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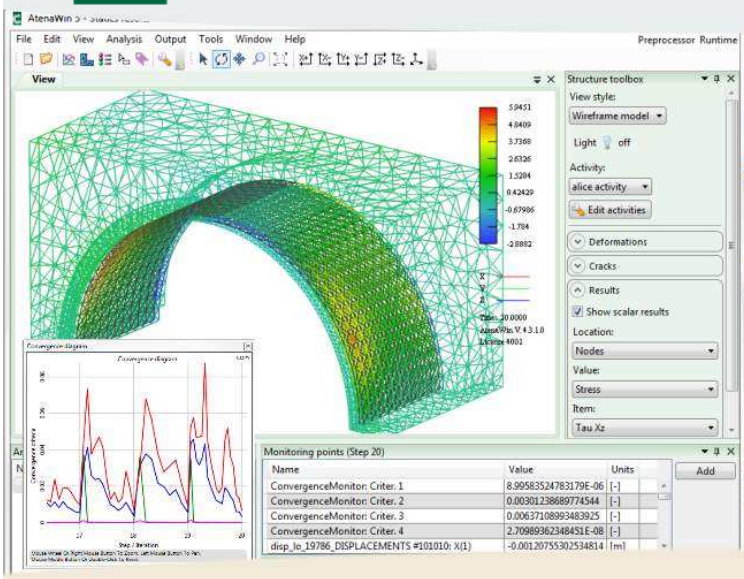


Product news

AmQuake

"AmQuake helps engineers to win projects"

With the help of AmQuake, it was possible to design a combined masonry reinforced concrete apartment complex in the city Kranj in Slovenia.

Program AmQuake was developed in cooperation between Cervenka Consulting and Wienerberger AG, Wiena. It allows engineers to design safe masonry buildings in seismic regions in accordance with the latest European standards (Eurocode 8) and modern seismic design methods. AmQuake is based on pushover analysis and equivalent frame method. This approach does not require complicated analysis methods while still utilizes a full structural capacity.

Program AmQuake was verified by experimental and analytical cases and is being applied to practical engineering structures.

ATENA

ATENA version 4.3.0 is now being tested in our office and by a few selected users. The release is planned for November.

The main new features include:

- 64bit AtenaWin and AtenaConsole
- improved implementation of hydration heat and general heat source codes
- an option to apply initial opening on contacts
- completely new graph component in AtenaWin
- many fixes and improvements in the analysis kernel, ATENA-GiD interface, the 3D GUE, AtenaWin+AtenaConsole, the manuals, and the installer

Summary of Current Research Projects:

CERHYD FRTI1/612

The project will develop a prototype software tool for engineers that will enable them to control the production process of concrete structures namely with regard to safety and durability. The model will take into account hydration process, curing methods, the development of hydration heat and possible defects or cracks. The defects invoked by concrete manufacturing have a significant effect on the durability and safety of concrete structures.

GAČR P105/10/1156 - COMOCOS

Complex modeling of concrete structures. The project is focused on the development of the complex methodology for reliability analysis of concrete structures based on a virtual nonlinear simulation and reliability. The approach is based on a randomization of nonlinear finite element analysis of concrete structures. Efficient techniques using both nonlinear analysis of concrete structures and stochastic simulation methods of the Monte Carlo type will be utilized. To determine parameters of material laws in models, inverse analysis based on artificial neural networks has to be performed including the task of damage identification based on dynamic testing. The aim is to develop, integrate and apply the methodologies used on the way from the experiment to the reliability assessment: Fracture-mechanical parameters testing, inverse analysis and damage identification, stochastic nonlinear computational model development, degradation of materials and life-cycle aspects, reliability assessment and risk aspects.

GAČR P104/11/083

Response of cement based composites to fatigue loading using advanced numerical modeling and testing. The project focuses on improvement of computational techniques for assessment of the residual life of cement based composites under long-term cyclic loading, particularly considering the following factors: material composition, fracture properties, frequency of loading, and varying load amplitude. Non-linear numerical models based on cumulative internal damage of the material and utilizing Wöhler (S-N) curves will be developed. Input data for 2D and 3D FE models will be obtained from tests on selected cement based composites with static and fatigue loading (basic database for normal concrete as well as for two classes of high performance concrete will be created). FEM calculations will be used for investigation of limit values for initiation of fatigue damage and fatigue crack growth. The results will be applied in durability assessment of civil engineering structures subjected to cyclic loading such as transport structures and their components, high-rise buildings, etc.

TAČR TA01011019

Simulation software tools for virtual reliability testing and lifetime analysis of concrete structures. The aim of the project is development of integrated software tools for reliability and lifetime assessment of concrete structures, emphasizing structures of traffic infrastructure. Individual approaches are in principle known, particular programs have been developed by members of both research teams and they already belong to high quality products worldwide. These approaches will be worked out, enriched and state of art methods will be implemented. The aim of the project is to integrate these software tools and to create a complex and user-friendly software tools at professional level for industrial use. The simulation tools will model reality well – including both nonlinearity and uncertainties.

E!5157 – ILATAS

Inspection and Lifetime Assessment Tool for Arch Structures. Historical and even new arch bridges all over Europe supporting road and railways structures are not designed for currently required EN-load combinations. The objective of this project is the development of monitoring and numerical-based reliability lifetime assessment device for arch bridge structures.

Articles in the year 2011

PUKL, R., CERVENKA, V., CERVENKA, J., Realistische Modellierung von Werkstoffen und nichtlineare Bemessung von Strukturen im Betonbau, Neue Normen und Werkstoffe im Betonbau, Holschemacher, ISBN 978-3-89932-306-1, pp. 41-56

PRYL, D., Tensile Fatigue of Concrete – Modelling High-cycle Experiments, Applied Mechanics 2011, Velké Bílovice, 18–20.4.2011, ISBN 978-80-87434-03-1, pp. 167

JANDA, Z., Nonlinear Analysis of Reactor Containment in Software ATENA, Applied Mechanics 2011, Velké Bílovice, 18–20.4.2011, ISBN 978-80-87434-03-1, pp. 75

CERVENKA, J., Design of prestressed concrete nuclear containments assisted by numerical simulations, fib symposium Prague 2011, ISBN 978-80-87158-29-6, pp. 839, 8-10. 6. 2011

CERVENKA, V., SISTEK. M., CERVENKA, J., Verification of global safety assisted by numerical simulation, fib symposium Prague 2011, ISBN 978-80-87158-29-6, pp. 62, 8-10. 6. 2011

CERVENKA, V., GANZ, H-R., Development of VLS prestressing anchors supported by laboratory tests and numerical simulations, Beton TKS, 2/2011, Czech Republic, ISSN 1213-3116. pp.34-39. (In Czech)

CERVENKA, J., Nonlinear Analysis of Pre-stressed Concrete Nuclear Containments, Nordic Concrete Research, Proc. of XXI Nordic Concrete research Symposium, Hämeenlinna, Finland 30.5-1.6.2011, ISBN 978-82-8208-025-5, ISSN 0800-6377. pp.437-440.

JENDELE, L., ŠMILAUER, V., ČERVENKA, J., Multi-scale Analysis of Heat Transport in Hydrating Concrete Structures, Civil-Comp Press, 2011, Proceedings of the Thirteenth International Conference on Civil, Structural and Environmental Engineering Computing, B.H.V. Topping and Y. Tsompanakis, (Editors), Civil-Comp Press, Stirlingshire, Scotland

PUKL, R., HAVLASEK, P., SAJDLOVA, T., CERVENKA, V., ADVANCED MODELLING OF FIBRE REINFORCED CONCRETE STRUCTURES, Proc. of fib Congress, Balatonfuered, Hungary, Editors: G. L. Balazs and E. Lubloy, ISBN 978-963-313-036-0, pp. 381

CERVENKA, V., Design of fibre reinforced concrete structures based on nonlinear analysis, Proc. Fibre Concrete 2011, Prague, Czech Republic, 8-9.9.2011, ISBN 978-80-01-04836-8, pp. 11

PUKL, R., SAJDLOVA, T., HAVLASEK, P., Identification of Material Parameters for Nonlinear Modeling of Fibre Reinforced Concrete Structures, Proc. Fibre Concrete 2011, Prague, Czech Republic, 8-9.9.2011, ISBN 978-80-01-04836-8, pp. 45

CERVENKA, J., JANDA, Z., PRYL, D., Numerical Simulation of Prestressed Concrete Containments, Proc. SMIRT 21, New Delhi

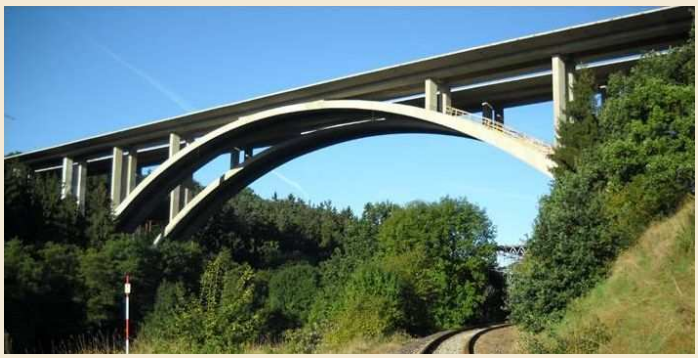
JANDA, Z., ČERVENKA, J., Numerická analýza tlakové zkoušky experimentálního kontejnmentu v laboratořích BARC, Indie, Konference o bezpečnosti komponent jaderných zařízení, Srní 2011, Česká Republika,

JÄGER, A., CERVENKA, J., JANDA, Z., KASA, M., LU, S., AmQuake – Eine Software für Mauerwerks-Design auf Grundlage der Push-Over Analyse nach Eurocode 6 und 8, D-A-CH Tagung, 15-16.9.2011

Practical application – Oparno bridge

(highway Prague – Dresden)

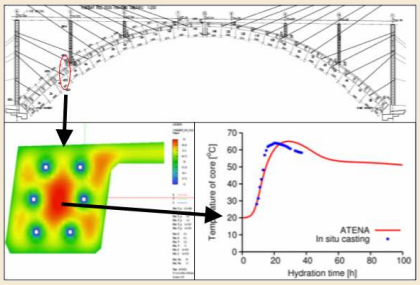
- *Bridge erected during 2008-2011*
- *Arch span 135 m*
- *Arches cast in situ from 6m segments*
- *Budget ~20 mil. €*



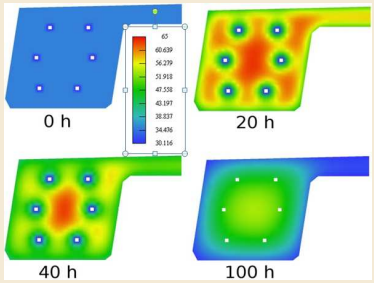
Progress in 08/2010

Optimal position of cooling pipes

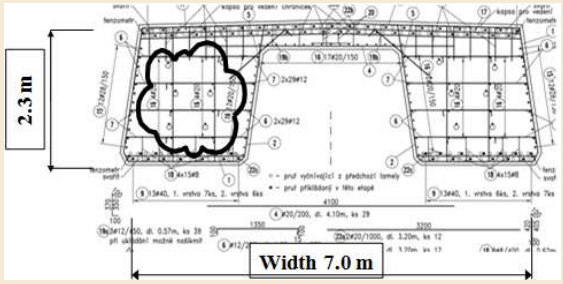
- Arch casting continues through the whole year – varying temperature
- Massive cast arch segments could attain temperature over 90°C during summer, which is unacceptable
- 12 cooling pipes inserted in the arch
- Two criteria:
  - Temperature below 70°C (possible delayed ettringite formation)
  - Reasonable stress field and temperature gradients



Measured temperature in the 4th segment, in the centroid



Temperature field



Optimal position of cooling pipes

Conclusions

- Model for heat and moisture transport
- Multiscale hydration model based on normalized chemical affinity
- Macro model implemented in ATENA software, module CCStructuresTransport
- Micromodel computed by CEMHYD3D
- Results of the transport analysis easily exportable to modules in ATENA, e.g. CCStructuresCreep
- Validation from engineering practice, (the Oparno bridge)

Numerical analysis of filigree ultimate strength test

Ing. Jaroslav Průša, FAST VUT Brno; Strasky, Husty and partners limited

The subject of this project was a verification of the special construction of bridge deck technology utilizing filigree-type of construction, in which precast filigree panels are used as a formwork for the cast-in-place construction of bridge decks. Such method offers savings in time and cost of bridge construction. However, the construction sequence should be considered in design. The method was investigated on the example of a real bridge in Czech Republic over the Hrabynka creek valley. Both, experimental and numerical investigations, were performed for assessment of ultimate load carrying capacity of the filigree deck panel shown in Fig. 1 and 2. Numerical analysis performed with ATENA considered material and geometrical nonlinearities and construction process. The used fracture-plastic material model for concrete is based on the theories of fracture mechanics and plasticity. In the first construction phase only the filigree panel is subjected to its dead load and the load of cast fresh concrete. In this stage the cast-in-place concrete is considered in a liquid state and has no bearing resistance. This leads to a certain stress state in the reinforcement and possible cracks in the filigree panel. In the second stage the cast concrete of deck is considered in a solid state with zero initial stress. In the third stage a live load is added and increased incrementally to failure. In this stage cast-in-place concrete is acting on member resistance, so the integral action of the whole cross-section is considered. The ultimate load carrying capacity achieved in the experiment (437 kN) was near the value obtained from analysis (413 kN). See Fig. 3, 4 and 5.

- **ultimate load carrying capacity – experiment ..... 437 kN**
- **ultimate load carrying capacity – numerical model..... 413 kN (difference 5,8%)**

This project was realized as a part of the grant project FI-IM5/128 "Progressive structures made of high-performance concrete in 2010," under the supervision of Prof. Ing. Jiří Stráský, DSc.

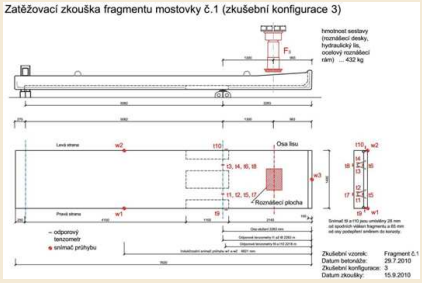


Fig. 1: Test arrangement.

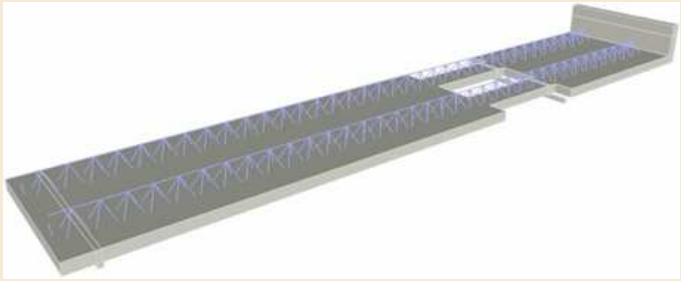


Fig. 2: : Calculation model (cast-in-place concrete is not shown)

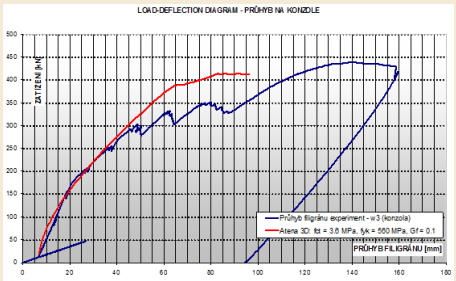


Fig. 3: The comparison of L-d diagrams obtained by experiment and calculation. Results are for loaded cantilever.

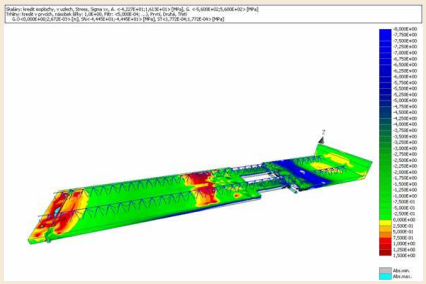


Fig. 4: Normal stress σxx in the filigree panel near the ultimate load carrying capacity.

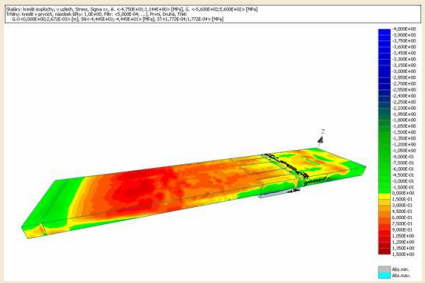


Fig. 5: Normal stress σxx in the cast-in-place concrete near load carrying capacity. (the picture shows the cracks width of 0.5 mm)

Optimization of RC columns with spiral stirrups

by Chan, Po Yu, National Taiwan University

In traditional reinforced concrete structures columns of rectangular cross section reinforced by longitudinal bars in corners and rectangular stirrups are typically used. However, the rectangular shape of ties is not the best form for efficient confining effect of stirrups. A better confinement can be ensured by a circular shape of stirrups.

Aiming for a more efficient technical solution Ruentex company proposed a series of new reinforcing stirrup patterns for rectangular concrete columns. This innovative solution was validated within a research and development project including experimental and numerical investigations, which was in part performed in the research work by Chen, Po Yu under the supervision of Dr. Chern, Jenn-Chuan (FEM Analysis and Optimization Design of 5-Spiral Stirrup Concrete Column, Master thesis, Taiwan National University, Department of Civil Engineering, 2010).

ATENA software was used to simulate the experimental behavior and explain the resistance of the columns. The numerical model used the fracture-plastic material model of ATENA, which simulates the confinement effect of concrete in compression by the Menetre-Willam plasticity surface and the crack development by the fracture mechanics.

Several arrangements of spiral reinforcement in the column cross section were considered as shown in Fig.1 and optimum diameter of stirrups and spiral dimensions were sought. The idea is to improve the load carrying capacity of concrete through a better confinement effect of stirrups.

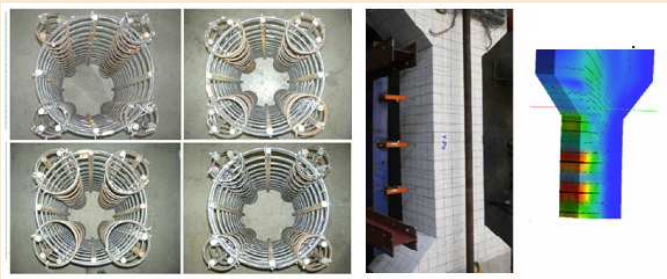


Fig.1 Cases of spiral stirrup arrangement sin column cross sections (left). Crack patterns at peak load of eccentrically loaded column in experiment and analysis (right).

The comparison of experiments and analysis showed a good agreement. The results obtained by numerical simulations, helped to explain the contribution of spiral reinforcement to column resistance. Based on this study it was possible to suggest an optimum design of spiral-reinforced columns. It is recommended that the ratio of inner and outer spiral diameters in spiral reinforcement diameter should be the same as the ratio of confined concrete areas.

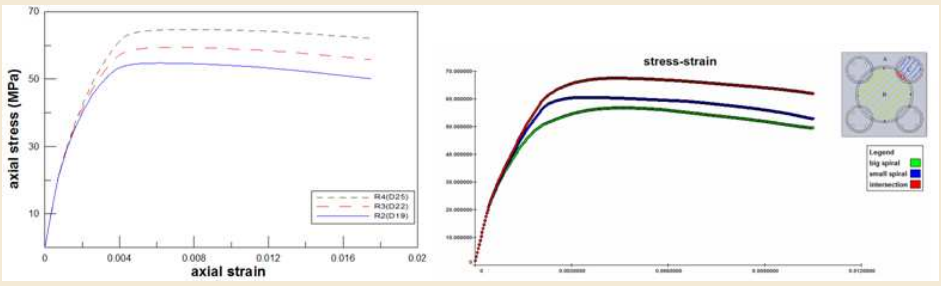


Fig.2 Development of average concrete stresses in columns (left).Stress distribution in concrete in 1/4 of cross section (right).

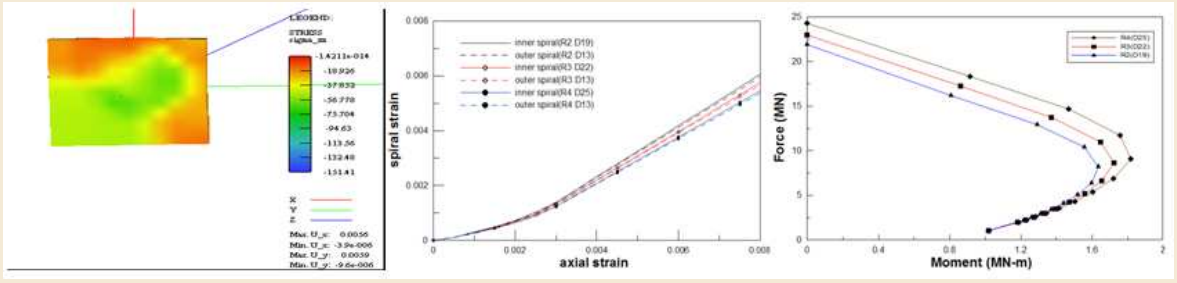


Fig.3 Stress development in confined concrete (left). Strains in spiral stirrups generated by axial strain in column (middle).Interaction diagram of column resistance obtained by the numerical simulations (right).

Further, a recommended relation between the diameter of inner and outer spirals is 3 for centric loading and 3.5 for eccentric loading.

The study has confirmed that a combination of experimental testing with numerical simulation is a powerful method for development of innovative structural technologies.

Where you can meet us

Upcoming Events, Exhibitions and Presentations

SMiRT 21, 21st International Conference on Structural Mechanics in Reactor Technology (India Habitat Centre) New Delhi, India, November 6-11, 2011

18th Concrete Days (Congress Centre ALDIS) Hradec Kralove, Czech Republic, November 23-24, 2011

REC 2012, 5th International Conference on Reliable Engineering Computing (Hotel Continental Brno) Brno, Czech Republic, June 13-15, 2012 Practical applications and practical challenges

ATENA Advanced User Seminar 2012 in CZECH language (CVUT Prague, Faculty of Civil Engineering) Prague, Czech Republic, preliminary scheduled for June, 2012 Info about the previous seminar CZ (2011)

ATENA Advanced User Seminar 2012 (CVUT Prague, Faculty of Civil Engineering) Prague, Czech Republic, preliminarily scheduled for September, 2012 Info about the previous seminar (2011)

IALCCE 2012, Third International Symposium on Life-Cycle Civil Engineering (Hofburg Palace) Vienna, Austria, October 3-6, 2012

FraMCoS - 8, 8th International Conference on Fracture Mechanics of Concrete and Concrete Structures (University of Castilla La-Mancha) Toledo, Spain, March 10-13, 2013