

DIANA Users Association

Annual report 2024

20-6-2025

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

Annual Report 2024

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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

During this reporting year, the Executive Committee consisted of:

Chairman: Dr.ir. A. de Boer, Ane de Boer Technisch Advies

Treasurer/ Secretary: Ir. C. v.d. Vliet, Arcadis Nederland BV

Committee member: Ir. R. Tai, 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 14th International DIANA Users Meeting in Valencia, Spain.
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 Activities

3.1 General

The Association has the intention to organize a general meeting of members twice a year, followed if possible by a technical meeting (lectures). In 2024 there have been held one general meetings and one technical meeting (lecture evening).

3.2. Technical lectures February 7th, 2024

Approach *Fib*/TU Delft - BEAM BLIND PREDICTION CONTEST

Krishna Ajithkumar Pillai, ABT

The research over the past decades in the field of concrete structures has greatly expanded the modelling techniques of concrete structures in terms of both numerical and analytical models. Blind prediction contests using complex experiments have been recognized as a useful tool to verify the various models and to possible improvements. For that reason, at TU Delft, we have been organizing a series of blind prediction contests since 2014. The selection of the experiments for the contests is based on the principle that they should have the configurations that can reflect a typical construction type, and, at the same time, the type of experiments should not be commonly reported in literature. The past four contests were very well received and were used as valuable inputs of applications such as improving the modelling strategies in the Dutch guidelines for non-linear analysis of concrete structures.

As the newest edition of the blind prediction contest, we are proposing **to predict two upcoming experiments on two full scale precast continuous concrete inverted T beams**. This is a part of the research program on safety assessment of existing precast concrete bridges, financially sponsored by Rijkswaterstaat, Dutch Ministry of Infrastructure and Water Management. The specimens are designed to represent typical multi-span precast girder bridges. They were made by precast inverted T beams and made continuous on-site using a cast-in-situ topping layer. Many details of this type of structures do not fulfil the requirements of the modern design codes anymore and are often seen in the existing structures in many countries in the world, like having very low shear reinforcement ratio. And because of the complex construction process, it is challenging to predict their resistance with generally available models (both analytically and numerically). The details of the two experiments can be find at the [experiments](#) description page.

Nonlinear analysis of concrete bridges and viaducts with dapped-ends

Manimaran Pari, TNO

Existing concrete bridges and viaducts with dapped-ends (tanden en nokken) in the Netherlands have gained attention in the recent past over their structural performance. A distinctive feature of these structures is that the main suspension reinforcement (ophangwapening) is bent away from the dapped-end. This detail has sparked discussions about whether the traditional assessment methods based on static equilibrium could reliably predict a potential brittle shear failure. For this instance, Nonlinear Finite element Analyses (NLFEA) can be used to gain insight on the structural behaviour, and potentially offer an alternative to the traditional assessment methods. However, given the impact of modelling choices on the predicted failure mechanism, there is a need for a robust and validated modelling strategy specifically for dapped-end beams in the Dutch context. To this end, initial steps have been taken through the assessment of two benchmark experiments representative of the Dutch

dapped-end beams using NLFEA in DIANA. The findings of this study shall be presented and they reaffirm the importance of a robust and validated modelling strategy.

Nonlinear reassessment of prestressed T-girder bridge with surprising outcomes

Coen van der Vliet, Arcadis

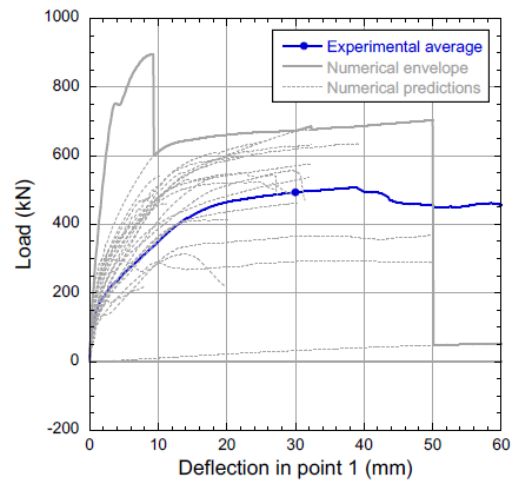
The Amsterdamse brug is a steel tied arch bridge crossing the Amsterdam-Rijnkanaal. The concrete approaches of the bridge consist of multiple statically indeterminate sections, each composed of prestressed T-shaped girders with cast-ins. A Quick scan assessment of the approach proved insufficient bearing capacity in shear, with tension-shear as governing mechanism. A nonlinear reassessment was carried out to analyse the structural behaviour prior to and after the development of the critical shear crack. The governing girder was modelled with solid elements, all other parts with shell elements. The calculations started with a creep and shrinkage analysis under SLS loads, followed by a failure analysis in which the loads were incremented up to failure. The results of the analysis (including the sensitivity study) provide useful insights in the behaviour of such a structure. The lecture gives an overview of the model and the most relevant results. In addition, it will evaluate the added value of model choices such as the decision to do a full creep and shrinkage analysis and the choice for solid elements.

Approach *Fib* 3RD BLIND SIMULATION COMPETITION, “Simulation of slabs reinforced with conventional flexural reinforcement and fibres subjected to punching loading configuration”

Lex van der Meer, ABT

This benchmark and the rules of the competition were announced in February 2023. Information about the properties of the materials at the age of 22 days was communicated at 10th April 2023. A total of 25 teams submitted 29 proposals, from which 25 proposals were considered in the final classification of the competition, corresponding to those submitted in proper time and format. Experiments were conducted at 18th and 27th of July 2023 on two slab prototypes for the appraisal of the predictive performance of the simulation proposals. The last test was transmitted in real time through a YouTube channel. The videos of the tests can be found in the following links: <https://youtu.be/Ru0szbEXWCo>, https://youtube.com/live/d6kIRS6_tPQ. The experimental results and those of the simulations were then analysed. The final classification was communicated to the participants on 29th September 2023. The following sections of the current report present the name of the participants, the experimental results, the numerical results, and the performance of the numerical predictions.

Predictive results of the teams:



(a)

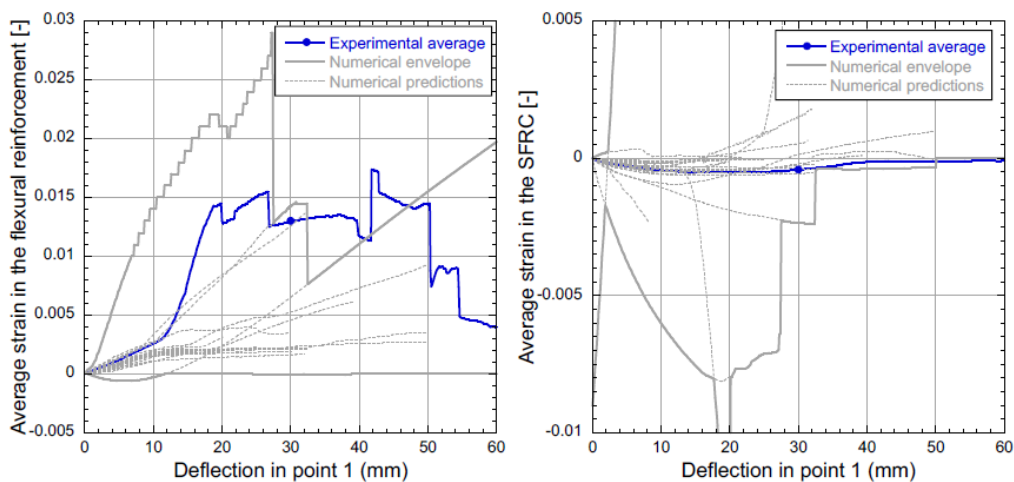


Figure 1. Experimental average, numerical envelope, and numerical predictions of all participants regarding the: load versus deflection in point 1 (a), average strain in the flexural reinforcement versus deflection in point 1 (b), and average strain in the SFRC versus deflection in point 1 (c)

3.3 International DIANA Users Meeting 24-25 September 2024, University of Valencia, Valencia, Spain

Tuesday, 24th September

Insights into the Educational Implementation of DIANA Software

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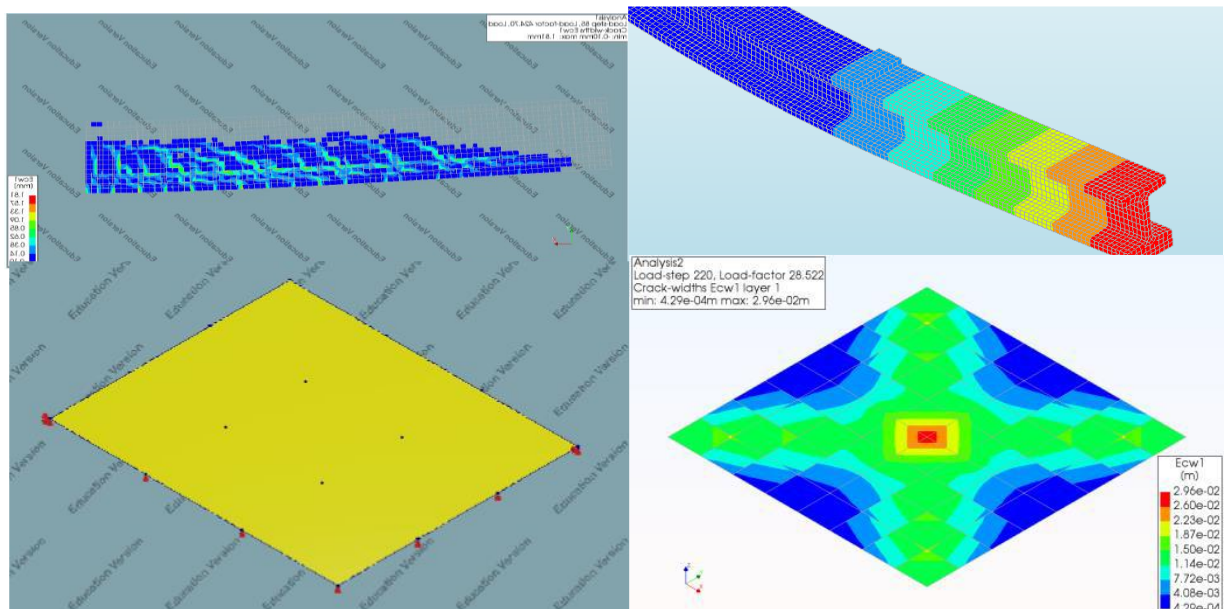
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Abstract

For approximately 10 years, the Diana software has been selected as one of the computer-based learning tools in the courses on analysis and modelling of concrete structures offered by the Department of Construction Engineering and Engineering Projects and the School of Civil Engineering at the Universitat Politècnica de València. The introduction of this tool brought about a shift in the traditional working methodology, which until then had relied on in-house tools more closely associated with learning the core concepts underlying the nonlinear analysis of concrete structures and the implementation of specific effects of concrete in various types of structural elements modelled as frames, membranes, plates, or solids.

The simplicity of creating models based on Python scripts and the continuous development of the Diana Interactive Environment encouraged instructors to utilize the software with their students, enabling them to develop models of certain complexity with relatively low time commitment. This has empowered students to explore the core concepts of the subject in a more practical manner and has allowed them to witness theoretical concepts applied in practical cases more aligned with professional practice. However, the opportunity to use this tool has presented a challenge for educators to balance the mechanical use of the Diana software with the fundamental core concepts that civil engineering master's students must grasp to comprehend their work.

This paper presents the methodology employed with students of the Master's Degree in Civil Engineering, highlighting the students' acceptance of the use of these tools, which brings them much closer to their future professional field. Simultaneously, it raises a series of relevant aspects that should be considered and discussed in the near future based on the teaching experience with the Diana Software.



Numerical study of experiments on prestressed concrete bridge girders made continuous

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ABSTRACT

As part of a broader research program which concerns the structural safety of prestressed bridge girder viaducts in the Netherlands, TU Delft is currently conducting an experimental program on prestressed concrete beams made continuous.

Due to specific structural features, such as a low shear reinforcement ratio, improper reinforcement detailing, connection between the prefabricated girder and cast-in-situ top slab, complex stress state at the intermediate support and the complex construction process, predicting their resistance using the Non-Linear Finite Element Method (NLFEM) is challenging. Many of the features which are present in this type of structures require a tailored computational modelling approach, which entails that this type of construction currently falls outside the scope of the Guidelines for Nonlinear Finite Element Analysis of Concrete Structures [1].

Once the final experimental program has been settled, a blind prediction of the whole experiment program will be carried out following the guidelines specified in [1]. This provides the opportunity to check if the numerical models following the current state of art guideline are capable of accurately predict the overall structural behaviour. Since the results of the experiments are unknown and no similar test results are available, the blind predictions can be considered as unbiased. In this way the applicational scope of the computational modelling strategies can be verified and extended with this specific type of structures where the actual shear failure mechanisms are still unclear. The uncertainty of the approach can be quantified in an unbiased way.

The NLFEM analysis used for the design of the experiments and the blind-predictions are based on a reference model which is composed in accordance with the guidelines stated in [1]. For the first two groups of experiments, containing 14 specimens, blind-predictions are performed which provide insight is given in the model uncertainty for this specific type of structure. Subsequently to the blind predictions the analysis are extended with sensitivity studies to evaluate the influence of certain modelling assumptions and input parameters. The identified sensitivities enable future research to focus on improving the modelling techniques focusing on these parameters, ultimately leading to better predictions. With the experimental results known, the additional simulations are carried out with the intention to approach the experimental results as much as possible by varying the solutions strategies. These simulations are considered as post-dictions. With these simulations, improved solutions strategies are proposed that are considered to be most suitable for the observed physical behaviour.

References:

[1] Max A.N. Hendriks and Marco A. Roosen (editors), "Guidelines for Nonlinear Finite Element Analysis of Concrete Structures", Rijkswaterstaat Centre for Infrastructure, Report RTD:1016-1:2019, 2019.

Antwerp Ring Road(R1)-Premetro crossing – Oosterweel

Zhekang Huang, Witteveen+Bos, the Netherlands

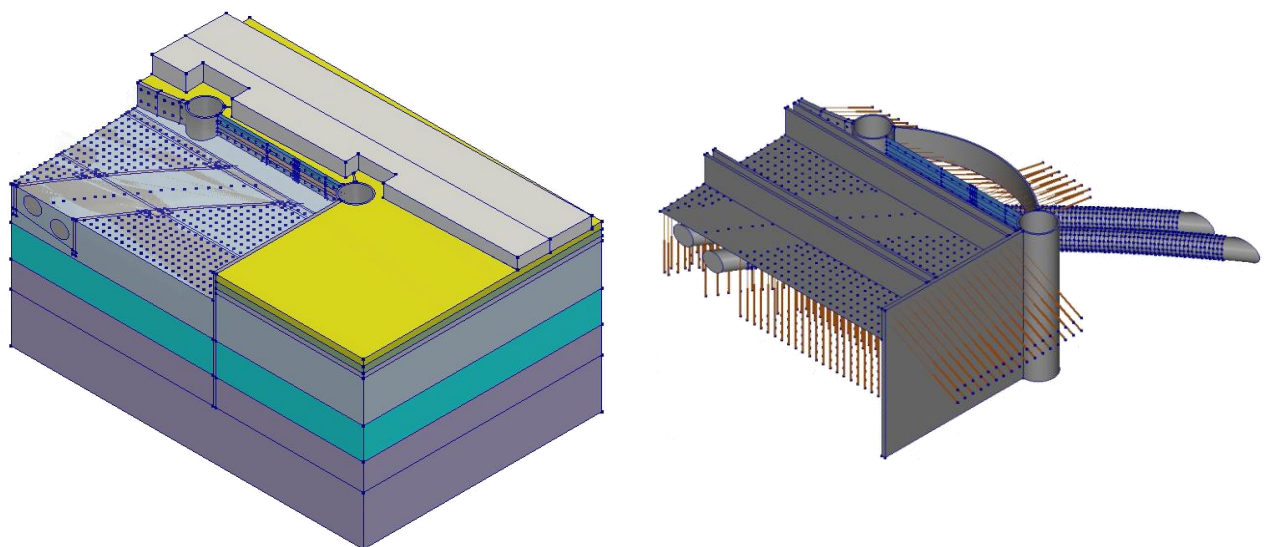
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Abstract

The R1 motorway, also known as the Ring of Antwerp, encircles the city of Antwerp, Belgium. Its strategic location as a primary conduit for a major port city and its intersection with several key highways makes the R1 one of Europe's busiest motorways. The Oosterweel project completes the Ring of Antwerp and has been initiated to improve the traffic flow. Besides, by bringing parts of the current highway underground, it improves the quality of life for residents of the city. Constructing large-scale infrastructure within a densely built and populated modern city presents significant challenges, originating from existing civil structures and buildings.

The R1-Premetro Crossing, a subcomponent of the Oosterweel Project, entails the construction of a new cut-and-cover tunnel above four existing metro tunnels built in the 1970s. At the most critical location, the distance between the top of the existing bored tunnel and the excavation level is a mere 0.5 meters. Additionally, considering the transport of hazardous materials within the cut-and-cover tunnel, explosion and implosion loads are included in order to guarantee safety in the event of unforeseen incidents.

In order to thoroughly examine the potential impact on the existing bored tunnels, a simple monolithic tube representation of the segmented tunnel is insufficient. Utilizing DIANA FEA, the tunnels are modeled with individual segments and joints, soil-structure interaction is taken into account and individual building phases are modeled, all to achieve the most accurate prediction possible of the tunnel's response. This approach allows for a comprehensive understanding of the potential influences on the existing infrastructure and thereby minimizing risks for both construction and use.



Optimisation of a polymer rail baseplate

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ABSTRACT

The rail infrastructure in the Netherlands is one of the densest in the world. Rail safety is an important aspect of such a dense network. Axle counting devices are used to determine whether track sections are available or not. These devices are best mounted close to the base plates, in order to allow for track bed maintenance without damage for the counters. Most base plates are made of steel, but in order to provide the proper electric insulation for axle counting devices the rail network owner considers the possibility of polymer rail plates. The first polymer baseplate design was subject to fatigue failure in the physical experiments after which the authors were involved in a multi-staged analysis with Diana and finally LS-Dyna. In the first stage, Diana was used to develop a detailed 3D solid model with non-linear connections in which the bolts and rail were explicitly modelled. This led to an improved design of the baseplate that was able to withstand the physical tests. However, the failure mechanism shifted from failure of the baseplate to failure of the bolts. In the second stage, it was proven that lateral movement of the baseplate due to 'caterpillar like' behaviour of the rubber underlay caused peak bending stresses in the bolt. In the final stage, the model was adopted in LS-Dyna to model aforementioned behaviour of the rubber underlay by employing a detailed contact algorithm that could capture the combined baseplate-rubber deformation and complex frictional interaction. The resulting model was able to describe the 'caterpillar' and used to propose an improved design.

Time-dependent structural finite element analysis of prestressed recycled aggregate concrete beams

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ABSTRACT

The Dutch government has set the goal of halving the consumption of primary raw materials by 2030. One of the important routes to achieve this goal is to produce recycled concrete aggregate (RCA) from old concrete and use it as raw material for new concrete, which in turn can be used to build new structures. However, until now the usage of recycled aggregate concrete (RAC) in structural applications has been rather limited, including prestressed concrete structural members. The reasons for this include the lack of understanding of creep and shrinkage properties of RAC and their long-term effects on the structural behaviour. Time-dependent structural finite element analysis may offer this insight, provided that it is fed by accurate shrinkage and creep material models. In this research we validate such a modelling approach based on experiments on six prestressed RAC beams with varying prestress levels, concrete mixtures and RCA replacement levels. The creep compliance and shrinkage functions are calibrated using data from accompanying material tests. Comparisons between the test and numerical results show good agreement in deflection rates and time-dependent prestress level, although the immediate response under the superimposed load turns out to be notably underestimated. The predicted total prestress losses for the beam tests with RCA

contents of 0%, 50% and 100% are 15.2%, 17.1% and 19.8%, and only deviates with plus/minus 1.1% from the measured prestress losses. We conclude that the adopted modelling approach can serve as an important basis for the design and analysis of prestressed RAC elements.

Long-term effects of creep and shrinkage on the structural behaviour of balanced cantilever prestressed concrete bridges

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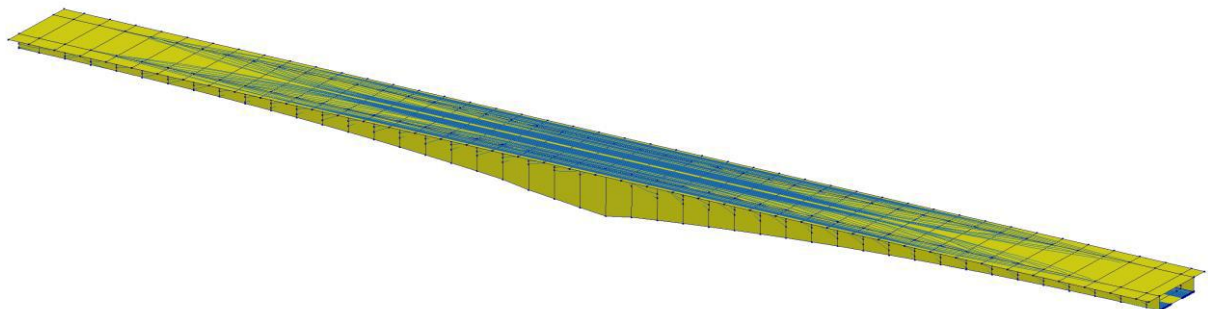
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ABSTRACT

Long term measurements reveal ongoing and excessive deformations in many balanced cantilever prestressed concrete bridges worldwide, contrary to what was anticipated in design. The recent literature on this topic attributes this unexpected behaviour to the time-dependent phenomena of creep and shrinkage, and the inadequacy of code-based models used in the past. This study investigates this hypothesis for a real world case in the Netherlands: the Rooyensteinse Brug. Using DIANA FEA, a detailed two-and-a-half-dimensional finite element (FE) model of this bridge is developed. To account for the construction phases, a time-dependent phased structural analysis is conducted. Creep and shrinkage effects are considered by using creep compliance and shrinkage strain curves. A sensitivity study explores the impact of different creep and shrinkage models, model uncertainties, maturity effects, and cross-sectional variability in drying characteristics. Findings reveal significant underestimation of long-term deflections by commonly used code-based models, while the state-of-the art RILEM B4 model is able to capture the observed trend. Acknowledging model uncertainties widens the potential range of deflections and prestress losses. Finally, incorporating cross-sectional variability in drying characteristics improves both the short and long-term deflection predictions in comparison to the in-situ measurements. The study demonstrates that a detailed FE model, combined with the RILEM B4 model and considering cross-sectional variability in drying characteristics, accurately describes the observed behaviour in the Rooyensteinse Brug. Hence, these results strongly support the hypothesis that creep and shrinkage are the primary causes of the recorded ongoing and excessive deformations.



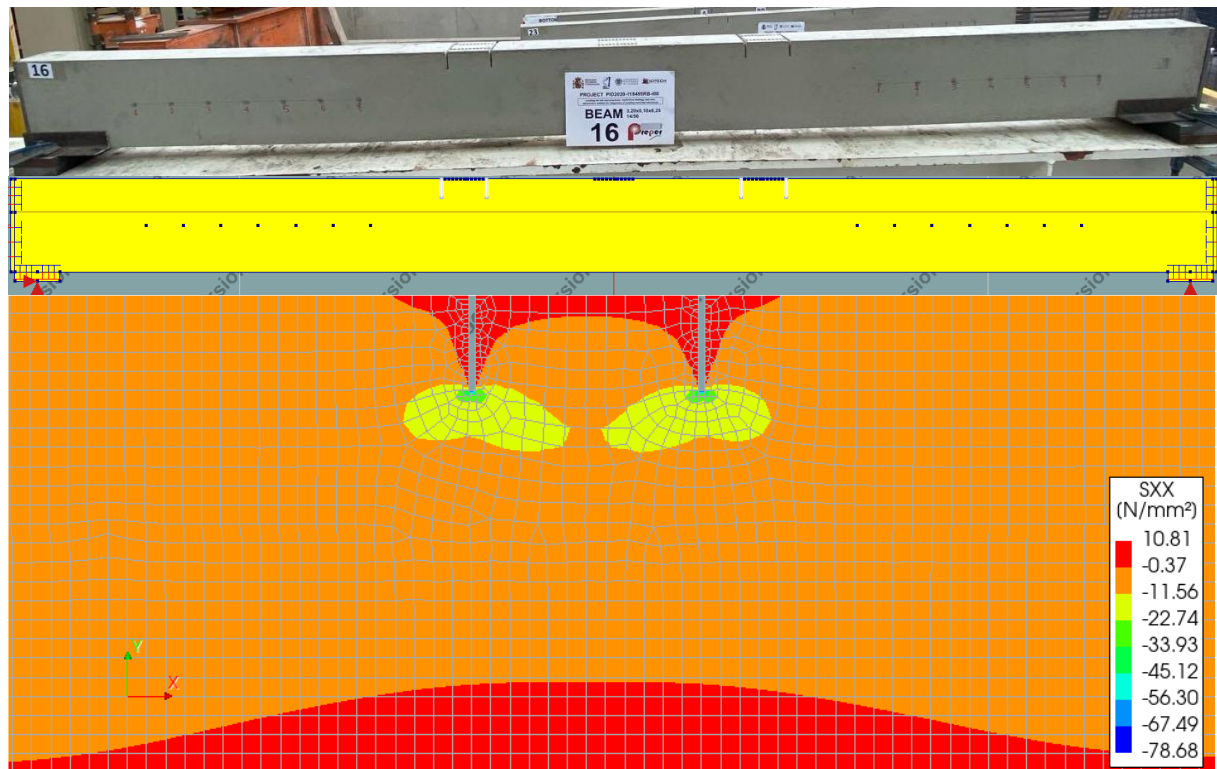
Digital twin model of a notched, post-tensioned concrete beam

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ABSTRACT

The main codes and standards provide specific guidelines and detailed requirements for designing the prestressing force in prestressed concrete elements. In this process, the designer determines the initial prestressing force and must estimate the losses that will occur during the element's service life. However, assessing these elements presents significant uncertainties. In particular, the effective prestressing force is a critical factor that influences the load-carrying capacity, in-service structural properties, and remaining durability of the element. Overestimating prestress losses can result in excessive camber and inefficient designs, while underestimating them can lead to excessive deflection and unexpected cracks. To address this challenge, indirect testing methods are used to obtain adequate measurements, such as deformations, stresses, crack width, and deflections. These measurements are essential for applying analytical or numerical approaches to estimate the residual prestressing force. A recent non-destructive method involves making saw cuts to release stresses, known as "saw-cut." This experimental method has been successfully applied in some cases, although its implementation is still limited. In this study, a sophisticated digital twin model has been meticulously developed to replicate the intricate characteristics of a post-tensioned concrete beam on which the saw-cut test was performed. This includes careful consideration of factors such as the precise location, depth, and spacing of the cuts, alongside meticulous characterization of material properties and the prestressing force. Such a digital model serves as a powerful tool for rigorously validating experimental findings and further enhancing our understanding of the intricate effects of prestressing on concrete elements. Consequently, it significantly contributes to the ongoing advancement of prestressed concrete technology and its broad applications within the field of structural engineering.



Usage of DIANA FEA as a Research and Educational Tool at NTUA

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ABSTRACT

The use of DIANA FEA analysis software at the Laboratory of Reinforced Concrete (RC), National Technical University of Athens (NTUA), as a research and educational tool, is demonstrated through a series of case studies, in which different features and capabilities of the software are used.

Initially, DIANA FEA is used as a nonlinear thermal and structural analysis tool for an applied research project, in order to establish critical design issues of a large 30x20m² in plan, 30m tall, RC caisson, during the construction and ponding phases (Fig.1).

Subsequently, the use of DIANA FEA as an educational tool is demonstrated through applications of DIANA FEA in:

- i) The Integrated Design Project (9th semester, NTUA), where a particular design is assigned and is fully developed by a five member team of students as a group: two design cases are presented, including
 - i.1) the structural design of a complex water flocculation tank in the Water Treatment plant of Patras Greece (seismicity zone II),
 - i.2) the feasibility design of a 130m RC precast post-tensioned RC wind turbine off the coast of Tinos island in the Aegean and
 - i.3) the structural design of a 200m tall high rise residential building in the Athens Coastal Development (Hellinikon) Project.

- ii) The use of DIANA FEA in Final Year Diploma Theses at NTUA, where the capabilities of the software as a batch process analyzer using Python scripts and MATLAB® are demonstrated over a set of applications, including
- ii.1) the optimal design of lightweight concrete RC slabs,
 - ii.2) the inelastic seismic performance prediction of masonry walls and infills and
 - ii.3) the use of UHPC in structural applications in Greece under combined Eurocode 2 and Eurocode 8 design requirements.

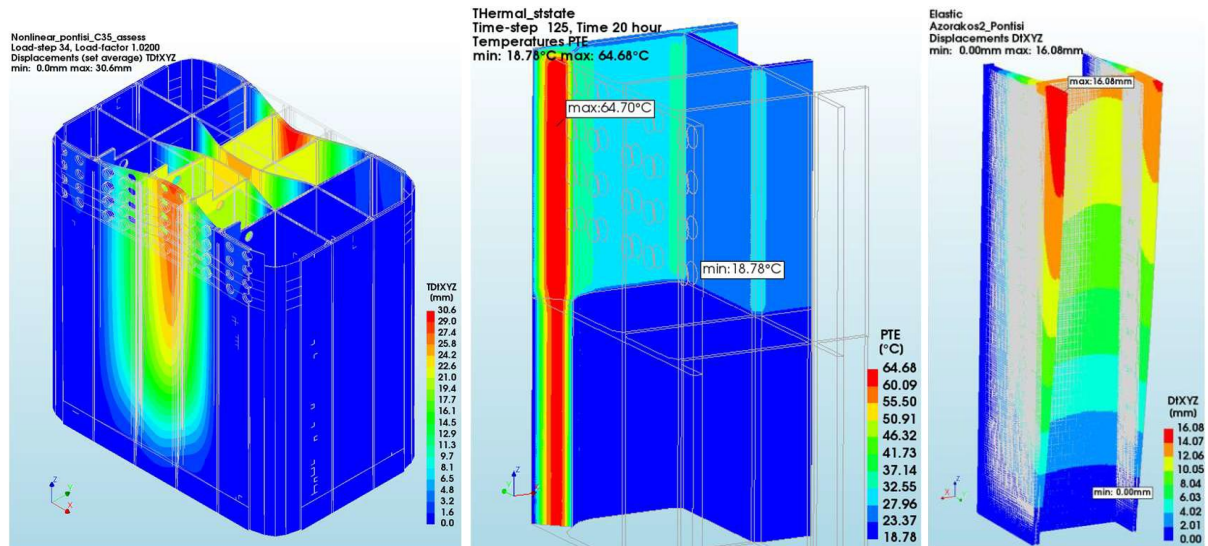


Fig. 1 Inelastic analysis models of a tall RC caisson during construction: global and local failure models (structural and thermal)

Finite element model for reinforced UHPFRC tensile elements.

Eduardo J. Mezquida-Alcaraz^{a,*}, Juan Navarro-Gregori^a, Majid Khorami^{a,b}, Pedro Serna^a

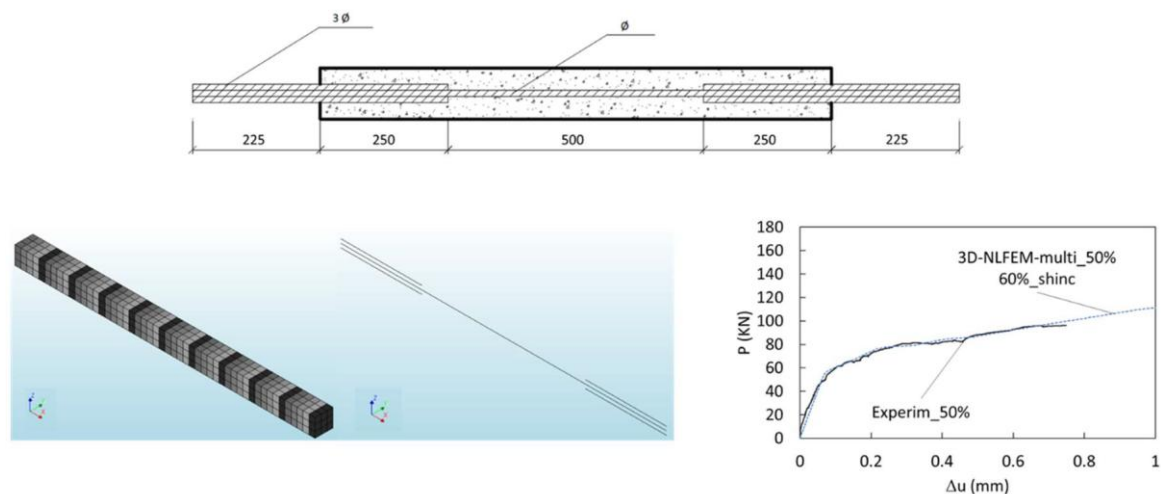
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^b Universidad UTE, Facultad de Arquitectura y Urbanismo, Calle Rumipamba s/n y Bourgeois, Quito, Ecuador.

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ABSTRACT

This research defines a reliable non-linear finite element model (NLFEM) to simulate the mechanical response of reinforced ultra-high-performance fiber-reinforced concrete (UHPFRC) tensile elements. The NLFEM is able to both: simulate with reliability the UHPFRC shrinkage effect and, considering its influence, simulate accurately the mechanical response of reinforced UHPFRC tensile elements deriving, from the simulation, the shrinkage strain range and its influence on the mechanical response. To support this study two experimental programs of reinforced UHPFRC tensile bars (ties) were considered for two reasons: achieve the UHPFRC shrinkage effect and obtain the experimental mechanical response of reinforced UHPFRC tensile elements. The defined NLFEM works in two phases: a shrinkage phase, when the shrinkage effect was simulated in the specimen's storage stage; a second phase called the tensile test, when the mechanical tensile test was simulated, including the internal stress state that resulted from the shrinkage phase. The first adopted experimental program was used to calibrate the shrinkage phase of the NLFEM. The mechanical responses of the tensile tests in the second experimental program were compared to the NLFEM simulated responses after applying the tensile test phase with very accurate results. The NLFEM allowed reliable predictions of the shrinkage strain range and to evaluate its influence on the mechanical UHPFRC response during both microcrack formation, where the tensile bar response started losing its initial stiffness, and the microcrack stabilization phase, when the particularization of the tension stiffening phenomena for UHPFRC and reinforcement took place.



Blind prediction contest results of prestressed concrete beams made continuous

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ABSTRACT

Over the past decades, research in the field of concrete structures has significantly advanced the modelling techniques of concrete structures, encompassing both numerical and analytical models. Blind prediction contests using complex experiments have been acknowledged as an effective tool for validating various models and identifying potential areas for improvement. Therefore, at TU Delft, a series of blind prediction contests has been held since 2014. The selection of experiments for the contests is based on the principle that they should feature configurations that reflect typical construction types, while also being experiments that are not commonly reported in literature. The previous blind prediction contests were well-received and provided valuable inputs for applications such as improving the modelling strategies in the Dutch guidelines for non-linear analysis of concrete structures. The results and finds of these contests were typically discussed in one of the meetings together with Diana user association. For the latest edition of the blind prediction contest, TU Delft has organized a blind prediction contest consists of two experiments on two full-scale precast continuous concrete inverted T beams. These experiments are a part of a more extensive research program on the safety assessment of existing precast concrete bridges supported by Rijkswaterstaat, the Dutch Ministry of Infrastructure and Water Management. The specimens were designed to represent typical multi-span precast girder bridges. They were made by precast inverted T beams and made continuous on-site using a cast-in-situ topping layer. Many details of this type of structure no longer meet the requirements of modern design codes and are often found in existing structures in many countries worldwide, with features that are not accepted by modern design codes such as a very low shear reinforcement ratio. Due to the complex construction process, predicting their resistance using generally available models (both analytically and numerically) is challenging.

As part of the blind prediction contest, TU Delft has received a wide variety of submissions from around the world. This diverse pool of participants reflects the growing interest and recognition of blind prediction contests as an effective tool for validating and improving modeling approaches, which are adopted in the structural safety assessment of prestressed concrete bridges. In this presentation, we will present the research project on the safety of existing precast concrete bridges made continuous. From the program, the two experiments that were selected will also be presented with a more detailed overview of the parameters and the results of the two experiments in the contests. Also, we will present the major finding by evaluating the predictions, the insight into the statistics of the blind prediction submissions reveals the extent of the participation and the diversity of the modeling techniques employed. Furthermore, the model uncertainty is further discussed that is accompanied with these specific blind predictions.

Nonlinear finite element analysis of lightly reinforced, deep, slender beams without shear reinforcement

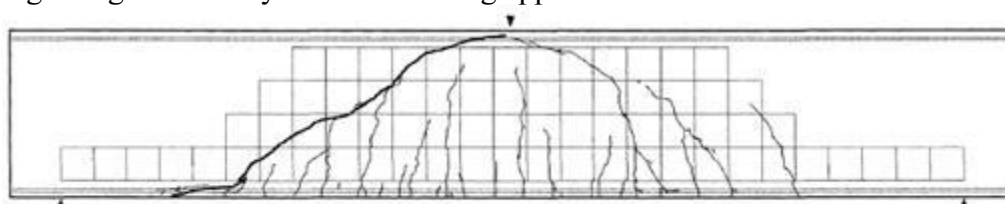
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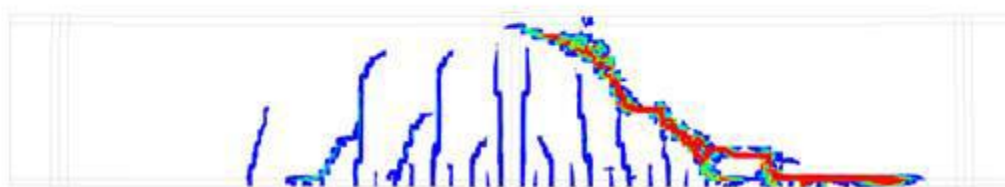
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ABSTRACT

Rijkswaterstaat, part of the Dutch Ministry of Infrastructure and Water Management, has developed a guideline for the modelling of concrete structures in The Netherlands with nonlinear finite element analyses. The guideline has been validated for various types of concrete structures; however, validation for lightly reinforced concrete structures, such as some slab bridges and deep beams, is lacking. Various international blind prediction challenges (e.g. the Toronto (2015) or Trondheim (2019) challenges) have demonstrated that the modelling of lightly reinforced deep beams without shear reinforcement is challenging. The results from blind predictions and even post-dictions show a large scatter in the failure loads that sometimes greatly deviate from the experimentally obtained failure load. Also modelling approaches according to the Rijkswaterstaat guideline poorly predicted the failure mode and failure load. The literature on this topic confirms that the nonlinear finite element analysis of shear failure in lightly reinforced deep beams without shear reinforcement is an extremely unstable problem with a strong sensitivity with respect to model parameters and solution procedure settings. This raises the question: What modelling guidelines are needed to analyse these kind of structural elements? In an attempt to answer this question, a parametric finite element model is developed to analyse a series of experimental tests on deep beams. The tested beams are taken from the literature and have heights varying between 0.95-2.1 m, reinforcement ratios varying between 0.14-1.26 %, and no shear reinforcement. We adopt a modelling approach based on a literature review, sensitivity analyses, and expert judgement. Hereby we were aiming for an approach that is as much as possible in line with the current modelling guideline, accepting less accurate but conservative failure load predictions. Based on the performed analyses, the adopted model is evaluated by comparing the numerical results with the experimental observations, and conclusions regarding the validity of the modelling approach are drawn.



Experiment (Sherwood 2008)



Model Prediction

Structural Reinforcement of Masonry Quay Walls in Amsterdam: A Nonlinear FEA approach

Stan den Hartog, Witteveen+Bos, the Netherlands

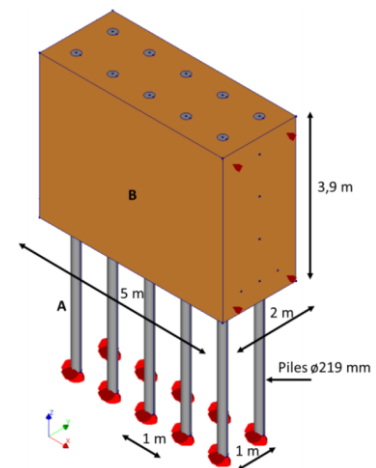
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ABSTRACT

This study focuses on a specific type of quay wall reinforcement in Amsterdam, wherein steel tube piles are used as a foundation replacement for the existing wooden piles. Grout is used to guarantee a connection between the steel piles and the masonry. The project aims to ensure the structural integrity of the masonry, primarily focusing on its capability to withstand forces under various conditions. Finite Element Analysis (FEA), utilizing DIANA FEA software, is employed to assess potential failure mechanisms and validate the structural adequacy of the proposed reinforcement.

The Total Strain Rotating Crack Model (TSRC-Model) is utilized to describe the structural behaviour of masonry. Furthermore, two critical interfaces are considered: between the steel tube piles and grout, and between grout and masonry.

Through nonlinear FEA, the study evaluates the capacity of the masonry to withstand loads, considering both permanent and variable loadings. Additionally, the analysis addresses potential failure modes in the interfaces between different materials. The results reveal that while the masonry adequately supports the applied loads, the connection between steel tube piles and grout requires reinforcement.



Based on the findings, it is recommended to augment the steel tube pile interface with steel rings to enhance the shear transfer capacity. However, the interface between grout and masonry demonstrates satisfactory performance without requiring additional strengthening measures. Overall, the proposed reinforcement strategy significantly extends the structure's lifespan, ensuring structural safety and stability for at least 30 years.

In conclusion, this study provides valuable insights into reinforcing masonry quay walls, emphasizing the importance of accurate modelling and thorough analysis to ensure structural integrity and longevity. The findings contribute to informed decision-making in infrastructure rehabilitation and maintenance projects.

DIANA for linear assessments? (Benefits of) a race horse on the slow lane

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ABSTRACT

Years ago, the Dutch Road Authority (Rijkswaterstaat) started a large programme to assess the structural reliability for their concrete bridges and viaducts. The viaducts can be divided in in-situ cast concrete slabs and girder viaducts, composed of prefabricated girders. One of the subtypes of the girder viaducts is the T-girder bridge. Rijkswaterstaat

assigned Arcadis to assess three prestressed T-girder viaducts; two of them with a linear calculation of the structural behaviour and a subsequent cross section check. This lecture is about the linear assessments, for which we used DIANA.

Although DIANA's powers lie for a large part in its nonlinear capabilities, we used it for the linear assessments as well. The lecture will present the projects, the modelling approach, some of the difficulties we encountered and some typical aspects of the section checks.

Why did we use solid elements?

And why did we perform a full phased creep and shrinkage analysis?

And, also important: would we do it again?

Safety formats for non-linear analysis assessment of punching shear strength in slab-column connections

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ABSTRACT

Nonlinear finite element analysis (NLFEA) is an interesting alternative for simulating the nonlinear structural behaviour of reinforced concrete (RC) structures. However, the wide use of advanced non-linear analysis is hindered by the incompatibility of NLFEA with most current design codes of practice, which are tailored for linear analysis and partial safety formats. This paper aims to compare different safety formats suitable for the design verification of RC structures with NLFEA. Their performance is compared using a slab-column connection experimental test with punching shear failure mode as a reference. The numerical simulations used the total strain fixed crack model implemented in the software DIANA to represent the concrete non-linear behaviour. The comparison of safety formats includes full-probabilistic and semi-probabilistic methods. Using a MATLAB script, a surrogate-model-based strategy was applied for the former case by coupling Diana software with the UQlab uncertainty quantification framework. The results indicate that NLFEA can be effectively applied for the design verification of punching shear in the design of RC flat slabs, provided that an adequate safety format is used. In general, the full-probabilistic analysis allowed a more detailed representation of the material, geometrical, and model uncertainties and an exact quantification of the probability of failure. However, the main disadvantage was the high computational cost for the simulations considered in this work.

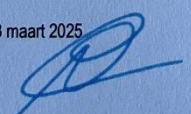
Keywords: non-linear analysis, NFLEA, safety formats, punching shear, reinforced concrete, probabilistic analysis

4. Financial aspects

SAMENVATTING BIJ FINANCIËEL JAARVERSLAG 2024

Balans	31 december 2024		1 januari 2024	
ACTIVA				
Vaste activa	€	-	€	-
Vlottende activa				
Vorderingen	€	5 865	€	6 045
Liquide middelen	€	13 276	€	12 171
		€	€	18 216
Totaal activa		€ 19 140		€ 18 216
PASSIVA				
Eigen vermogen	€	18 691	€	16 479
		€	€	16 479
Kortlopende schulden	€	449	€	1 737
		€	€	1 737
Reserveringen en voorzieningen	€	-		
		€		
Totaal passiva		€ 19 140		€ 18 216

Winst- en verliesrekening	debet		credit	
Netto omzet	€	-	€	14 050
Kostprijs van de omzet	€	7 322	€	-
Bruto omzetresultaat	€	-	€	6 728
Personeelskosten	€	3 856	€	-
Algemene beheerskosten	€	663	€	-
Financiële baten	€	-	€	-
Financiële lasten	€	-	€	-
Resultaat uit gewone bedrijfsvoering	€	4 519	€	-
Buitengewone baten en lasten	€	-	€	3
Resultaat (winst)	€	-	€	2 212

Penningmeester DOV: datum: 13 maart 2025  Coen van der Vliet	Accordering kascommissie: datum: _____ datum: _____ marcel.t.hart <small>Digitally signed by marcel.t.hart DN: cn=marcel.t.hart, ou=Corporate Zone, email=marcel.t.hart@haskoning.com Date: 2025.03.11 15:09:26 +01'00'</small> Ab van den Bos Marcel 't Hart
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Ab van den Bos
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5. Publication list 2024

Netherlands

Arcadis and Rijkswaterstaat

Extended linear finite element calculation of a 70-years old prestressed concrete viaduct

René Veerman¹, Coen van der Vliet¹, Baptiste Korff²

Proceedings IABSE Symposium Manchester 2024, Construction's role for a world in emergency, 10-12 April 2024, Manchester, UK

¹ Arcadis Nederland BV, Amersfoort, The Netherlands

² Rijkswaterstaat, Dutch Ministry of Infrastructure and Water Management, Utrecht, The Netherlands

Delft University of Technology

An integrated approach for seismic design and modelling of plywood-retrofitted timber floors.

Michelle Mirra

Elsevier Procedia Structural Integrity, Volume 64, 2024, Pages 869-876.

Department of Engineering Structures, Section of Bio-Based Structures and Materials, Delft University of Technology, Stevinweg 1, 2628 CN Delft, The Netherlands.

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A set of calculation tools supporting the design, modelling and application of plywood-based seismic retrofitting interventions on timber floors in existing buildings

Michele Mirra

Elsevier Structures Volume 63, May 2024, 106378

Department of Engineering Structures, Section of Biobased Structures and Materials, Delft University of Technology, Stevinweg 1, 2628 CN Delft, The Netherlands

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International Journal of Architectural Heritage, 1–17.

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^b Geoscience & Engineering, Technische Universiteit Delft, Delft, Netherlands

Comparative numerical study to simulate masonry with bed joint reinforced repointing

Ka Ho Lee, Anjali Mehrotra, Rita Esposito

Engineering Structures Volume 300, 1 February 2024, 117135

Faculty of Civil Engineering and Geosciences, Delft University of Technology, the Netherlands.

Analysis procedures accounting for load redistribution mechanisms in masonry earth retaining structures under traffic loading

Satyadhrik Sharma, Michele Longo, Francesco Messali
Engineering Structures Volume 315, 15 September 2024, 118420, pp 1026–1036
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Modelling of thermo-mechanical behaviour of tunnels under fire conditions

R.A. Sanabria Díaz, Eva O.L. Lantsoght, M.A.N. Hendriks
Bridge Maintenance, Safety, Management, Digitalization and Sustainability - Jensen, Frangopol & Schmidt (eds) (c) 2024 The Author(s), ISBN 978-1-032-77040-6 , Open Access: www.taylorfrancis.com, CC BY-NC-ND 4.0 license

Shear Experiments On Straight Reinforced Concrete Slabs

Zarate Garnica, G., Lu, J., Yang, Y., Lantsoght, E. O. L., & Hendriks, M. A. N. (2024). In E. Villacís, C. Ayarza, J. Bucheli, S. Yazdani, & A. Singh (Eds.), Proceedings of International Structural Engineering and Construction: March 2024, Volume 11 Issue 1 (1 ed., Vol. 11). Article STR-07 (Proceedings of International Structural Engineering and Construction). ISEC Press. [https://doi.org/10.14455/ISEC.2024.11\(1\).STR-07](https://doi.org/10.14455/ISEC.2024.11(1).STR-07)

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Improving circularity of inverted T-girders Structural assessment of the prefabricated inverted T-girder system

N.H.V. (Noah) le Mair
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System behaviour in prestressed concrete T-beam bridges

Sebastiaan Ensink
PhD Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, the Netherlands

Marine Pumped Hydro Energy Storage; Shape design of the reservoir

Lucas Wesseling
Master Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, The Netherlands

Assessing Structural Integrity of Concrete Half-joints Using Sensor Data; A Case Study of the Naardertrekvaart Bridge

Amco de Jong
Master Thesis, Delft University of Technology, Repository Delft University of Technology

Assessment of system behaviour of prestressed concrete girder bridges using staggered 2D Non-Linear Finite Element Approach

Sneha Kasturi Rangan

Master Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, The Netherlands

Optimization of reinforcement design for Diaphragm wall

Wei Xiaoyan

Master Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, The Netherlands

Thin Glass Sandwich Panel Designed For Visual Comfort - Designing The Core Of The Panel To Dynamically Enhance The Visual Comfort Of The Façade

Grienne van der Ham

Master Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, The Netherlands

Quantifying the probability of light damage to masonry structures: An exploration of crack initiation and progression due to seismic vibrations on masonry buildings with existing damage

Korswagen, P. A.

PhD Thesis, Delft University of Technology, Delft, the Netherlands

<https://doi.org/10.4233/uuid:e56827d2-c821-4547-922e-ea24bd748e68>

Calibrated Numerical models for masonry buildings subjected to subsidence-related ground settlements

Javier Fuertes Guadarrama

Master Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, The Netherlands

Numerical modelling of a masonry farmhouse retrofitted with bed joint reinforced repointing

Jarno Frankenmolen

Master Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, The Netherlands

Structural Behavior of Steel-Concrete-Steel Immersed Tunnels with Imperfections and Varying Interface Conditions

Vasileia Matoula Michou

Master Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, The Netherlands

Development of a Rapid Screening Approach to Estimate the Seismic Capacity of Typical Buildings in Groningen

Rithu Maria

Master Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, The Netherlands

A Numerical Parametric Study On The Influence Of The Bond Pattern On The Two-Way Out-Of-Plane Bending Capacity Of Masonry Walls

Stefan Niels Martijn Alblas

Master Thesis, Delft University of Technology, Repository Delft University of Technology, Delft, The Netherlands

Analysis procedures accounting for load redistribution mechanisms in masonry earth retaining structures under traffic loading

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Delft University of Technology and City of Amsterdam

MT-InSAR Optimisation for Structural Health Monitoring

Hao Kuai¹, Valentina Macchiarulo¹, Satyadhrik Sharma¹, Pantelis Karamitopoulos^{1,2}, Francesco Messali¹, Giorgia Giardina¹

In: EWSHM 2024 11th European Workshop on Structural Health Monitoring, e-Journal of Nondestructive Testing - ISSN 1435-4934 - www.ndt.net

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Testing dike stability under uplift conditions; an experimental study

C. Zwanenburg^{1,2}, C. Cengiz¹, M.P. Fransen¹, B. Wittekoek¹, L. Wopereis¹

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Delft University of Technology and Gerardini Ingegneria Sismica

Assessment and Rehabilitation of Civil Structures Design and modelling tools for timber-based seismic retrofitting: from research to practice

Michele Mirra^a, Andrea Gerardini^b

In: SMAR 2024 – 7th International Conference on Smart Monitoring, Elsevier Structural Integrity 64 (2024) 877–884, Article Open Access

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Combining Architectural Conservation and Seismic Strengthening in the Wood-Based Retrofitting of a Monumental Timber Roof: The Case Study of St. Andrew's Church in Ceto, Brescia, Italy

Mirra^a, M., Gerardini^b, A., Ghirardelli^c, S., Ravenshorst^a, G., & van de Kuilen^{a,d}, J. W. International Journal of Architectural Heritage, 18(5), 750–770

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Modelling of thermo-mechanical behaviour of tunnels under fire conditions

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In: J. S. Jensen, D. M. Frangopol, & J. W. Schmidt (Eds.), Bridge Maintenance, Safety, Management, Digitalization and Sustainability (pp. 3950-3957). CRC Press / Balkema - Taylor & Francis Group. <https://doi.org/10.1201/9781003483755-466>

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Fire design verification of an immersed tunnel using nonlinear analysis

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Delft University of Technology, Tianjin University and University of Nottingham

3D Scanning and structural analysis of Heinz Isler's shell for swimming pools

Peter Eigenraam^a, Qingpeng Li^b, John Chilton^c, Andrew Borgart^a

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Royal HaskoningDHV

Non-linear dynamic analysis of Collapsed grandstand

T. Xu, W. Meijers, S.J.H. Meijers and R. Verlinde

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H. He and W. Meijers

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Huan He & Sander J. H. Meijers

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Advanced Technology and Research, Industry and Buildings, Haskoning DHV Nederland B.V, Rotterdam, 3068AX, The Netherlands

Royal HaskoningDHV and Delft University of Technology

S Toshniwal^a, J Sluijs^a, SJH Meijers^a, S Sharma^b and F Messali^b

Engineering methodology to assess the seismic out-of-plane response of two-way spanning unreinforced masonry walls with multiple openings

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TNO and Delft University of Technology

Garzón Amortegui, J.F., Slobbe A.T., Tošić, N., Torrenti J.M., Bigaj-van Vliet, A.J.,

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Utrecht University

Designing a Safe and Optimal Heat Storage System in Salt Caverns for Maximum Thermal Efficiency and Heat Output

Mohamad Alameh –0546070 -

Utrecht University, Energy Science, Faculty of Geosciences, Utrecht, The Netherlands

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Strain concentration factor at field joints for offshore concrete coated pipelines – Literature review

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[Journal of Pipeline Science and Engineering Volume 4, Issue 3](#), September 2024, 100196

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Accuracy of stochastic finite element analyses for the safety assessment of unreinforced masonry shear walls

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Accuracy of stochastic finite element analyses for the safety assessment of unreinforced masonry shear walls, Civil Engineering and Environmental Systems, Taylor&Francis Group, Open Access

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Belgium

Numerical investigations on innovative hollow section column-splice connections resorting to laser cutting technology

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 15th NORDIC Steel construction conference 2024 (NSCC 2024), Lulea, Sweden, 26-28 June, 2024

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Influence of modeling choices and prior information on the Bayesian assessment of a reinforced concrete bridge

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Structural Concrete [Volume25, Issue3](#) June 2024 Pages 1713-1734

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Efficient Bayesian model selection and calibration using field data for a reinforced concrete slab bridge

[Eline Vereecken](#) ^{a,b}, [Arthur Slobbe](#) ^b, [Árpád Rózsás](#), [Wouter Botte](#) ^a, [Geert Lombaert](#) ^c, [Robby Caspeele](#) ^a

[Structure and Infrastructure Engineering](#) Maintenance, Management, Life-Cycle Design and Performance Volume 20, 2024 - [Issue 5](#)

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Various numerical modeling procedures of XIX-century masonry building

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Brasil

Thermal Analysis of Concrete Blocks and Stack-Bond Prisms under Different Boundary Conditions

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MDPI - Constr. Mater. 2024, 4(1), 58-71; <https://doi.org/10.3390/constrmater4010004>

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A Mesoscopic Approach for the Numerical Simulation of a Mass Concrete Structure Construction Using Post-Cooling Systems

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MDPI, Buildings 2024, 14, 3232

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Database analysis of diagonally- reinforced coupling beams and development of new connection detailing for steel and composite coupling beams

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Master Thesis, The University Of British Columbia , Okanagan, Canada

China

Finite element data-driven deep learning-based tensile failure analysis of precast bridge slab joint

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Improved GAN-based deep learning approach for strain field prediction and failure analysis of precast bridge slab joints

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Experimental and numerical investigation on seismic performance of SFRC shear walls with CFRP bars

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[Structures Volume 67](#), September 2024, 106958

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Flexural performance of GFRP-sheathed cold-formed steel composite panel filled with lightweight phosphogypsum

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[Structures Volume 65](#), July 2024, 106731

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Shear mechanism of RCS joints with whole column-section diaphragm

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Investigation of cracking mechanism of the first tunnel lining during double-arch tunnel construction

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[Underground Space Volume 14](#), February 2024, Pages 1-17

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Effect of beam-column depth ratio on seismic behavior of precast RC column-steel beam joint

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[Journal of Building Engineering](#), [Volume 91](#), 15 August 2024, 109603

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Study on the bond-slip numerical simulation in the analysis of reinforced concrete wall-beam-slab joint under cyclic loading

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[Construction and Building Materials](#) [Volume 449](#), 25 October 2024, 138266

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Anisotropic Behavior in 3D Printed Concrete: Finite Element Simulation Approach

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Cyclic behavior and shear strength of exterior reinforced concrete beam-column joints with inclined columns

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Seismic performance of reinforced concrete beam-column joints with diagonal bars wrapped by steel tubes: experimental, numerical and analytical study

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Concept and flexural performance of non-prestressed steel plate-UHPC-NC composite girder bridge

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Investigation on Seismic Behavior of Prestressed Steel Strand Composite Reinforced High-Strength Concrete Column

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Experimental and numerical assessment of reinforced concrete column under cyclic loading

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Implementation of Laser Scanning and HBIM Technology for the Structural Evaluation of Built Heritage in Ecuador

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Using past experience in modern analysis of arch dams

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Distributed learning with compressed gradient differences

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The earthquake performance of a cultural heritage building: cathedral of St James in Sibenik, Croatia

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Numerical simulation of the 2010 4-story reinforced concrete structure tested on the E-defense shake table

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Finite Element Analysis of The Effect of Fiber Content on The Flexural Strength of SFRC Beams with Steel Rebars

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Effect of material quality on cemented sand and gravel (CSG) dam slope design of Cibee

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Comprehensive Review on the Flexure Behaviour of Corroded Reinforcement Concrete Beams Under Sustained Loads

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Numerical Validation Of Long-Term Behaviour Of Reinforced Recycled Aggregate Concrete Beam

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Safety assessment of existing prestressed reinforced concrete bridge decks through different approaches

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Ceramic Stress Sensor Based on Thick Film Piezo-Resistive Ink for Structural Applications

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Computational modeling of reinforced concrete dapped-end beams

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Exchange Information Requirements (EIR) in BIM Uses for the structural analysis of historic buildings: the case study of Aldobrandeschi Palace in Grosseto

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Impact of sound-insulated joints in the dynamic behavior of Cross-Laminated Timber structures

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Investigation of modal damage-sensitive features of a scaled three-storey steel frame for vibration-based damage detection

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Applied Element Modelling of cyclic flexural and torsional response of non-planar RC walls.

Andrea Orgnoni¹, Rui Pinho²

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Seismic Vulnerability Assessment of a Building Aggregate in the Historical Centre of Florence

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Investigating the Influence of the Improved Multibody Rope Approach on the Structural Behavior of Dakar Mosque Gridshell Structure

Jonathan Melchiorre, Stefano Invernizzi and Amedeo Manuello Bertetto

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Experimental and Numerical Damage Assessment of the Garisenda Tower: Investigation by AE, Thermal, Seismic, and Permanent Strain Analyses

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Seismic finite element method simulation of a soil-steel bridge with a gravel-rubber mix

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A 2D TBI model to study lateral dynamics in ship impact event

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Japan

Nonlinear Analysis On The Experimental Response Of Reinforced Concrete Underground Structure Using Laminated Shell Elements

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FEM Analysis of Reinforced Concrete Exterior Beam-Column Joint Structures Subjected to High Varying Axial Forces

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Nonlinear analysis on the experimental response of reinforced concrete underground structure using laminated shell elements

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Effect of composite slab and connection detail on cyclic behavior of steel beam-to-HSS column moment connections

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Post-earthquake repair of welded unreinforced flange-bolted web connections considering composite slab effects

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Numerical simulation on behavior of damaged composite girders repaired using CFRP sheets

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Evaluation of Fiber Orientation in UHPC Members Using X-ray Micro-CT and Estimation of Member Strength

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Enhancing structural performance evaluation of PC girder bridges through Bayesian model updating

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Contribution of 3D model representation in subsurface geotechnical investigations

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Moment Redistribution in Continuous Beams with High-Strength Reinforcement

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Stiffness reduction model of vertically divided reinforced concrete structural walls under lateral loading

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Malaysia

Fracture analysis of steel fibre-reinforced concrete using Finite element method modeling

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Composites for Civil Engineering: Strengthening and New Constructions

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Seismic performance assessment of stone masonry buildings: Efficacy of various strengthening elements

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Seismic fragility evaluation of the Nepalese pagoda temple: A case study of Laxmi Narsingha temple

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Strengthening non-engineered building using vegetal FRCC retrofitting: A numerical modeling approach for seismic assessment

Akhilesh

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New Zealand

Practical issues in time-history analysis of low-rise concrete wall buildings with subterranean levels

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First Findings on the Mechanical Analysis of Cob Using a Discontinuity Layout Optimization (DLO) Approach

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Poland

Application of EPS Geofoam below Soil–Steel Composite Bridge Subjected to Seismic Excitations

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Multi-Step Procedure for Predicting Early-Age Thermal Cracking Risk in Mass Concrete Structures

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The Influence of a Suspended Mass in a Geodesic Dome Under Seismic Excitations

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Long-term monitoring of earth pressure in a soil-steel composite railway tunnel

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Modeling of Heat and Mass Transfer in Cement-Based Materials during Cement Hydration—A Review

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Scalable BIM based open workflow for structural analysis of masonry building aggregates

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Seismic assessment of a dome structure with minarets as secondary elements: The case of Soltaniyeh Dome in Iran

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Mechanical Models For Fibre Reinforced Cementitious Composites - Application To The Design Of A Railway Precast Bridge Deck

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Preservation and Protection of Cultural Heritage: Vibration Monitoring and Seismic Vulnerability of the Ruins of Carmo Convent (Lisbon)

Nuno Mendes ,Nicoletta Bianchini, Luis Gerardo, Flores Salazar, Georgios

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Digital Tools for the Preventive Conservation of Built Heritage: The Church of Santa Ana in Seville

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A study of stone arch bridge's flood reliability through a surrogate model approach.

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Experimental and numerical analysis of different vertical connections of precast shear walls with special regard towards deformability

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Structural Concrete, Volume25, Issue1, February 2024, Pages 85-110

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Examples of solving the problem of the theory of viscoelasticity by the finite element method in relation to reinforced concrete structures

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E3S Web Conferences, Volume 533, 2024, XXVII International Scientific Conference on Advance in Civil Engineering “Construction the Formation of Living Environment” (FORM-2024)

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Methodology for determining true temperature stresses during the construction of massive monolithic reinforced concrete structures

Turina V.S., Chepurnenko A.S., Akopyan V.F.

Construction Materials and Products, ISSN 618-7183, Journal homepage: <https://bstu-journals.ru>

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Small-Scale and Large-Scale Modeling of Fiber-Reinforced Concrete Girders

Aleksandar Landović¹, Arpad Čeh¹, Anka Starčev-Ćurčin² and Miloš Šešlija²

MDPI: Buildings 2024, 14, 3812. <https://doi.org/10.3390/buildings14123812>

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Integral Abutment Bridges – Continuum Modelling Of Soil-Structure Interaction Using Finite Element Analysis With Interface Elements

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Master Thesis, Faculty of Civil Engineering, Stellenbosch University, Stellenbosch, South Afrika

Computationally-efficient high-fidelity nonlinear FEA of seismically isolated post-tensioned RC bridges

George Markou^a, Mohammad AlHamaydeh^b

[Structures Volume 60](#), February 2024, 105816

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Photogrammetry-aided numerical seismic assessment of historical structures composed of adobe, stone and brick masonry. Application to the San Juan Bautista Church built on the Inca temple of Huaytará, Peru

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[Engineering Failure Analysis Volume 158](#), April 2024, 107984

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Gaussian Copula-based Bayesian network approach for characterizing spatial variability in aging steel bridges

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3D modelling of the interaction between bending and corrosion-induced cracks in reinforced concrete beams

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[Construction and Building Materials Volume 411](#), 12 January 2024, 134272

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Development of a proof loading method for railway bridges with masonry abutments

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In: J. S. Jensen, D. M. Frangopol, & J. W. Schmidt (Eds.), Bridge Maintenance, Safety, Management, Digitalization and Sustainability. CRC Press / Balkema - Taylor & Francis Group.

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Combining monitoring information and UHPFRC strengthening to extend bridge service duration

Numa Bertola, Eugen Brühwiler

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Turkey

Different Soil-Structure Interaction Modelling Strategies for Seismic Analysis of a Masonry Church.

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International Journal of Architectural Heritage, 1–22

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Site response analysis by generating a new 3d mesh design with surface topography: a 3d site response analysis of northwest Turkey

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Bulletin of Earthquake Engineering (2024) 22:5571–5597,

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Internal force transfer in segmental RC structures

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Res. Eng. Struct. Mater., 2024; 10(4): 1639-1662

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Fire resistance of offshore concrete Structures

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Finite element modeling of active cracking in actively reinforced concrete pavement slab exposed to fluctuating temperature

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Experimental behaviour, FE modelling and design of large-scale reinforced concrete deep beams shear-strengthened with embedded fibre reinforced polymer bars

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Mesoscale Numerical Study on Time-Dependent Nonuniform Steel Corrosion-Induced Damage in Recycled Aggregate Concrete Systems

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Journal of Materials in Civil Engineering Volume 36, Issue 5,

<https://doi.org/10.1061/JMCEE7.MTENG-16711>

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Analysis and design of 3D printed reinforced concrete walls under in-plane quasi-static loading

M. Aghajani Delavar, H. Chen, P. Sideris

[Engineering Structures Volume 303](#), 15 March 2024, 117535

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Sustainable reinforced concrete design: The role of ultra-high performance concrete (UHPC) in life-cycle structural performance and environmental impacts

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Plastic hinge length in reinforced HPFRCC beams and columns

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[Engineering Structures Volume 315](#), 15 September 2024, 118345

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Verification, validation, and uncertainty quantification (VVUQ) in structural analysis of concrete dams

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Frontiers Built Environment, Sec. Dam Engineering and Design, Volume 10 - 2024

<https://doi.org/10.3389/fbuil.2024.1452415>

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Sensitivity analysis of parameters affecting the seismic performance of RC columns strengthened by fabric-reinforced cementitious mortar

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IOP Publishing Ltd, Mater. Res. Express 11 (2024) 055602

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Three-dimensional nonlinear finite element analysis of corroded reinforced concrete beams strengthened by CFRP sheets.

Nguyen ^a, T. K., Nguyen ^a, N. T., Tran ^c, H. A., Nguyen ^a, H. G., Tran ^b, P. (2024).

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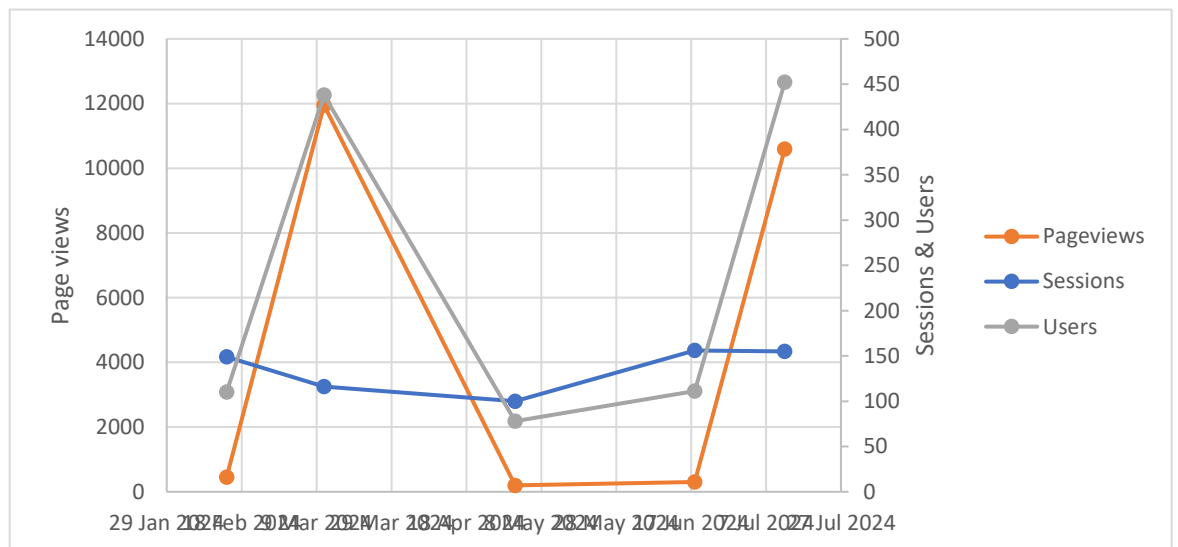
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6. Pageviews, sessions and users of the DOV website in 2024

	Sessions	Pageviews	Users
14 Feb 2024	149	448	110
11 Mar 2024	116	11953	438
1 May 2024	100	199	78
18 Jun 2024	156	302	111
12 Jul 2024	155	10591	452



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