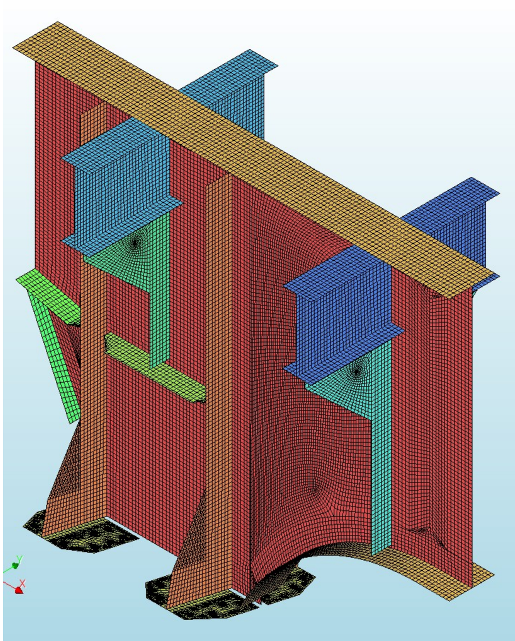
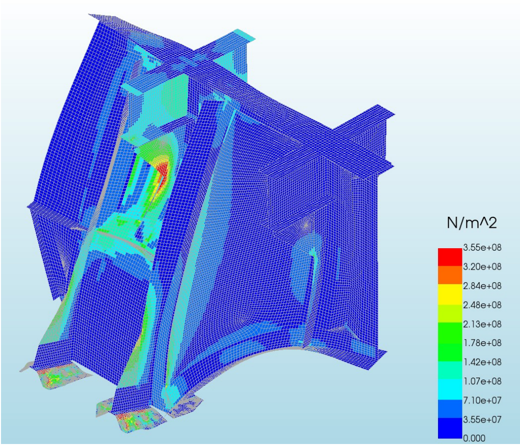
DIANA Users Association

Annual report 2016





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

Annual Report 2016

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 2016

During this reporting year, the Executive Committee consisted of:

Chairman:	Dr.ir. Ane de Boer, Centre for Infrastructures, Ministry of Infrastructures and the Environment, Utrecht
Secretary/ Treasurer:	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 11th International DIANA Users Meeting in Lausanne, Switserland.
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. Preparation of general and technical meetings.
6. Association finance.
7. 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 2016 there have been held two general meetings and two technical meetings (lecture evenings).

3.2 Technical lectures March 24th, 2016

Renovation of the Waalbrug Nijmegen

Ernst Klamer, RHDHV

A lot of re-examinations in all sorts of variations have been executed to both maintain and expand the current Waalbrug. Different facets will be further discussed during this presentation.

Stochastic structural analysis of corroded RC structures

Arthur Slobbe, TNO Structural Reliability

Reinforcement corrosion in reinforced concrete structures has been a subject of research for many years at many institutions. The combination with stochastic calculations is one of those. In this presentation, the approach and some intermediate results will be further explained.

Random fields for non-linear finite element analysis of reinforced concrete

Robin van der Have, former: TU Delft/DIANA FEA BV, now: RHDHV

To execute stochastic analysis is one thing, however the input for a calculation of the variable parameters for the physical properties in the form of random fields is the next step. A few methods have been researched and result in a side by side setting. Also the availability for the engineering practice will be presented.

Stirrup reinforcement expansion in FE models with beam or shell elements

Gerd-Jan Schreppers, DIANA FEA BV

Beam and shell elements got an expansion in the form of bringing in stirrups, which can also be taken into account in a nonlinear analysis. This expansion enlarge the use and speed of modelling in beam and shell elements to reach the ultimate limit state load of a structure.

Validatione/verification NLFEA Guideline

Max Hendriks, TU Delft/ NTNU

The NLFEA Guideline was published for the first time in 2012 for only beam structures. In the meantime, a new version has been published in which the slab structures are incorporated Thereby, the most common structures have been covered by this version of the NLFEA Guideline 2.1. That was also the reason to set up reports in which the simulations, that have been executed for validation/verification, have been incorporated to come to a verified guideline. These reports are divided in Parts, like reinforced beams, prestressed beams and slabs. Additional to the 3 reports, there is a report with the overall results of the simulations sofar. An insight in the different simulations will be given.

3.3 International DIANA Users Meeting Autumn 2016

An international meeting was scheduled in Lausanne Switzerland, École Polytechnique Fédérale de Lausanne (EPFL), 27-28 October 2016. Unfortunately there were not enough submitted abstracts, so the meeting was cancelled.
In October 2017 there will be organized another International DIANA Users Meeting.

3.4 Technical lectures December 6th, 2016

Reliability finite element analysis of reinforced concrete beams without shear reinforcement

Panagiotis Evangeliou, DIANA FEA BV / Delft University of Technology

In the modern structural engineering field, the significant influence of inherent uncertainties on system behavior constitutes the necessity of a stochastic approach to the engineering problems. However, the treatment of these uncertainties by the traditional deterministic engineering approach is questionable. The notion that this approach can be considered representative of all the possible scenarios of structural response, while based only on extreme and mean realizations of the specific parameters, is not true in most cases. Consequently, the deterministic approach cannot lead to rigorous assessment of the structural reliability. This possibility is, on the other hand, provided by stochastic approaches at the expense of increased solution system complexity and, consequently, increased computational effort.
The deterministic structural analysis field is, today, dominated by the finite element method implemented with finite element analysis software packages. In the case of reinforced concrete structures, a highly nonlinear response is exhibited due to extensive cracking, especially in the case of shear failure. The analytical models provided by the modern codes cannot realistically approximate this highly nonlinear response and, therefore, resort to a rather conservative approach. As a result, to examine the deterministic response of reinforced concrete structures, the implementation of nonlinear finite element analysis is necessitated.
Furthermore, the structural reliability assessment is currently carried out with semi-probabilistic approaches. However, the specific methods provide a conservative and limited approach to reliability assessment. On the other hand, high accuracy full-probabilistic approaches, such as Monte Carlo, are not applicable in combination with the computationally expensive finite element analysis due to the enormous

computational cost required. However, during the last decade, the probabilistic analysis has advanced with the development of adaptive response surface methods, which significantly reduce the computational effort while maintaining a high accuracy. Consequently, these methods provide the required framework for coupling of nonlinear finite element analysis with full-probabilistic analysis; leading, hence, to rigorous assessment of the structural reliability. The coupling of finite element analysis with adaptive response surface methods is implemented in DIANA FEA software under the probabilistic module named PROBAB. In this study, PROBAB is studied and applied for the structural reliability assessment of reinforced concrete beams with failure mode transition propagated by material and model uncertainties. The examined reinforced concrete beams are part of an ongoing experimental project in TU Delft. The selected experimental data reflect the effect of the inherent material uncertainty to both the capacity and failure mode, flexural or shear, of the beam. Consequently, it is attempted to quantify this effect in terms of structural reliability by means of probabilistic nonlinear finite element analysis.
To generate unbiased results, a robust finite element model is developed; a model that, for each realization of the stochastic material parameters, provides sufficient accuracy in the assessment of both the structural capacity and the failure mode. To this end, explicit studies of the material constitutive models, the loading conditions, the finite element mesh, and the numerical analysis scheme are undertaken. For this explicit study the selected experimental results and the existing analytical models are utilized. Eventually, the finite element model is calibrated and used as a "virtual experiment" for the probabilistic finite element analysis. The probabilistic analysis is focused on the resistance side of the structure, affected by the material uncertainty. For deterministic action effects, the reliability index and design point are determined, and the probability of occurrence of each failure mode is computed. A parallel system of generated response surface functions is tested as a more automatized procedure for computing the probability of occurrence of each failure mode. A parametric study is carried out to realize the effect of the specified probabilistic analysis parameters. The sensitivity of the structural response to the assumed stochasticity of the material parameters is derived.

How much additional reinforcement is required?

Subtitle: Case study to determine required reinforcement to withstand blast load in the Ketheltunnel

Ricky Tai and Coen van der Vliet, Arcadis NL

Many of the tunnels in the Netherlands are not designed to withstand a blast load due to an accident with a LPG truck. Partially this is due to the expectation of highly uneconomical designs of tunnels when considering this load. The Rijkswaterstaat, part of the Dutch ministry of infrastructure and environment, and owner of many tunnels in the Netherlands, wanted to gain more insight into the costs of including this blast load in the design of tunnels. Hence, Arcadis was asked in a case study to determine the additional reinforcement required when this load was considered in the current design of the existing Ketheltunnel.

Prior to the detailed analyses two simple calculations have been performed. In these calculations the tunnel section was schematised as a beam structure. For the first simple calculation the beams were converted into equivalent mass-spring system with a single degree of freedom. With this model the eigenfrequencies and maximum deflections have been approximated. The second simple calculation is based on the development of beam-structure-mechanisms via the formation of plastic hinges. This calculation is based on the energy balance and describes the relation between the deformation of the hinge, the plastic moment capacity of the beam, and the blast load. Valuable information about the effectiveness of adding reinforcement and other feasible design considerations have been gained through this simple calculation.

After the simple calculations, a 2-D model with plane stress elements has been modelled into the finite element software Diana FEA. An initial analysis with linear-elastic material properties provided a design with massive amounts of reinforcement that would not suffice to the detailing requirements. A sequential analysis with non-linear material properties and design considerations has been made to determine the required reinforcement.

Steel–Concrete–Steel Sandwich Immersed Tunnels For Large Spans

Kubilay Bekarlar, Marcel t'Hart, RHDHV

Traditional reinforced concrete tunnels with a large span have a limit for the behavior in the transversal direction. There was insufficient knowledge in the behavior regarding whether the steel-concrete-steel sandwich immersed tunnels can offer a solution for tunnels with an extreme large span. Furthermore, it has been researched how internal powers / pressure will distribute over a steel-concrete-steel sandwich immersed tunnel for an extreme span, called the structural response.
For a detailed analysis of the distribution of intern power / pressure, the finite element method model has been used.

Modelling damaged concrete based on an extension of the smeared crack concept

Raghavan, V.[1], Slobbe, A.T.[2], Schreppers, G.M.A.[3], Burggraaf, H.G.[2]
[1] *MSc student, TU Delft*
[2] TNO Structural Reliability*, Delft*
[3] *DIANA FEA BV, Delft*

The lecture concerns an ongoing research on the modelling of damaged concrete in the framework of the reexamination of the existing concrete constructions. Existing concrete constructions can be damaged due to occuring loads and affected mechanisms(for example corrosion of reinforcement) For an accurate reexamination of a structure, occurring damage must be considered. The local material behavior will be influenced, which results in a possible change of the structural behavior.
The modelling of the specific processes which causes damage can be difficult, because:
(i) it can contain complex phenomena(physical and electro-chemical) on microscale,
(ii) it can require a lot of calculations (CPU power) and
(iii) the required damage data is often not accessible.
Consequently the step to full fill an analysis of the structural behavior often turns out to be too ambitious.
An alternative approach is to consider damaged concrete as "new" material with the presence of damage as a starting point. For this, the smeared crack concept approach in DIANA has been expanded with the possibility to take over initial damage.

In order to take into account the uncertainties in the size and the spatial distribution, these specific input parameters can be considered as a random field.
This modelling approach of damaged concrete is validated with the help of an experiment on an undamaged and a damaged concrete girder(experiments of Maekawa and Pimanmas)
Based on a consideration of the bearing capacity and the failure mechanism conclusions will be drawn about the effectiveness of this expanded concept.

4. Financial aspects 2016

SAMENVATTING BIJ FINANCIEEL JAARVERSLAG 2016

Balans	31 december 2016		1 januari 2016	
ACTIVA				
Vaste activa	€ -			
		€ -		
Vlottende activa				
Vorderingen	€ 797		€ 5 585	
Liquide middelen	€ 32 371		€ 28 657	
		€ 33 169		€ 34 243
Totaal activa		**€ 33 169**		**€ 34 243**
PASSIVA				
Eigen vermogen	€ 32 361		€ 32 884	
		€ 32 361		€ 32 884
Kortlopende schulden	€ 808		€ 1 359	
		€ 808		€ 1 359
Reserveringen en voorzieningen	€ -			
		€ -		
Totaal passiva		**€ 33 169**		**€ 34 243**

Winst- en verliesrekening 2016	debet	credit
Netto omzet	€ -	€ 4 200
Kostprijs van de omzet	€ 1 719	€ -
Bruto omzetresultaat	**€ -**	**€ 2 481**
Personeelskosten	€ 2 498	€ -
Algemene beheerskosten	€ 507	€ -
Financiële baten	€ -	€ -
Financiële lasten		
Resultaat uit gewone bedrijfsvoering	**€ 3 005**	**€ -**
Buitengewone baten en lasten	€ -	€ 0
Resultaat (verlies)	**€ 523**	**€ -**

Penningmeester DOV:	Accordering kascommissie:	
datum: 8 mei 2017	datum: 21 april 2017	datum: 21 april 2017
Coen van der Vliet	Sander Meijers	Kris Riemens

5. Publication list

ABT

M. Menting, K. Riemens, P. de Vries, M. Attahiri, Bruggen voor het leven, Cement 2016/6

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Blomfors, Mattias; Zandi Hanjari, Kamyab; Lundgren, Karin: Development of engineering assessment method for anchorage in reinforced concrete. Nordic Concrete Research

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Orlic, B. 2016. Rock mechanics for deep subsurface geo-energy production and storage. Proceedings of the XVth Symposium on Engineering Geology and Geotechnics. Belgrade, 22-23 September 2016.

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Behaviour of Composite Laminated Shell Structures; Braunschweig, Germany, 03/2015.

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E. Goulas, Design of Double-Curvature Arch Dams in Terms of Geometric and Stress Constraints by Using Script-Based Finite Element Modelling, Master Thesis, May 2016, Available from DIANA FEA BV (13MB).

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Ministry of Infrastructure and the Environment

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