resonance occurs because the bandwidth of frequencies for the loading is close to the natural frequency of the structure itself.
Adjustments to the concrete frame were modelled to shift the eigenfrequency outside the bandwidth of frequencies of the dynamic load. The ability to quickly analyse many situations by using Python resulted in the conclusion that no practical adjustments to the concrete frame could shift the eigenfrequency enough to reduce the

vibrations. By adding a tuned mass damper to the machine, the vibrations were eventually significantly reduced and the specified criteria were met.

THEME: Shear Force behaviour

Resistance of shear tension cracks in prestressed beams

Cor van der Veen, S.J. Kroeze, M.A. Roosen and M.A.N. Hendriks, Delft University of Technology, the Netherlands

Summary
The aim of this study is to investigate how the shear resistance of prestressed beams with respect to the formation of the first shear tension crack can be determined? In the present Eurocode this type of calculations is based on the principal stress which equals the concrete (design) uniaxial tensile strength. Point of departure are the flexural and shear stresses which both are applied to calculate the (simplified) principal stresses.
In this analytical method the vertical stress component and the effect of the disturbed areas (near support and applied point load) in the prestressed beams are not taken into account. Furthermore, it appears to be very important whether the prestressed beam, experimentally loaded by a point load, was cracked in bending or not before the first shear tension crack occurs. Therefore, it was decided to analyse 29 prestressed beams, experimentally loaded by a point load, in which shear tension cracks were observed.
A linear finite element analysis (plane stress) was performed for all experiments in order to investigate the effect of a) the vertical stress component, b) disturbed areas, c) cracked or uncracked in bending on the principal stress at the instance of the formation of the first shear tension crack.
Moreover, different strength criteria's are considered i.e. the uniaxial tensile strength and the bi-axial concrete tensile strength in which the effect of the bi-axial compressive stress on the tensile strength is taken into account.
The found results will be presented and conclusions will be drawn if the Eurocode approach is conservative or not and if a more suitable prediction for shear tension is possible.

A comparative analysis on the Long-Term performance of a T-shaped girder by using 1D, 2D and 3D FE approaches

Emanuele Canestro[1], Alfred Strauss[2], Helder Sousa[1]
[1] University of Surrey, United Kingdom
[2] University of Natural Resources and Life Sciences, Austria

Summary
In today's world, progress towards sustainable transportation networks is a priority where demands for a prolonged life-time, sometimes more than 100 years, is an important issue. For the particular case of prestressed concrete bridges, the long-term assessment plays a crucial role in order to better plan the maintenance requirements in accordance with future demands. The time-history, the construction phases, the mechanical properties of concrete and the effective loads applied are crucial inputs for a deeper and accurate predictions based on FE models.

Further to a laboratorial test on a scaled T-shaped girder, this work aims to promote a comparative analysis on how different FE approaches to simulate the beam behaviour leads to different long-term predictions. More precisely, these FE approaches considered (i) beam elements, (ii) shell elements and (iii) solid elements. Monitoring data will support a discussion on the accuracy of each approach.
Conclusions from this discussion also aims, as a marginal contribution, to better understand the essential requirements for the long-term performance of prestressed concrete bridges towards their lifetime.

System behaviour in concrete T-beam bridges

Sebastiaan Ensink, Delft University of Technology, the Netherlands

Summary
In the Netherlands, approximately 66 prestressed concrete T-beam bridges with cast-in between decks mainly built around the sixties are still in service.
Upon assessment, the strength of these bridges is often too low. This is partly due to the increased traffic loads and partly due to the changes in codes, for example the Eurocode provisions for shear.
However, for these types of bridges several mechanism could possibly contribute to a higher load bearing capacity that are usually not taken into account.
One of the possible beneficial mechanism is compressive membrane action (CMA), in transverse direction, in the concrete deck slab.
Another potential mechanism is arch action, in longitudinal direction, in the T-beam.
To explore these mechanism, and the ultimate load capacity, an existing simply supported multi-span T-beam bridge was tested in full size collapse tests. In total seven experiments were carried out using a single point load placed on the T-beam.
To analyze these tests a nonlinear finite element model of the complete bridge is being developed using DIANA and Python code.
For the assessment of existing bridges in the Netherlands with nonlinear finite element models usually a single beam is modelled.
However, with a full bridge model it becomes possible to analyse the so called 'system behaviour' of the bridge with the aforementioned mechanism. Ultimately, the goal of this research is to improve the calculation methods for the existing T-beam bridges in the Netherlands.

THEME: Time dependency & Guidelines

Numerical simulation of massive concrete structures during construction

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Summary
In mass concrete, thermally induced stresses are a main cause of cracking. At early ages, the heat released by the cement hydration promotes temperature gradients between the core and the surface regions and thus considerable tensile stresses may

appear due to differential volumetric deformations and to additional external restraints.
In this context, the authors present some realistic simulations of the thermo-mechanical behaviour of massive structures (such as hydroelectric plants and arch dams) during the construction phase.
The numerical simulations were performed by means of DIANA; the thermal problem was reproduced using a transient model, which encompasses the heat generated by cement hydration, the heat transfers to the environment, and the effect of cooling pipes; for the mechanical problem, the time-dependent behaviour of concrete was represented by the theory of viscoelasticity, taking into account the maturity effects.
Additionally, the numerical study of an arch dam under normal operating scenarios is also presented.

Demonstration of the guidelines for nonlinear finite element analysis for three prestressed concrete beams

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Summary
The Ministry of Infrastructure and Water Management (Rijkswaterstaat) intends to commission the assessment of the shear capacity of a number of concrete bridges, using nonlinear finite element analysis (NLFEA) and the RTD1016 guidelines for nonlinear finite element analysis of concrete structures .
The bridges under consideration are constructed with prestressed concrete girders.
This work investigates how well the failure process and the maximum load capacity of three pre-selected experiments with prestressed concrete girders can be predicted by NLFEA.
The analyses are performed according to the RTD1016 guidelines.
Furthermore, the analyses are performed as ‘blind predictions’, meaning that the analyst does not have prior knowledge of the experimental results.
In general, the failure mechanisms and the sequence of events are well simulated by the numerical analyses.
The presentation will give an outline of the experimental setup and results, the analytical analyses, the nonlinear finite element analyses and the application of the safety formats for nonlinear finite element analyses.
Finally, the concluding remarks will be discussed as well as recommendations for the RTD guidelines.

THEME: Dynamics II

Ground vibration study (Underground railway transport System) : Modelling approach, challenges and findings

Nischal Sehrawat, Witteveen+Bos Engineering and Consulting, the Netherlands

Summary
Train induced vibrations have been getting a lot of attention lately as modern transportation system expands.
A study on the same was carried out by Witteveen+Bos recently using DIANA finite element package.
Therefore we would like to share our modelling approach(es), challenges, findings, shortcomings and future recommendations.
The presentation will focus upon different aspects of time and frequency domain methods, simulating infinite domain lengths using PML as well as Liesmer Kuhlmeyer layers and using embedded beam elements.

Static and dynamic 3-D FEM analysis of a 150-m high asphaltic-concrete core rockfill dam under construction in a high seismic area

Anton Tzenkov, Stucky SA, Switzerland

Summary
A 150 m tall asphaltic-core embankment dam is being constructed for production of hydropower in a mountainous region characterised with steep valley walls and complex foundation conditions. The shells of the dam are built of alluvium fill and rockfill.
The present contribution provides an overview of the verification of the design of the dam.
Both static and seismic load combinations have been investigated by means of 3D FEM analysis performed using DIANA.
Emphasis is made on the stress and strain analysis being crucial for the design of the horizontally curved and vertically inclined asphaltic core.
Furthermore, the seismic analysis and its results are highlighted, since the dam site is located in an area of very high seismic hazard.
The contribution is concluding with lessons learned from the finite element analysis of such type of dam.

DIANA Users Wishes, DIANA New Features & Case Study Award

3.5 Technical lectures December 11th, 2018

Finite Element Modelling of ASR Affected Reinforced Concrete Beams Based on Realistic Pre-damage

Niels Kostense, Arcadis

A new type of finite element model, called the double mesh model is proposed in this thesis. With the level of free expansion as the input, the model is able to simulate the restrained ASR expansion by taking into account the effects of physical restraints. The retrained ASR expansion in reinforced concrete cubes and beams are simulated. Numerical expansion obtained from this new model showed a good agreement with the experiments.
Then, the expanded beams are loaded in shear to simulate the shear behaviour of ASR affected concrete beams. In this new model, ASR damage is embedded through a realistic simulation of ASR expansion. Whereas, in the traditional method, ASR damage is taken into account by a direct reduction of the input material properties and the expansions are not simulated. According to the data obtained from experiments, even though the mechanical properties of concrete are reduced due to ASR, but this not necessarily leading to the decrease in the capacity of the beams. In some experiments the change of failure mode is observed where the unaffected beam failed in shear but the ASR affected one failed in bending. This is because in ASR affected beams, the increase in shear load results in the enlargement of the existing ASR cracks instead of generating new diagonal shear cracks, and thus the shear failure is prevented. In the pre-cracking method, the effects of ASR cracks on the capacity and the failure mode are taken into account in the model since the ASR cracks are simulated. Whereas, in the traditional method, where the ASR damage is included through the reduction of the input properties, the effects of ASR cracks are not able to be reflected in the model.

Advanced re-examination of Bubbledeck floor with DIANA

Kris W. Riemens, ABT

A bubbledeck floor is a concrete floor structure consisting of a prefab bottom layer on which plastic spheres are placed to reduce the dead weight. After installing the prefab floor and the spheres, concrete is poured between the spheres, finished by the top floor layer.
Following the collapse of a parking garage of Eindhoven Airport in May 2017 where the bubbledeck floor were also applied, the question arose whether existing structures with such type of floors are sufficiently safe.
Subsequently, the Ministry of Interior Relations issued the following information document: "Research on the structural safety of wide slab floors in existing buildings completed after 1999" (dated 05-10-2017).
It has been established that several spherical flooring floors in existing buildings in the Netherlands do not have the bearing capacity to carry the occurring loads on which they were originally designed. To gain insight into the structural behavior of bubbledeck floors and to setup the risks, ABT set up advanced nonlinear FE models in DIANA with 3D solid elements. It is shown that the bearing capacity for specific configurations is indeed significantly lower than the original calculated design capacity. Consequently, DIANA models have been built up with reinforcement solutions that can be used to increase the bearing capacity of the different floors.

Automatic calculation Unity Checks for shear force and bending moment for bridge decks from most unfavourable load combinations

Chantal Frissen, DIANA FEA

Since 2010, the DESIGN application is available within DIANA for the purpose of determining the reinforcement configuration for at least bridge decks. This application DESIGN is now further expanded in DIANA 10.3 and applies to both shell and 3D solid FE models.
The cross-section bearing capacity for shear force and bending moment are determined. Besides, the most unfavorable load combinations are automatically determined so that the maximum shear force and reinforcement moments are obtained. The corresponding load cases of the most unfavorable load combinations can also be displayed clearly.
By presenting the results as Unity Check, it can easily be determined whether a new or existing bridge suffices or not. In addition, these Unity Check results can be displayed in a contour plot where the locations of the bridge deck does not comply can be made transparent. The numerical value of the UC gives an indication of a possible reinforcement loss.
A demo will also be given in which a skewed slab with DESIGN is analyzed.

4. Financial aspects 2018

SAMENVATTING BIJ FINANCIEEL JAARVERSLAG 2018

Balans	31 december 2018	1 januari 2018
ACTIVA		
Vaste activa	€ -	
	€ -	
Vlottende activa		
Vorderingen	€ 2 297	€ 5 654
Liquide middelen	€ 20 836	€ 26 298
	€ 23 133	€ 31 951
Totaal activa	€ 23 133	€ 31 951
PASSIVA		
Eigen vermogen	€ 22 341	€ 32 015
	€ 22 341	€ 32 015
Kortlopende schulden	€ 791	€ 47
	€ 791	€ 47
Reserveringen en voorzieningen	€ -	
	€ -	
Totaal passiva	€ 23 133	€ 32 062

Winst- en verliesrekening 2018	debet	credit
Netto omzet	€ -	€ 7 721
Kostprijs van de omzet	€ 8 488	€ -
Bruto omzetresultaat	€ 767	€ -
Personeelskosten	€ 5 740	€ -
Algemene beheerskosten	€ 3 185	€ -
Financiële baten	€ -	€ 18
Financiële lasten		
Resultaat uit gewone bedrijfsvoering	€ 8 907	€ -
Buitengewone baten en lasten	€ -	€ 0
Resultaat (verlies)	€ 9 674	€ -

Penningmeester DOV:	Accordering kascommissie:	
datum: 29 maart 2019	datum: 12-05-2019	datum: 12 april 19
Coen van der Vliet	Kris Riemens	Johan de Boon

5. Publication list 2018

ABT

Chris van der Ploeg (ABT): De Keuze Voor Parametrisch Ontwerpen, CEMENT 7, 2018.

Michael Menting (ABT): Revolutionair Ontwerp Ultraslanke Trap, CEMENT 3, 2018.

Arcadis

Hikmet Uysal (Arcadis): Sterker dan verwacht, CEMENT 2, 2018

Chen, Xin. Finite Element Modelling of ASR Affected Reinforced Concrete Beams Based on Realistic Pre-damage. Master Thesis. Delft University of Technology, 23 October 2018.

Chalmers University of Technology, Sweden

Gottsäter, E., Larsson Ivanov, O., Molnár, M., Plos, M. (2018): Validation of Temperature Simulations in a Portal Frame Bridge, Structures 15, pp. 341-348

Shu, J., Bagge, N., Plos, M., Johansson, M., Yang, Y., Zandi, K. (2018): Shear Capacity of a RC Bridge Deck Slab: Comparison between Multilevel Assessment and Field Test, Journal of Structural Engineering (United States) 144(7)

Robuschi, S., Lundgren, K., Fernandez, I., Zandi, K., and Flansbjer, M.. "Anchorage capacity of corroded smooth reinforcement bars in existing rein-forced structures". In: Proceedings of the 12th fib International PhD Symposium in Civil Engineering(2018), ISBN 978-80-01-06401-6, Czech Technical University in Prague, Prague , 29-31 August, pp. 1039-1046.

Delft University of Technology

Srinidhi B.R., TU Delft (2018): A Hyperbolic Model For Degradation In Tension Mode-I Fracture Of Masonry, Master Thesis.

E. O. L. Lantsoght (Universidad San Francisco de Quito); A. de Boer; C. van der Veen & D. A. Hordijk (TU Delft): Modelling Of The Proof Load Test On Viaduct De Beek, Computational Modelling of Concrete Structures - Meschke, Pichler & Rots (Eds) - Euro-C 2018.

M Pari & J G Rots (TU Delft); M A N Hendriks (TU Delft)**:** Non-Proportional Loading For 3d Stress Situations In Sequentially Linear Analysis, Computational Modelling of Concrete Structures - Meschke, Pichler & Rots (Eds) - Euro-C 2018.

Reignard Tan, Max A. N. Hendriks, Terje Kanstad (NTNU/TU Delft) (2018): An Investigation Of The Strain Profile Over The Cover In Reinforced Concrete Elements Subjected To Tension, Fib Congress, 7-11 October 2018, Melbourne, Australia.

A. de Boer; M. A. N. Hendriks, C. van der Veen (TU Delft); B Belletti (Univ. Parma): Organising An Internaitonal Blind Prediction Contest For Improving A Guideline For The Nonlinear Finite Element Analysis Of Concrete Structures, Euro-C 2018.

Morten Engen (Multiconsult/NTNU); Max A. N. Hendriks (NTNU/TU Delft); Jan Arve Overli (NTNU); Erik Aldstedt (Multiconsult): Reliability Assessments Of Large Reinforced Concrete Structures Using Nonlinear Finite Element Analyses: Challenges And Solutions, Springer International Publishing AG 2018 D.A. Hordijk and M. Luković (eds.), High Tech Concrete: Where Technology and Engineering Meet, DOI 10.1007/978-3-319-59471-2_193.

University of Sao Paulo, Brasil

Gabriela Bandeira de Melo Lins de Albuquerque (Universidad Sao Paulo) (2018): Analise Numerico-Experimental De Vigas De Concreto Armado Com Restricoes Axial E Rotacional Em Situacao De Incendio.

Universidade Estadual de Campinas, Brasil

Rafael A Sanabria D, Leonardo H. B. de Oliveira, Leandro Mouta Trautwein, Luiz Carlos de Almeida (UNICAMP); Antonio Carlos dos Santos (Univ. Federal de Uberlandia): Aspects Of Finite Element Modeling Of Punching Shear Behavior Of Reinforced Concrete Flat Slabs, Latin American Journal of Solids and Structures, 2018, 15(10), e120.

Opole University of Technology, Poland

Tomasz Maleska, Damian Beben (Opole Univ. Technology): Behaviour Of Corrugated Steel Plate Bridge With High Soil Cover Under Seismic Excitation, MATEC Web of Conferences 174. 04003 (2018) ECCE 2018.

Connor Consulting Ltd & others, New Zealand

Mohammad Soleymani Ashtiani (Connor Consulting Ltd), Rajesh P Dhakal (Univ. Canterbury), Allan N Scott (Univ. Canterbury): Cyclic Response Analysis Of High-Strength Self-Compacting Concrete Beam-Column Joints: Numerical Modelling And Experimental Validation, Bulletin of the New Zealand Society for Earthquake Engineering, Vol. 51, No. 1, March 2018.

Fluminense Federal University, Brazil

V. D. Barbosa, N. S. Galgoul (Fluminense Federal University, Brazil): Designing Piled Foundations With A Full 3d Model, The Open Construction and Building Technology Journal, 2018, 12, 65-78.

US Department of the Interior - Bureau of Reclamation: Evaluation Of Numerical Models And Input Parameters In The Analysis Of Concrete Dams, USSD Workshop, May 2018.

University of Florida, USA

Sangyoung Han (Univ. Florida), Sanghyun Chun, Kukjoo Kim, Adrian M Lawrence, Mang Tia: Evaluation Of Soil Insulation Effect On Thermal Behavior Of Drilled Shafts As Mass Concrete, Han et al., Cogent Engineering (2018), 5: 1468202.

Ghent University, Belgium

Kevin Pynckels - Ghent University: Modelling Creep And Creep Recovery Of T-Shaped Concrete Beams Using NLFEA: Validation Based On Experimental Investigations, Master Thesis 2018.

VolkerWessels Infrastructure

Guido Bongers, Remco Mast (VolkerInfra): Modulair Parametrisch Ontwerpen, CEMENT 6 2018.

University of Dresden, Germany

Alaleh Shehni, Ulrich Haussler-Combe (Univ. Dresden): New Approach On Discretization Methods For Mesoscopic Study Of Concrete Structures, 6th European Conference on Computational Mechanics, August 2018.

DIANA FEA BV

Pim van der Aa, Ab van den Bos (DIANA FEA): Parametrisch Ontwerpen in DIANA, CEMENT 6 2018.

California Institute of Technology, USA

Hamed Ebrahimian (California Inst. Technology), Rodrigo Astroza (Univ. Los Andes); Joel P. Conte, Tara C. Hutchinson (Univ. California at San Diego): Pretest Nonlinear Finite-Element Modeling And Response Simulation Of A Full-Scale 5-

Story Reinforced Concrete Building Tested On The Nees-Ucsd Shake Table, J. Struct. Eng., 2018, 144(3): 04018009.

Tokyo Electric Power Services Co Ltd & others, Japan

C. Miura (Tokyo Electric Power Services Co Ltd); Y. Ariga (Hirosaki University); K. Inoko (Waterworks Bureau, Sapporo); K. Takehara (JIP Techno Science Corporation): Seismic Response Of Large Undergound Purification Reservoir Induced By Earthquake Motion In The Short - Axis Direction, Journal of Japan Association for Earthquake Engineering, Vol 18, No 3, 2018.

Delft University & others

F. Ferretti & C. Mazzotti (Univ. Bologna); R. Esposito & J. G. Rots (TU Delft): Shear-Sliding Behavior Of Masonry: Numerical Micro-Modeling Of Triplet Tests, Euro-C 2018

University of Valencia, Spain

Eduardo J. Mezquida-Alcaraz, Juan Navarro-Gregori, Juan Angel Lopez, Pedro Serna-Ros (Instituto de Ciencia y Technologia del Hormigon (ICITECH)), Universitat Politecnica de Valencia: Validation Of A Non-Linear Hinge Model For Tensile Behavior Of UHPFRC Using A Finite Element Model, Computers and Concrete, Vol 23 No.1.

BAM Infra & others

Johan Bolhuis (BAM Infra); Hans Laagland, Paul Teeuwen (Witteveen+Bos); Jan Blaakmeer (Saint-Gobain Weber Beamix): Wereldprimeur Met Geprinte Brug, CEMENT 2, 2018.

Royal HaskoningDHV

Koen van Vlegen, Robin van der Have, Gijs Joosen, Pieter Schreurs (Royal HaskoningDHV): Possibilities of digital engineering(Mogelijkheden Van Digital Engineering), CEMENT 7 2018.

TNO Applied Geosciences, the Netherlands

Brunner, L., Koenen, M., Orlic, B., Wollenweber, J. 2018. A Bayesian belief network to assess risk of CO_2 leakage through wellbores. *14th International Conference on Greenhouse Gas Control Technologies*, GHGT-14, 21-25 October 2018, Melbourne, Australia.

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Orlic, B., Koenen, M., Neele, F. 2018. Effects of batch-wise CO_2 injection on well integrity: a numerical model of cement interface debonding. Extended abstract. *International Symposium on Energy Geotechnics,* SEG-2018, 25-28 September 2018, Lausanne, Switzerland.

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