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**EDITORIAL**

Dear Friends and Partners of the Institute for Concrete and Masonry Structures,

With this 28th issue of "Darmstadt Concrete" we continue our Institute's good practice of informing you promptly at the turn of the year of our activities in the year gone by. While the year's end is marked by political debate around possible coalitions, at the level of both the federal government and that of Hesse, and their consequences for universities, some crucial decisions have been taken for the future direction of research and teaching at our Institute, of which we want to inform you in this foreword.

As we already told you last year, the chair of "Werkstoffe im Bauwesen" at our Institute has been vacant since the spring of 2012. The procedure to fill this vacancy is at an advanced stage and we are very hopeful that a competent successor to our colleague Prof. Dr.-Ing. Harald Garrecht will be able to take up the position at the TU Darmstadt by the spring of 2014. Naturally, this past year's teaching in the subject areas of mineral construction materials, construction physics and construction chemistry needed to be fully maintained. Our special thanks for this go to Prof. Garrecht who, in spite of his considerable commitments at the University of Stuttgart, continued to supervise courses at the TU Darmstadt and thereby ensured continuity. In this task he was actively supported by his collaborators who remained in Darmstadt, in particular Mrs. Alexandrakis (Dipl.-Ing.) and Dr. Steindlberger as well as Mr. Röser (Dipl.-Ing.), who therefore also deserve our express thanks.

With effect from 15.5.2013, Dr.-Ing. Gerd Simsch was appointed to the professorship for "Nachhaltiges Bauen im Bestand", a position established in the framework of cooperation at our Institute. This important area of sustainable renovation of building stock ideally complements "Nachhaltigkeit im Bauwesen", a field of research developed in recent years. In accordance with the cooperation agreed between TU Darmstadt and Bilfinger Hochbau GmbH, Prof. Simsch will, in parallel with his activity at the University, work full-time for Bilfinger Bauperformance GmbH, a company of Bilfinger SE, and bring with him an excellent network to our joint teaching and research activity, in addition to his enormous practical experience. The first postgraduate course in "Nachhaltiges Bauen im Bestand" started in October and is well attended by engineering and architecture students. The first research applications have already been submitted. This will further enhance the Institute's national and international visibility and we look on our joint future research tasks with confidence.

Following the departure of Prof. Garrecht, the Research and Test Laboratory at the Institut für Massivbau is currently led by Prof. Graubner alone, who is nevertheless supported in its management by Dr.-Ing. K.-H. Lieberum and Dr.-Ing. T. Proske, both long-term members of staff. In the past year the latter were able to obtain substantial testing commissions in the most diverse areas and thus ensured that the unfortunately markedly reduced staff was sufficiently occupied. The new appointment to the chair of "Werkstoffe im Bauwesen" is to be accompanied by a significant increase in personnel as well as a reorientation of tasks in the Research and Test Laboratory so as to take into account the financial requirements set down by the University's administration.

In order to clarify the changed course contents also to the outside world, the Faculty has agreed on the new designation of "Bau- und Umweltingenieurwissenschaften" which we will use as of now. The Faculty's change in teaching to undergraduate and postgraduate courses is completed. Unfortunately, the concerns voiced in past editions of this annual report as to the consequences of this change in the shape of excessive bureaucratisation of research and teaching were fully justified. With the introduction of an integrated postgraduate course for civil engineers we are currently doing our utmost to be able to guarantee also in future the usual quality of our students. Consistently high numbers of new students and feedback from companies demonstrate the industry's great demand for engineers with a broad-based university education.

This end-of-year report gives us the welcome opportunity to thank our staff for their work. The success achieved this year by our Institute would not have been conceivable without the high quality and great commitment with which our scientists as well as our employees in the secretariats, technical services and laboratories tackle their projects and tasks. This is also the forum in which we congratulate this year's exceptionally large number of research assistants who were able to conclude their research work with the successful defence of their thesis and extend a hearty welcome to the "newcomers". So as to give you the customary insight into our work, you will find our scientists' brief reports on current research activities and development projects in both German and English.

Not least, we would like to offer our thanks to the “Freunde des Instituts für Massivbau der TU Darmstadt e.V.” and in particular to the committee members Herr Hanek and Dr.-Ing. Six for their constant and benevolent support. They greatly assist us not only as organisers of the “Darmstädter Massivbauseminare” but advise, support and sponsor our 3 faculties in many ways. This year we celebrated the 25th anniversary of the Friends with a special event in the Darmstadt State Archive, during which long-standing and deserving members were honoured, and for which occasion we were able to engage our former President Prof. Johann-Dietrich Wörner, Chairman of the Board of Deutsches Zentrum für Luft- und Raumfahrt (DLR) to give a ceremonial address on the subject of “Construction in the Universe”. Numerous members and friends of the Institute availed themselves of the opportunity to meet former colleagues and at the same time acquaint themselves with the Institute’s state of play and current research activities.

The past year’s successful research outcomes and the high level of acceptance of our work among students allow us to face the future with optimism. On behalf of the entire Institute we wish you and your families a happy and peaceful Christmas and a good start for all your undertakings in the New Year.

Prof. Dr.-Ing. Carl-Alexander Graubner

Prof. Dr.-Ing. Gerd Simsch

**Impressions of the bankett for the 25th anniversary of the association of "Freunde des Instituts für Massivbau der TU Darmstadt e.V."**

## REVIEW OF THE LAST YEAR

### NEW PROFESSOR

With effect from 15.5.2013 Dr.-Ing. Gerd Simsch was appointed, on a part-time basis, for the professorship “Nachhaltiges Bauen im Bestand" in the framework of a cooperation arrangement with our Institute. The purpose of this professorship is to strengthen through teaching and research the transfer of knowledge from science to practice while integrating practical subjects into academic education and research. The focus is on sustainable renovation methods in the field of solid construction with regard in particular to structural-physical requirements of quality and comfort. The research is focused on structural civil engineering, with technological problems and solutions under life cycle considerations taking priority. The development and integration of knowledge will encompass in particular the fields of construction design, structural planning, construction and project execution. The foremost aim of teaching is to impart the relevant technical and economic fundamentals and competencies for the renovation and improvement of buildings, with particular consideration of the idea of sustainability.

Prof. Simsch studied construction engineering at the Technische Universität Darmstadt and in 1994 gained his doctorate in the field of high-performance concrete at our Institute. Since 1994 he has worked for the Bilfinger SE group in technical and management positions at the head quarter as well as in civil and building units. He is currently full-time managing director of Bilfinger Bauperformance GmbH, his professorship under the cooperation arrangement being part-time.

## SEMINARS AND EVENTS

Klima- und ressourcenschonendes Bauen mit Beton, Session at the 2nd Darmstädter Ingenieurkongress – Bau und Umwelt

On March 12th and 13th, 2013 the 2nd "Darmstädter Ingenieurkongress – Bau und Umwelt" took place at the *darmstadtium*, the conference center in Darmstadt, hosted by the department Civil engineering and Geodesy. The Institute for Concrete and Masonry Structures organized the session „Development and application of Eco-friendly Concretes".

With nearly 100 participants for our session, the seminar was a great success, which was confirmed by the positive feedback from our guests. Renowned speakers contributed significantly to the success. At this point we want to thank everybody for his presentation. Following an overview of the speakers and topics:

Prof. Dr.-Ing. **Harald S. Müller**, Institut für Massivbau und Baustofftechnologie, Karlsruher Institut für Technologie (KIT), Nachhaltiger Beton - Stand der Technik und künftige Entwicklungen

Dr.-Ing. **Christoph Müller**, VDZ gGmbH Forschungsinstitut der Zementindustrie, Neuartige klimafreundliche Zemente

Prof. Dr.-Ing. **Horst-Michael Ludwig**, F.A. Finger-Institut für Baustoffkunde, Bauhaus-Universität Weimar, Gesteinskörnungen für ressourcenschonende Betone

Dr.-Ing. **Anya Vollpracht**, Institut für Bauforschung, RWTH Aachen, Dauerhaftigkeit von Betonen mit industriellen Nebenprodukten

Prof. Dr.-Ing. **Harald Garrecht**, Institut für Werkstoffe im Bauwesen, Universität Stuttgart, Beton aus nachwachsenden Rohstoffen

Training seminar for structural engineers

The department of concrete and masonry construction cordially invited engineering experts to the 2013 seminar series. Speakers from practise give presentations on newest developments in civil engineering. Throughout the year we were able to attract more than 600 structural engineers. The seminar series was again fully booked and followed the established event concept. Not exclusively, but to a fair share, the seminar series "examples for the design of Eurocodes" was responsible for the very positive feedback from the audience. Furthermore, topics on the latest technological developments in the glass and structural-facing sector and the fire design were discussed. Below you find all six individual seminars; three of which were held in spring, the other three seminars were held in autumn.

- Examples for design according to Eurocode 6 – masonry structures| 13.02.2013
- glass and structural-facing sector | 20.02.2013
- Examples for design according to Eurocode 3 – steel structures | 06.03.2013
- Design for structural fire protection | 04.09.2013
- Examples for design according to Eurocode 2 – concrete structures | 18.09.2013
- Examples for design according to Eurocode 7 – geotechnical design | 25.09.2013

Due to the positive feedback from the past years, we will organise the seminar again in 2014. We are confident that the combination of interesting topics and renowned speakers will again attract many structural engineers. Again six seminars concerning the following themes will be offered.

- DAfStb-guideline steel fiber concrete - backgrounds | 26.02.2014
- Eurocode 1 (actions on structures) – backgrounds | 12.03.2014
- Eurocode 5 (timber structures) - Examples for design | 02.04.2014
- Design and construction of work and supporting scaffolding | 17.09.2014
- Structural damage | 01.10.2014
- News about fixing systems | 08.10.2014

Updates on the seminars, as well as the registration can be found on the homepage of the department of solid construction (www.massivbau.tu-darmstadt.de) under the section „Veranstaltungen". In case of questions, please don't hesitate to contact Mr. Valentin Förster, M.Sc.

Darmstadt Days for Prefabricated Concrete Elements

Due to our cooperation with the professional association "Deutscher Betonfertigteilbau e. V." and the "Beton Marketing West GmbH", we were able to host the renowned seminar series "Darmstadt Days for Prefabricated Concrete Elements" again in 2013. The presented topics varied from the characteristics of prefabricated constructions, which already begin with the initial sketch, to special construction elements and corresponding methods, such as job-mixed additions or prestressed constructions. Further, stability considerations define a focal point with examples, such as lateral buckling and the design and construction of the connections. A total of 300 structural engineers and students participated in the event. The seminars were complemented by an exhibition of renowned manufactures of construction products related to the topic of precast construction.

Due to the positive feedback from the past years, we will offer the seminar series again in 2014. The structure of the event will be setup in alliance with our former events: top-notch papers in their field will be presented, as well as practical examples and our well-attended exhibition. We are confident to attracted a highly diversified audience with a combination of interesting topics and renowned speakers form science and practice. The topics for the upcoming seminar series in spring 2014 are lined up as follows:

- Designing, manufacturing and art | 20.03.2014
- Pre-dimensioning and prestressing | 21.03.2014
- Design und concrete | 03.04.2014
- Connections: Construction and design | 04.04.2014

Generally speaking, the seminar content is tailored towards engineers from practise. However, a separate "student day" takes place in which the design of precast concrete elements will be treated. Thus, the lecture "prefabricated constructions", which takes place in the context of the Darmstadt days of prefabricated concrete elements, can be incorporated into the student's study design. The first day of the seminar series includes a special focus on the design possibilities with prefabricated concrete elements (e.g. photo concrete) aiming to target not only architect, but students in the field of architecture.

Update on the event can be found on the homepage of the department of solid construction (www.massivbau.tu-darmstadt.de). Enter the section named „Veranstaltungen". In case of questions, please don't hesitate to contact Mr. Valentin Förster, M.Sc.

Meeting of the JCSS at TU Darmstadt

March, 7th and 8th 2013, the meeting of the JCSS - Joint Committee on Structural Safety - was held at TU Darmstadt. The annual meeting of the worldwide leading experts in the field of risk analysis of structures is organised to exchange research results and new ideas. Main topics of this years´s meeting were the review of the basic standard for structural safety ISO 2394 as well as the Probabilistic Model Code. Especially the following topics were discussed:

- Extension of Probabilistic Model Code concerning issues like robustness, environmental attack, traffic loads, thermal loads, explosion, glass, material properties variability (indirect measurements).
- „Risk Analysis and Risk Management“: Temporary structures/activities, risk evaluation principles, linking LQI to design standards, natural hazards guideline and natural hazards guideline for developing countries and global risk expert network.

Summer Festival


Quelle: Darmstädter Echo, Foto: Claus Völker

On June 6th, following the association's yearly general meeting, the summer festival of the "Association of Friends of the Institute of Concrete and Masonry Structures and Buildings Materials of the TU Darmstadt" took place. Main topic of this year's event was the association's 25-years anniversary. On May 18th 1988 the association was founded by 13 persons under the guidance of Prof. Dr.-Ing. Gert König. During this year's get-together in the Hessian State Archive the association could welcome many of its over 200 members – amongst them students, former students as well as friends, benefactors and colleagues of the building industry. After the welcome speech of the chairman Prof. Dr.-Ing. Gerd Simsch the guests could enjoy an interesting presentation of the former president of the TU Darmstadt, Prof. Dr.-Ing. Johann-Dietrich Wörner, himself a member of the association for many years. The following reception was highlighted by the musical interlude of the well-known concert pianist Mrs. Susanne Hardick.

Annual Meeting 2013 of the DFG – Priority Program “Lightweight Concrete Structures”

From November 13. to 15. 2013 the 3rd meeting of the participating scientists of the priority program 1542 " Lightweight Concrete Structures " (SPP 1542) of the German Research Foundation was held in Darmstadt. The involved scientists are Civil Engineers, Architects, Mechanical Engineers and Mathematicians. 55 young scientists and professors from renowned German universities shared their latest research findings in the field of "Lightweight Concrete Structures". We are very proud to have the opportunity to host the participants of this meeting at our university. With an evening city tour we showed our guests the old city-center of Darmstadt and the professional and personal conversations were continued in the famous restaurant “Bockshaut”.

More information on SPP 1542 can be found on our website www.massivbau.to.

## COLLABORATION IN STANDARD BODIES

Prof. Graubner is still chairman of the standardization committee NA 005-06-01AA "Masonry Construction", the leading national standards body dealing with issues of standardization in the field of masonry structure. He simultaneously acts as German delegate at European level. In this position he prepares the official introduction of DIN EN 1996 substituting DIN 1053 for design and construction of masonry structures in Germany. Due to his high responsibility in the above mentioned committee Prof. Graubner gave up his position as chairman of DIN-Committee NA 005-51-01 AA "Basis for Design and Calculation of Structures" in march 2013. Nonetheless, he is still member of this standard body with major focus on the reliability-based aspects of analysis and design of concrete structures. Moreover, he is selected member of standard committee NA 005-07-01 AA "Design and Construction of Reinforced Concrete".

Following the aforementioned activities in the field of masonry structures Prof. Graubner is editorial advisor for "Mauerwerk" journal. Recently he is also coeditor of "Mauerwerksbau aktuell", a yearbook which reflects the latest developments and advances in both research and practice of masonry constructions.

Prof. Graubner is member of the "Round Table for Sustainable Construction" consulting the Federal Ministry for Transport, Construction and Urban Development. He is also active in the working group "Sustainability Assessment of Road Infrastructure" at the Federal Highways Research Institute. As a long-standing member of different expert groups Prof. Graubner supports the national German Center of Competence in Civil Engineering.

Prof. Graubner was again elected as the member of assembly of TU Darmstadt for the next 3 years period. In addition he advices the "Förderinitiative Interdisziplinäre Forschung" at Technische Universität Darmstadt, which supports inter-discipline research project activities. At the same time he is a representative expert of the „Graduate School of Energy Science and Engineering" financed by German Research Foundation (DFG).

In 2013, Prof. Simsch was elected as a member of DIN presidium. Since many years he is in charge of the chairman of Building and Civil Engineering Standards Committee, member of "Round Table for Sustainable Construction" of the Federal Ministry of Transport, Building and Urban Development and the member of subcommittee for "Energy efficiency of Buildings" at the Federation of German Industries.

## EXCURSIONS

Bridge Excursion

On Friday, 21st June 2013, 27 students of the Institute of Concrete and Masonry Structures and their lecturer Mr. Kohoutek met at the bridge building site at Seehofstraße, Frankfurt, where an integral steel composite bridge near the railway station Südbahnhof is being built. The excursion began with an introduction of the project by engineers of DB Projektbau, the representatives of the company Max Bögl and the proofing engineer Mr. Vorndran.

**Bridge building site Seehofstraße – view onto the abutments**

At the site, the students got an explanation of the underground works, the works on the supporting bridge structures as well as the works on the integral bridge. Hereby the students got a good insight into the special requirements for the works near the railway tracks of Deutsche Bahn.

We want to thank all for the support and the carrying out of the excursion. This trip was only possible with the generous support from the „Freunde des Instituts für Massivbau". We would like to thank the members at this point sincerely.

Excursion to the European Central Bank (ECB) in Frankfurt

On July 8th 15 students of the Section of Concrete and Masonry Structures took the unique opportunity to visit the building site of the new European Central Bank headquarters in Frankfurt. Due to the fact that the structural work was mostly finished and facade construction and internal finishing were continually supplemented from the building's base upwards, the excursion provided an excellent overview over the various building stages, starting from the plain construction in the top floors down to the almost ready-to-move-in office premises in the lower levels. A special highlight, and at the same time a substantial challenge for all involved parties, was the integration of the cultural heritage rated building shell of the former Großmarkthalle (wholesale market hall) into the new building complex. During the two hours walkabout, the group was guided by Mrs. Renate Dittrich, the building-owner's leading architect, as well as by Prof. Graubner and Dr. Hausmann, the responsible inspection engineers of the engineering consultant KHP. Once more this excursion offered the chance to view an interesting building from a perspective that won't be given again. In the future the spectacular view of the top level floors will be reserved to the ECB managing board and the national central bank directors. We sincerely thank Mrs. Renate Dittrich and the ECB for their commitment towards the practical education of our students.

**Excursion to the European Central Bank (ECB) in Frankfurt**

## PERSONAL MATTERS

Getting his PHD at the TU Darmstadt Dr.-Ing. **Martin Heimann** concluded his career at our institute and now is employed at the BASF SE.

Also Dr.-Ing. **Torsten Mielecke** obtained his PHD at the Fachbereich Bau- und Umweltingenieurwissenschaften. Since the beginning of 2013 he is managing director of the LCEE GmbH.

The employment of Dipl.-Wirtsch.-Ing. **Christian Siegel** at the Institute for Concrete and Masonry Structures was finished in November. He is now employed at the Lidl Stiftung & Co. KG as a project manager and intends to submit his PHD-Thesis in next spring.

Dipl.-Wirtsch.-Ing. **André Tischer** also ends his work in our team. He still works on his PHD-thesis, which is supposed to be ready in summer 2014.

## PHD

Intensive research needs the exceptional commitment of the scientific staff. With the completion of a PHD-thesis the scientist documents the most important results of his scientific work and the gained knowledge. This year, we want to congratulate the following employees of the Institute for Concrete and Masonry Structures for their successful PHD:

**Dr.-Ing. Kay-Uwe Thorn**

**Dr.-Ing. Andreas Greck**

**Dr.-Ing. Martin Heimann**

**Dr.-Ing. Torsten Mielecke**

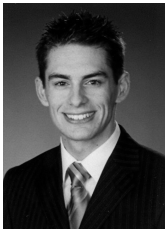
Dr.-Ing. Martin Heimann, Dr.-Ing. Torsten Mielecke, Dipl.-Wirtsch.-Ing. Christian Siegel, Dipl.-Wirtsch.-Ing. André Tischer, Dr.-Ing. Kay-Uwe Thorn, Dr.-Ing. Andreas Greck (from left to right)

## NEW COLLEAGUES

Since January 1st 2013 Dipl.-Ing. **Peter Ramge** is employed at the Institute for Concrete and Masonry Structures. He studied civil engineering at the Technische Universität Darmstadt with focus on concrete structures. He graduated in 2005 with the diploma thesis "Segregation Behaviour of the Coarse Aggregates in Self-Compacting Concrete". Between 2005 and 2006 he worked as a structural engineer. Since 2006 he works as scientific assistant, initially at the Institute for Building Materials of the Leibniz University Hanover (2006 to 2007), where he concentrated on concrete technology issues, and later (2008 to 2012) in Berlin at the BAM Federal Institute for Materials Research and Testing in the divisions "Building Materials" and "Technology of Construction Materials" respectively.

Mrs. Dipl.-Wirtsch.-Ing. **Katharina Fritz** is employed at the Institute for Concrete and Masonry Structures since October 1st, 2013. She studied civil engineering and business administration at the Technische Universität Darmstadt. During her studies she already focused on "Sustainability of buildings and civil engineering structures". Her thesis was about the "Sustainability of civil engineering structures and traffic infrastructures" and she graduated in December 2011 with the diploma thesis "Sustainability in Building´s operations". Until 2013 she worked as a project engineer for complex railway infrastructure projects at the DB ProjektBau GmbH in Frankfurt am Main. Mrs. Fritz is responsible for the lecture "Facility Management & Sustainable Design" and her focus of research will still be on the "Sustainability of buildings and civil engineering structures".

Mr. Dipl.-Ing. (FH) **Gökhan Uysal** M.Sc. (TUM) has started on 1st October 2013 as Ph.D. student at the Institute for Concrete and Masonry Structures in cooperation with the BMW Group. His research area focusses on life cycle costs under uncertainty and life cycle oriented real estate project development. During his studies in architecture at the University of Applied Sciences Munich and industrial engineering at the University of Technology Munich, Mr. Uysal was already responsible for construction projects in early planning phases at the architectural offices Hild und K and Allmann Sattler Wappner.



Mr. Dipl.-Ing. **Jochen Zeier** is a new research associate at the Institute for Concrete and Masonry Structures since October 1st, 2013. He studied civil engineering at the Technische Universität Darmstadt. During his studies he already focused on "Construction Engineering". His thesis was about the development of a "Design Model for NSM FRP Reinforcement for Concrete Members". Therefor he did a semester abroad at the University of Calgary, Alberta, Canada. He graduated with the diploma thesis "Development of a practical design approach for the connection of steel pipes to concrete structures" in February 2011. Afterwards he worked as a project engineer in the department for the planning of structural framework at Julius Berger International GmbH up to February 2013. From March to September 2013 he was as a junior site manager on a construction site of an athletics and football stadium with up to 30.000 seats in Uyo, Akwa Ibom State, Nigeria. Mr. Zeier is responsible for the lecture "Basics of construction Engineering" and his focus of research will be on "Construction Engineering".

Mrs. M.Sc. **Claudia Weißmann** is a doctoral student at the Institute for Concrete and Masonry Structures since December 1st, 2013. Her PhD position is also included in the "Building Integration and Energy Self-Sustaining Settlement Areas" research platform which is part of the Darmstadt Graduate School of Excellence Energy Science and Engineering. Mrs. Weißmann studied civil engineering and business administration at the Technische Universität Darmstadt. She finished her studies in November 2013. In her technical thesis she wrote about "The Vietnamese certification system LOTUS in comparison to the German DGNB system as a certification system of the second generation". Her master thesis contained an "Analysis of the Utilization of Life Cycle Costing and Life Cycle Assessment for Efficient Buildings". During her graduation Mrs. Weißmann will be in charge for the lectures "Indoor Environment I & II" and "Sustainable Construction in existing Buildings".

## GUEST RESEARCHERS

Mr. **Kanishka Bhattacharya** B.Eng. from Indian Institute of Technology Roorkee is a guest-researcher at the Institute for Concrete and Masonry Structures and stays in Darmstadt from September 2013 until March 2014. His research activity is part of the "IIT Master Sandwich Scholarship Programme" instead, which is funded by the German Academic Exchange Service (DAAD). He conducts research in the area of concrete pressure on inclined and curved formwork and investigate this field by numerical calculations. Mr. Kanishka Bhattacharya is supervised by Mr. Björn Freund. Mr. Kanishka Bhattacharya made during his stay his master's thesis.

Mr. **Chacrit Malithong** from Sirindhorn International Institute of Technology was between April and May 2013 as the guest intern at institute for concrete and masonry structures of Technische Universität Darmstadt. His internship at TU Darmstadt was organized as a part of exchange and international program of Technische Universität Darmstadt and Sirindhorn International Institute of Technology. Under supervision of Mr. Moien Rezvani, he made collaborations with running projects entitled “Reduction of Environmental Impacts of Concrete Construction by Developing Cements with High Limestone Contents” and “Adaption of DIN 1045-2 to support the application of eco-friendly cements and concretes”. At the end of his stay, his activities and experiments in laboratory were evaluated as 6 credit points.

Within the scope of the joint German Russian research project “Development of new production modes of lightweight glass ceramic materials from natural and recycling raw materials” (is financed by federal Ministry of Education and Research (BMBF)) the Planning Workshops have taken place in 2013.

Prof. **Olga Kazmina** from the Tomsk Polytechnic University has worked as a guest scientist in Chair of Building Materials, Building Physics and Building Chemistry. From 10.01.2013 to 28.02.2013 the postgraduate student Mrs. Maria Dushkina from the Tomsk Polytechnic University worked within the scope of the project. She has carried out the experimental studies in model mixtures. The results of the cooperation were published in joint articles.

**AWARDS**

Bilfinger Award

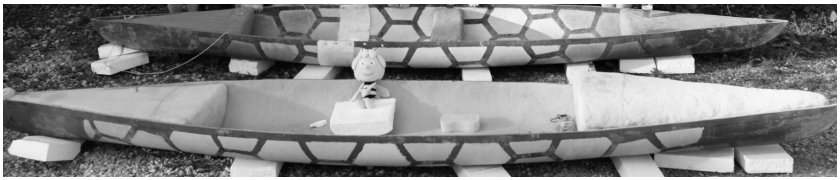
At the TU Darmstadt every year excellent young engineers will be awarded for outstanding achievements with the Bilfinger Award. At the graduation party in February 2013 this price has been given to Mr. Thomas Hessel for his thesis „Human influence on the resistance of reinforced concrete elements“. We congratulate Mr. **Thomas Hessel** on this success.

Dreßler Award 2013

This year the Dreßler-Bau-Preis was awarded for the first time at the TU Darmstadt. The award will be handed over for outstanding bachelor thesis in the technical disciplines Concrete Structures and Construction Management. In December 2013, the first award was given to **Anna Louisa Müller** for her bachelor thesis "Resource efficient cements containing clinker, blast furnace slag and limestone powder” by the President of TU Darmstadt at a festive ceremony. We congratulate Mrs. Müller on this success.

Concrete Canoe Competition

In June a team of the TU Darmstadt took part in the 14th German Concrete Canoe Competition in Nürnberg. The team was coached by Dipl.-Ing. Peter Ramge and Moien Rezvani M.Sc. of the Section of Concrete and Masonry Structures. The two racing canoes taking part were “FLOTTE Maja” and “FLOTTE Willi”. Even though the actual racing competition was sadly not so successful for our team; we still had our sense of achievement in winning the third prize in the T-shirt competition. In the name of the whole team we would like to thank all the sponsors that supported us with donations in either money or kind. Especially the generous support of the “Association of Friends of the Institute of Concrete and Masonry Structures and Buildings Materials of the TU Darmstadt” is to be named in this regard. (see full length report by Peter Ramge on page 37)



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In teaching, a support by experts from the private sector, the industry, administration and organizations is necessary and highly appreciated, especially in order to include all practical aspects of civil engineering.

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| | |
|---|---|
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| Dipl.-Ing. Wolfgang Klein | Gebäudetechnik |
| Dipl.-Ing. Eberhard Pelke | Geschichte des konstruktiven Ingenieurbaus |
| Dr.-Ing. Gert Riegel | Facility Management |
| Dr.-Ing. Holger Schmidt | Risiko und Sicherheit im konstruktiven Ingenieurbau |
| Dipl.-Ing. Heinz Steiger | Massivbrückenbau und Traggerüste |
| Dipl.-Ing. Thomas Becker | Grundlagen der energetischen Bewertung und Optimierung von Gebäuden |

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**Selected Papers:**

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# IMPACT LOADS ON METAL ANCHORS FOR USE IN ASPHALT

Elena Alexandrakis, Karl-Heinz Lieberum, Thomas Niwinski, Waldemar Gunkel

Metal anchors for use in concrete have been an intensive research topic for several years. The European Organisation for Technical Approvals (EOTA) describes in ETAG 001, the guideline for European Technical Approval of Metal Anchors for use in concrete, different fixing types and their design methods. Asphalt anchors, such as the TSM A created by the company Toge-Dübel A. Gerhard KG (Figure 1), are not yet sufficiently investigated and therefore not yet regulated for all possible areas of applications.

Figure 1: anchor for use in asphalt TSM A22x155 IM16

The material properties of asphalt have due to their components of bitumen and aggregate specific characteristics. Bitumen shows a viscoelastic behavior under load. Deformations through impact are thus increasing through rising temperature and are also time dependent. It is therefore advisable to use asphalt anchors initially only for short-term loads. For this purpose, preliminary tests were carried out according to ETAG 001 with shock loading to determine failure modes and fracture patterns. Furthermore, a maximum load was determined. This load shows the limit before the formation of a crack, asphalt cone failure

or pull-out failure. For the determination of the limit load, a short-time load was applied to the anchor. The load was applied impulsively in one second, to simulate for example a collision by a forklift.

The specimens produced in the asphalt plant Darmstadt were compacted layer by layer in a wooden formwork. The used screw anchor, which consists of galvanized steel, was mounted with rotation into the drilled hole filled with injection mortar (Figure 2).

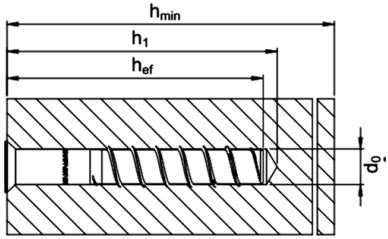


Figure 2: Technical details of asphalt scew TSM A

After installing the attachments, the tensile force was applied impulsively through a servo-hydraulic loading device. The control signal was chosen as a rectangular pulse with a load limiter. The limit load that has to be determined represents the load before the formation of a crack, asphalt cone failure or pull-out failure.

The results of the experiments showed a dependence of the load heights from the bitumen content and the asphalt structure. Besides, it was observed during the experiments that bitumen reduced asphalts tend towards outbreak. Moreover, anchor spacing and edge distance required by the ETAG were significant on the safe side.

# DEVELOPMENT OF MASONRY CODE EUROCODE 6 - DIN EN 1996

Valentin Förster, Carl-Alexander Graubner

On July 1th, 2012, the official introduction for all Eurocodes by the German Building Authorities except Eurocode 6 "masonry" and Eurocode 8 "earthquake" took place. However, the German Institute for Building Technology (DIBt) published a "statement of equivalence" (1) related to Eurocode 6 for the design of masonry, which was released in addition to the aforementioned introduction. Since then it is possible to design masonry components by applying the old standard – DIN 1053-1 – as well as the new standard with national annex – DIN EN 1996/NA. A special mixing rule allows the design of individual components within one structure according to different standards. However, it was not yet possible to conduct a "fire protection design" according to Eurocode 6, because the appending national annex (DIN EN 1996-1-2/NA:2013-06) was not yet available. Due to the fact that the corresponding national annexes for fire design now are published for all parts of the Eurocode 6, the so-called "cold" and "fire protection design" is possible.

Probably DIN EN 1996 will be officially introduced by the building authorities in January 2015 with a cut-off date that excludes a transition period. As of January 2015, the design according to the old standard – DIN 1053-1 – will not be allowed anymore. To ease the use a consolidated version of DIN EN 1996/NA was developed (publisher: Beuth and Ernst & Sohn), which also contains a column with annotations from well-known experts.

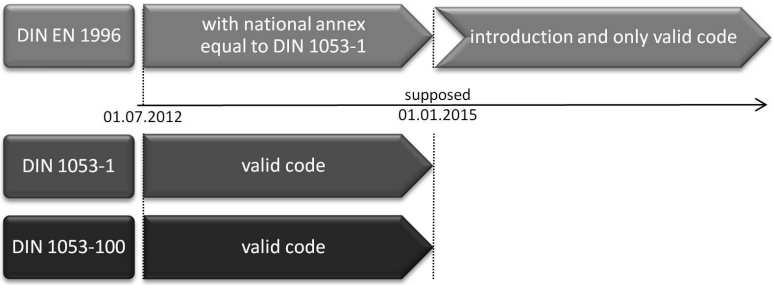


Figure 1: Timeline for the introduction of Eurocode 6 in Germany (1), (2)

The new generation of masonry codes comes with quite remarkable improvements in part 3 of the Eurocode 6. This part contains the simplified design method which is sufficient for the design of usual constructions. Recently the simplified method also includes block masonry with large units and reduced overlapping length as well as masonry walls which are loaded from ceilings only on a part of the cross section.

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# PRESSURE OF FRESH CONCRETE
# RESULTS OF FULL SCALE TESTS

Björn Freund, Carl-Alexander Graubner

In the DFG-research-project “Bases for the development of adaptive formwork systems for free formed concrete structures” which belongs to the DFG-priority-program 1542 fifteen full-scale-tests were carried out. Relevant testing parameters are shown in Table 1. For the full-scale tests two formwork systems were built (1). The reference tests were performed three times (Test–No. 1.1 to 1.3). Scheduled was a consistency class F5, according to DIN EN 206-1, a vertical rising rate $v_{vert} \approx 2$ m/h and an inclination of 45° to the vertical for the inclined formwork. The wall thickness was 20 cm and regular reinforcement was built in. The walls were compacted with an internal vibrator with a diameter of 38 mm.

Table 1: Test parameters

| Point of view | Test-No. | Incli-nation | Thick-ness | $v_{vert}$ | Table flow | Consistency -class | Reinforce-ment | Compacting | $t_{E,eff}$ |
|---|---|---|---|---|---|---|---|---|---|
| [-] | [-] | [°] | [cm] | [m/h] | [cm] | [-] | [-] | [-] | [h] |
| **Reference** | **1.1-1.3** | **45** | **20** | **2.3** | **56.0** | **F5** | **Yes** | **Ø 38 mm** | 11.7 |
| **Casting rate** | **2** | 45 | 20 | **1.2** | 64.0 | F6 | Yes | ∅ 38 mm | 8.8 |
| | **3** | 45 | 20 | **4.1** | 64.5 | F6 | Yes | ∅ 38 mm | 6.6 |
| **Consistency** | **4** | 45 | 20 | 2.2 | 51.0 | **F4** | Yes | ∅ 38 mm | 5.9 |
| | **5** | 45 | 20 | 2.3 | 85.0*1 | **SCC** | Yes | -- | 9.0 |
| **Intensity comp.** | **6** | 45 | 20 | 2.3 | 56.5 | F5 | Yes | **Ø 58 mm** | 10.8 |
| **Reinforcement** | **7** | 45 | 20 | 2.3 | 60.0 | F5 | **No** | ∅ 38 mm | 10.9 |
| **Thickness** | **8** | 45 | **10** | 2.3 | 60.0 | F5 | Yes | ∅ 38 mm | 9.3 |
| | **9** | 45 | **10** | **4.0** | 62.5 | F5 | Yes | ∅ 38 mm | 11.2 |
| | **10** | 45 | **10** | 2.1 | 57.0 | F5 | **No** | ∅ 38 mm | 10.4 |
| | **11** | 45 | **10** | 2.3 | 87.5*1 | **SCC** | Yes | -- | 16.2 |
| **Inclination** | **12** | **60** | 20 | 2.4 | 65.0 | F6 | Yes | ∅ 38 mm | 11.8 |
| | **13** | **30** | 20 | 2.3 | 57.0 | F5 | Yes | ∅ 38 mm | 12.2 |

*1: Slump flow

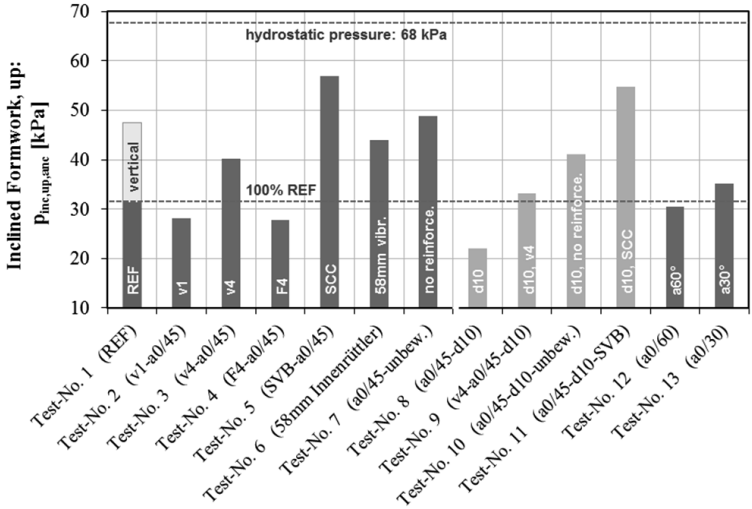


Figure 1: Formwork pressure of the upper inclined formwork $p_{inc,up,anc}$, calculated from the measured anchor-forces and their acting areas (pressure normal to the formwork)

Figure 1 shows the maximum formwork pressure of the upper inclined formwork normal to the surface. For Test No. 1.3 Figure 1 also shows the maximum formwork pressure of the vertical formwork. Compaction intensity (T.-No.6), reinforcement artio (T.-No.7) and wall thickness (T.-No.8) had a significant influence of the formwork pressure. A detailed documentation of all test results is published in (2).

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# DECISIVE COMBINATIONS OF ACTIONS FOR DESIGN OF INTERIOR REINFORCED CONCRETE WALLS

Jaroslav Kohoutek, Ngoc Linh Tran, Carl-Alexander Graubner

With the introduction of the partial safety concept structural elements are designed in ultimate limit state with a separate consideration of the resistance $R_d$ and the action $E_d$. On the action side it is divided into permanent and variable actions. The probabilities of the simultaneous occurrence of variable actions are covered by the so-called combination coefficients $\psi_0$ corresponding to the prompted reliability level. In multi-storey buildings both innovations formally lead to a variety of possible combinations of actions with corresponding computational effort.

Figure 1 presents a static model for interior load bearing walls made of reinforced concrete, which was taken from masonry code (see (1), appendix C). The number of combinations of actions (LC) for interior walls which have to be formally considered is 64. Ten selected possible load combinations are presented in table 1.

Table 1: Selection of possible LCs for design of interior reinforced concrete walls

| | **LC 2** | **LC 7 max $M_{Ed}$ corr. max $N_{Ed}$** | **LC 10** | **LC 17** | **LC 23 max $M_{Ed}$ corr. min $N_{Ed}$** | **LC 26** | **LC 32** | **LC 36** | **LC 40** | **LC 55** |
|---|---|---|---|---|---|---|---|---|---|---|
| Self-weight $\gamma_G$ | 1,35 | 1,35 | 1,35 | 1,35 | 1,35 | 1,35 | 1,35 | 1,0 | 1,0 | 1,0 |
| Imposed load $\gamma_{Q,o}$ | 1,5 | 1,5 | 1,5 | 0 | 0 | 0 | 0 | 1,5 | 1,5 | 0 |
| Live load $\gamma_{q1}$ | 1,5 | 1,5 | 0 | 1,5 | 1,5 | 0 | 0 | 1,5 | 1,5 | 1,5 |
| Live load $\gamma_{q2}$ | 1,5 | 0 | 1,5 | 1,5 | 0 | 1,5 | 0 | 1,5 | 0 | 0 |
| Live load $\gamma_{q3}$ | 1,5 | 0 | 1,5 | 1,5 | 0 | 1,5 | 0 | 0 | 0 | 0 |
| Live load $\gamma_{q4}$ | 0 | 1,5 | 0 | 1,5 | 1,5 | 0 | 0 | 0 | 0 | 1,5 |

An extensive parameter study was carried out to find decisive combinations of actions. Hereby span ratio $L_3/L_4$, celling height $h_1$, wall dimensions h/d, ratio of live load and self-weight q/g, number of floors above n as well as concrete grade are varied. To determine the maximal load action on the wall the required reinforcement ratio ρ is calculated.

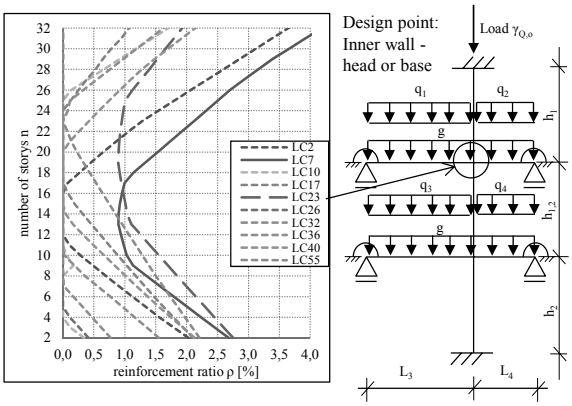



Figure 1: Possible and decisive load combinations (LC) for a interior wall made of concrete C30/37 with h = 0,20 m, $h_{1,2}$ = 3,0 m, $L_3/L_4$ = 2; q/g = 0,43

In summary, it can be noted that in the design only the combinations of actions, which lead to maximal moment max. $M_{Ed}$ as well as the corresponding maximal/minimal axial force max. $N_{Ed}$ / min. $N_{Ed}$, are decisive.

$$E_d = \Sigma\{1{,}35 \cdot G_k + 1{,}5 \cdot Q_{k,o} + 1{,}5 \cdot q_{k,1} + 1{,}5 \cdot q_{k,4}\} \quad \text{(a)}$$

$$E_d = \Sigma\{1{,}35 \cdot G_k + 1{,}5 \cdot q_{k,1} + 1{,}5 \cdot q_{k,4}\} \quad \text{(b)}$$

Based on these results the computational effort can be significantly reduced in practice.


(1) DIN EN 1996-1-1:2013-02, Eurocode 6: Bemessung und Konstruktion von Mauerwerksbauten – Teil 1-1: Allgemeine Regeln für bewehrtes und unbewehrtes Mauerwerk, Beuth Verlag, Berlin, 2013

# SOIL PRESSURE ON ABUTMENT WALLS OF INTEGRAL BRIDGES

Jaroslav Kohoutek

Integral bridges made of reinforced or prestressed concrete are monolithically connected between superstructure and substructure and form a statically indetermined frame structure. Thermal loads on the horizontal member with a constant value $\Delta T_N$ as well as temperature differences between the top and bottom $\Delta T_M$ lead to restraints in the structure. This causes movements of the abutment wall which lead to a mobilised earth pressure min $e_{mob}$ on the abutment wall. According to RE-ING (1) and Berger et al. (2), min $e_{mob}$ lies in between active earth pressure $e_a$ and earth pressure at rest $e_0$, while max $e_{mob}$ lies in between earth pressure at rest $e_0$ and passive earth pressure $e_p$.

$$e_a \leq \min e_{mob}(z) = e_0 - (e_0 - e_a) \cdot \frac{v(z)/z}{b + v(z)/z} \leq e_0 \qquad \text{(a)}$$

$$e_0 \leq \max e_{mob}(z) = e_0 + (e_p - e_0) \cdot \frac{v(z)/z}{a + v(z)/z} \leq e_p \qquad \text{(b)}$$

a factor for soil compaction: For soils according to RIZ-ING Was 7 a = 0,02.

b = a/10

v(z) horizontal displacement at depth z [m]

In figure 1 the earth pressures on a frame structure caused by thermal loads expressed in Eq. (c) and Eq. (d) are shown.

$\Delta T_{pos} = 0{,}75 \cdot \Delta T_{M,heat}$ (top warmer +12,3K) + $\Delta T_{N,exp}$ (+29K warm) (c)

$\Delta T_{neg} = 0{,}75 \cdot \Delta T_{M,cool}$ (top cooler -8K) + $\Delta T_{N,con}$ (-26K cool) (d)

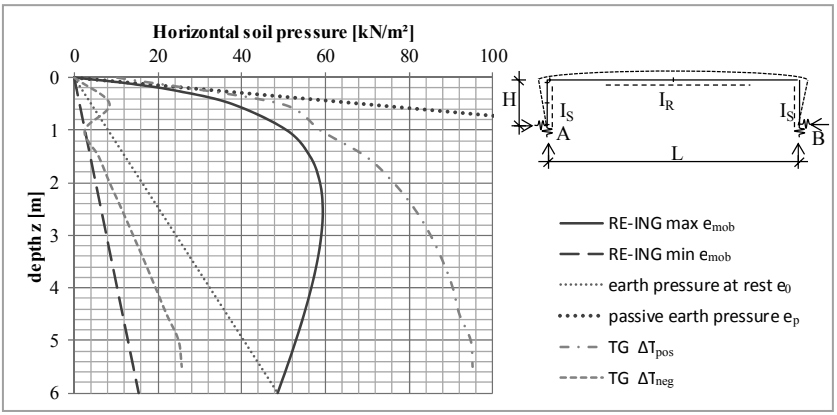



Figure 1: Comparison of the earth pressures on the abutment wall of a frame bridge with L = 90 m and H = 6 m caused by thermal loads (in compliance with (3))

The results show, that earth pressures min $e_{mob}$ according to RE-ING lead to safe results of minimal earth pressures. This has a high significance e.g. for the bending design criteria, because earth pressures cause favorable normal forces. At the same time the results show, that the maximal earth pressures are significantly higher than max $e_{mob}$ according to (1). Reasons for the higher earth pressures on the abutment wall are movements of the base points as well as the restrained rotation of the head of the abutment by the horizontal member, which usually have not been taken into account in design standards. These effects will be further analyzed in a dissertation.


(1) Draft: Richtlinie für den Entwurf und die Ausbildung von Ingenieurbauwerken (RE-ING), Bundesministerium für Verkehr, Bau und Stadtentwicklung, 2011.

(2) Berger, D.; Graubner, C.-A.; Pelke, E.; Zink, M.: Besonderheiten bei Entwurf und Bemessung integraler Betonbrücken, Beton- und Stahlbetonbau, Ernst & Sohn 2004.

(3) Israel, K.: Soil-structure-interaction analysis of integral bridges, masterthesis at the Institute of Concrete and Masonry Structures, TU Darmstadt, 2013.

# NUMERICAL MODELLING STRATEGIES FOR PREDOMINANT LATERAL OUT-OF-PLANE LOADED MASONRY WALLS

Michael Schmitt

The modelling of masonry structures generally differs in three different levels of accuracy (see figure 1). Basically a distinction is made between discrete and homogeneous modelling, in which the discrete modelling distinguishes in micro-level and meso-level. In the micro-level bricks and mortar are modelled in detail with a high degree of accuracy. In the meso-level ("simplified micro-level") the mortar layer are modelled through interface-elements. For that purpose the elements describing bricks have to be scaled up to the thickness of the joint. The macro-level does not differentiate bricks and mortar completely. The masonry is modelled as homogeneous continuum with smeared material (see (1)).

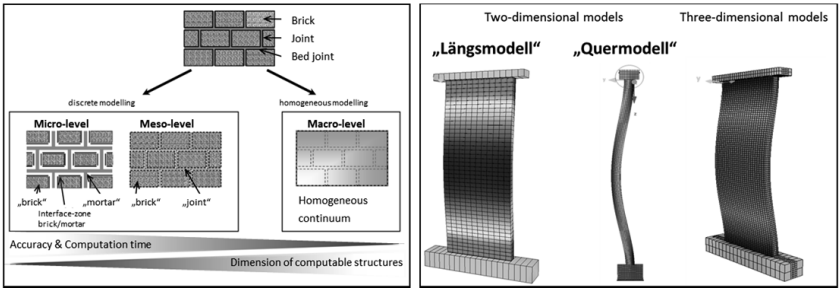



Figure 1: levels of modelling according to (1) and (2)

It is prejudicial that the potential failure mechanisms in masonry cannot be determined exactly and the crack formation on the bed joints cannot be localised clearly. Computation time decreases with a low level on detail, whereby it is possible to model large structures. Up to now individual wall details are usually modelled in the micro-level, whereas whole masonry walls with proportional low input can be simulated in the macro-level.

Another determination concerning the modelling type can be taken in reference to two- or three-dimensional models. In two-dimensional-plate models the thickness of the masonry wall determines the thickness of the elements. Depending on software solutions stresses can be viewed on the surface of the wall but not inside the element. By placing several elements in the thickness of the wall, the stresses can be viewed sophisticated inside the wall. Because of the absence of the longitudinal direction, it is only possible to model two-sided supported masonry walls (see (2)). This disadvantage can be countered using three-dimensional-models.

For the research of predominant lateral out-of-plane loaded masonry walls the detailed and realistic modelling of the wall thickness plays a decisive role. That is the reason why 3-D-modellings should be used for three-sided or four-sided supported walls. However if the structural behaviour as well as the modes of failure are clearly clarified, 2-D-modellings can be used.

(1) M. Mistler, Verformungsbasiertes seismisches Bemessungskonzept für Mauerwerksbauten, Aachen: Dissertation, Selbstverlag, 2006

(2) S. Schmitt, Numerische Untersuchungen zur Ermittlung von Membrandruckkräften bei nichttragenden Mauerwerkswänden, Masterthesis, Darmstadt, 2013

# DEMAND FORECASTING IN CONSTRUCTION LOGISTICS: PRELIMINARY INVESTIGATION ON THE APPLICATION OF "ARTIFICIAL NEURAL NETWORKS"

André Tischer

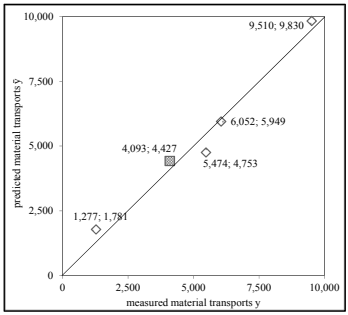
In the design phase of new construction projects the planners of construction logistics have to carry out the resource planning and to compare different logistics strategies against each other with reasonable effort. One of the main parameters that has to be known for this purpose is the ´total number of material transports´ to site. But: its value is unknown and uncertain. Furthermore, it depends on different influencing factors as the size of the building or the construction time.

The problem is that the uncertain value of the parameter has to be predicted and estimated in the early design phase with reasonable effort and with the highest possible quality. One possibility to solve this problem of prediction would be to apply artificial neural networks (ANN) methodology - as introduced in Figure 1 - using several sets of empirical data for training and testing an ANN.

In this paper we present preliminary results of a modelled, trained and, finally, tested Radial Basis Function (RBF) net - as one possible architecture of an ANN used for our problem. To this we used $n_j$=4 sets of data with j=[1,4] for training the net and $n_j$=1 set of data for testing it (j=5). In particular, we wanted to estimate for a project the ´total number of material transports´ (output $y_j$) if the size of a building, measured in m²-Gross Floor Area (input $x_{j1}$), and the total construction time, measured in working days (input $x_{j2}$), is known.

Figure 1 summarises the results of predictions by the net for the worked example: The prediction error of the model for each of the data sets is between -2% and 39%. The Mean Absolute Percentage Error (MAPE) is 13%. Keeping in mind that we just used four training sets of data for the ANN and modelled it with only two input neurons the MAPE seems to be not all that bad. It remains for future work to train the net with more data sets and to review the architecture of the ANN used for our problem.

| j | x1 | x2 | y | 10 Iteration to predict the centres | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | d1 | g1 | d2 | g2 | ŷ | Error | MAPE |
| 1 | 511 | 121,422 | 9,510 | 10,711 | 0.9915 | 52,933 | 0.7788 | 9,830 | +3% | |
| 2 | 660 | 29,467 | 6,052 | 81,244 | 0.6121 | 23,266 | 0.9605 | 5,949 | -2% | |
| 3 | 601 | 100,000 | 5,474 | 10,711 | 0.9915 | 47,267 | 0.8469 | 4,753 | -13% | 13% |
| 4 | 380 | 76,000 | 1,277 | 34,711 | 0.9143 | 23,267 | 0.9605 | 1,781 | +39% | |
| 5 | 460 | 37,015 | 4,093 | 73,696 | 0.6677 | 15,718 | 0.9818 | 4,427 | +8% | |



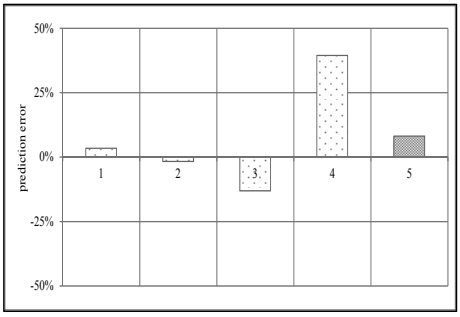




Figure 1: Data for training the RBF net and prediction by the net of the worked example.

# PREDICTION OF SHEAR STRENGTH OF REINFORCED CONCRETE BEAMS WITHOUT STIRRUPS

Ngoc Linh Tran, Carl-Alexander Graubner

Due to the complicated load bearing behaviour predicting the shear strength of reinforced concrete elements is still a big challenge. All the current design concepts of shear resistance of reinforced concrete elements use empirical calculation models, e.g. according to DIN-1045-1, which are often limited by certain boundary conditions. In this article a new calculation model for predicting the shear strength of reinforced concrete beams without stirrups is presented. The considered shear strength $V_R$ [kN] depends on the characteristic concrete strength $f_{ck}$ [N/mm$^2$], longitudinal reinforcement ratio $\rho = A_s/(bd)$, elastic modulus ratio between reinforcement and concrete $n_e = E_s/E_c$,width $b$ [mm] and height $d$ [mm] of cross section and distance $a$ [mm] between load point and support. The main idea of this approach is the consideration of shear strength in compression zone and an additional shear strength in tension zone. To calculate the shear strength in tension zone, an effective height of shear region is defined, which depends on concrete strain of crack zone from support to load point ( see Fig. 1).

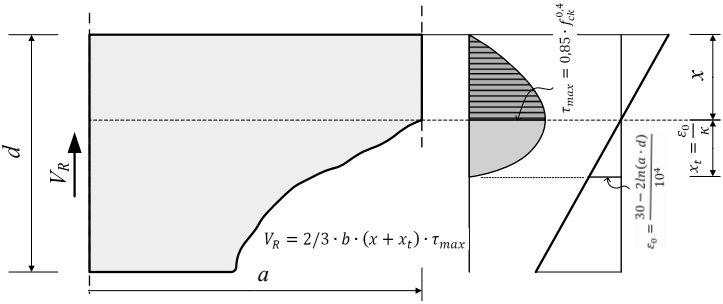
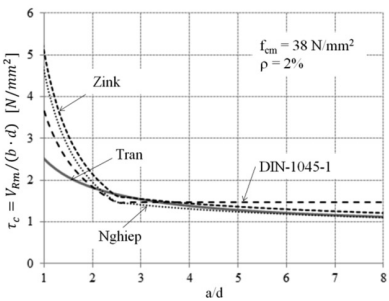



Figure 1: Calculation model

Formula (a) describes the average shear strength. Here $k_x = \left(\sqrt{1 + 2/(\rho n_e)} - 1\right) \cdot \rho n_e$ describes the relative height of compression zone.

$$V_{Rm} = \frac{0{,}85}{3} bd \cdot f_{ck}^{0,4} \cdot k_x \left(1 + \sqrt{1 + 1{,}9 \cdot (3 - k_x)\frac{d}{a}[14{,}4 - \ln(a^{1,33} d^{0,44})]}\right) \cdot 10^{-3} \qquad \text{(a)}$$

For elements with axial force including pre-stressed members, an additional shear force $V_N$ resulted can be added to the shear strength. A comparison of calculation results using the new developed calculation model and the models of DIN-1045-1, Zink (2) and Nghiep (3) with the experimental results (1) is presented in the Fig.2.




Experimental Data

| Description | $f_c$ | d | b | a | $V_{u,exp}$ | $\tau_{u,exp}$ | ρ |
|---|---|---|---|---|---|---|---|
| | N/mm² | mm | mm | mm | kN | N/mm² | % |
| Max | 127,50 | 2000 | 3000 | 8758 | 1295,30 | 4,31 | 9,50 |
| Average | 34,26 | 295 | 209 | 1056 | 84,82 | 1,48 | 2,41 |
| Min | 12,20 | 41 | 21 | 124 | 1,90 | 0,34 | 0,25 |
| Total 1162 samples were taken from (1) | | | | | | | |

Evaluation of Model Uncertainty

| Description | Tran | Zink | Nghiep | DIN-1045-1 |
|---|---|---|---|---|
| $\theta_m$ | 1,040 | 0,988 | 1,074 | 1,044 |
| $\sigma_\theta$ | 0,177 | 0,173 | 0,185 | 0,211 |
| $V_\theta$ | 0,170 | 0,176 | 0,172 | 0,202 |
| $\theta_{max}$ | 1,719 | 1,770 | 1,926 | 1,994 |
| $\theta_{min}$ | 0,653 | 0,503 | 0,537 | 0,606 |

Figure 2: Comparison of some calculation models

The results in Fig. 2 show that the new calculation model gives the best result compared to the other considered models. In the new model, no special modification, e.g. for the case of near support region, is required. After evaluating the sensitivity factors a safety factor $\gamma_R = 1.5$ is suggested for determination of the design value $V_{Rd} = (1/1.5) \cdot V_{Rm}$. This corresponds to the safety index β of 4.4 as recommended in (1) for a period of 50 years.


(1) K.H. Reineck, D.A. Kuchma, B. Fitik: Erweiterte Datenbanken zur Überprüfung der Querkraftbemessung, DAfStb, Heft 597, 2012.

(2) M. Zink: Zum Biegeschubversagen schlanker Bauteile aus Hochleistungsbeton mit und ohne Vorspannung. Doctoral thesis, University of Leipzig, 2000.

(3) V.H. Nghiep: Shear Design of Straight and Haunched Concrete Beams without Stirrups, Doctoral thesis, TU Hamburg-Harburg, 2011.

# CARBONATION OF CONCRETES WITH CEMENTS CONTAINING HIGH AMOUNTS OF LIMESTONE

Stefan Hainer, Tilo Proske, Carl-Alexander Graubner

In recent years extensive strategies for the reduction of the clinker content in concrete were developed to reduce the costs and environmental effects of the concrete industry. The use of composite cements with several main constituents was most commonly practiced. The Portland cement clinker in cement will be replaced by latent hydraulic (blast furnace slag), pozzolanic (fly ash, trass) or inert constituents (limestone). In contrast to limestone, pozzolanic and latent hydraulic main constituents provide a significant contribution to the compressive strength in present of portland cement clinker. Unfortunately they are not available in appropriate quantity and in some cases only locally. The accumulated amounts of fly ash and slag in Germany are already used completely in the concrete industry. For that reason, the use of larger amounts of limestone in cement has been investigated in experimental investigations.

In the first step, concrete specimens were prepared at a water-cement ratio of 0.50 with a CEM I 52.5 R. The clinker component CEM I was substituted by limestone stepwise. Both the compressive strength and the Carbonation resistance were tested. Using around 60% clinker, a compressive strength of approximately 40 N/mm ² was achieved. The measured carbonation depth using the accelerated carbonation test (2% $CO_2$ for 28d) was about 8 mm. Using a water-cement ratio of 0.50 higher amounts of limestone powder resulted in a low compressive strength and a large carbonation depth.

In the next step the water-cement ratio was reduced from 0.50 to 0.40 and 0.30. A reduction of water cement ratio at equal cement composition leads to higher strengths and reduced carbonation depths. The results of the experimental investigation are shown in figure 1.

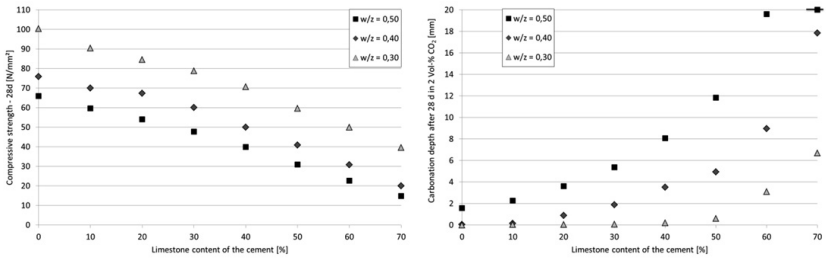



Figure 1: Compressive strength (left), carbonation depth (right)

At a reduced water-cement ratio, a compressive strength of approximately 40 N/mm² can be obtained using a cement containing 50% limestone and at a water-cement ratio of 0.40. With a further reduction of the water-cement ratio to 0.30 the strength of 40 N/mm² can be obtained with 70% limestone. The measured carbonation depths of these concretes fine fall below the critical carbonation depth of 8 mm. The depth of 8 mm was determined in preliminary tests on concretes produced with conventional cements mixture and mixture compositions according to DIN 1045-2 for exposure class XC4. Therefore the use of these types of concrete mix design should be useable for exposure classes XC1-XC4.

# INFLUENCE OF ENVIRONMENTAL CONDITIONS ON THE CARBONATION RESISTANCE OF CONCRETE

Stefan Hainer, Tilo Proske

Material properties of concrete are examined mainly in specified laboratory conditions. Commonly concrete specimens are stored after a defined curing period at a relative humidity of 65% and a temperature of 20°C. In contrast, typical boundary conditions of exposed concrete surfaces are alternating wetting and drying cycles. In addition, the frequency of precipitation, precipitation intensity and humidity are dependent on location and season. In particular, the carbonation progress of concrete is strongly influenced by such environmental conditions as the weathered concrete surface must ensure the protection of the steel reinforcement. In addition, the environmental conditions may have different effects on the concrete properties depending on the cement type. Therefore the real carbonation resistance of concrete can only be determined on specimens that are exposed to real environmental conditions. This method can be used according to DIN EN 12390-10, but the results are not reproducible and transferable to other locations without limitations. An interesting method was published in (1), in which the specimens are dipped at regular intervals for time periods of about 2 hours in water, should reflect the real environmental conditions sufficiently accurate and should be carried out consistent.

In experimental tests, it was investigated whether such a method can represent real environmental conditions adequate close to reality. Specimen of 4 different concretes were produced and exposed to four different environmental conditions. The compressive strength was determined after 140 days, the carbonation depth after an exposure period of 210 days. All specimens were cured for 7 days. After the curing, samples were stored in a conditioned chamber at 20 ° C and 65% RH, additional specimens dipped 2 times per week

for about 2 hours in water. Also specimens were stored outside, both exposed to weather conditions as well as protected from the rain. The results of the determined compressive strengths and carbonation depths are shown in figure 1:

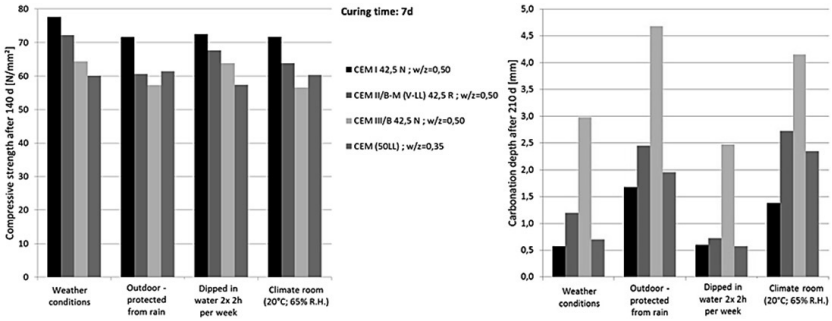



Figure 1: Compressive strength (left), carbonation depth (left)

The results show that different environmental conditions affect the carbonation depth stronger than the compressive strength. According to this the compressive strength can be determined sufficiently accurate under laboratory conditions (20°C; 65% R.H.). Contrary, the identified carbonation depth of specimens exposed to weathering is much lower than for specimens that were stored under laboratory conditions. The reason for this is a continuous moisture penetration, which slows the $CO_2$ diffusion in the concrete. The method of dipping the specimen in water allows a sufficiently accurate simulation of the real environmental conditions concerning the progress of carbonation. This is valid for all investigated cements

(1) Meyer, A., Wierig, H.-J., & Husmann, K. (1967). Karbonatisierung von Schwerbeton (Bd. Deutscher Ausschuss für Stahlbeton Heft 182). Berlin: Wilhelm Ernst & Sohn.

# REDUCTION OF ENVIRONMETAL IMPACT OF CONCRETE CONSTRUCTIONS BY USING NEW TYPE OF CEMENTS WITH ADEQUATE AVAILABLE RAW MATERIALS

Moien Rezvani, Tilo Proske, Stefan Hainer

The target of this cooperative project was to develop new cement types with the limestone content beyond DIN EN 197-1 limits in both laboratory and mass-produce scale, in order to reduce the environmental impact of concrete construction. Different limestone contents between 35 to 70 percent of cement clinker were chosen. The chemical and mineralogical composition of limestone were in the range of DIN EN 197-1 (75 to 100 M.-% of $CaCO_3$).

The results showed that the by employing the modified and improved concrete technology, the cements with a limestone content up to 50 M.-% are basically can fulfill the mechanical and durability requirement of a structural concrete. Moreover, fresh concrete properties of concretes made of cements with high limestone content were proved according to DIN 1045-2. Laboratory tests showed that some fresh and long term behavior of these concrete are highly dependent on the interaction among the type of limestone and applied superplasticizer.

A practical test was conducted in a ready mix concrete plant. This experience showed that an appropriate and robust concrete mixture made of clinker reduced cement in a full-scale case can be produced by a slight modification in the dosage of superplasticizer and adjusting the aggregates grading curve.

All in all, it can be concluded that production and application of concretes with composed of cements with high amount of limestone content up to 50 M.-% requires more stringent supervision as well as technical consideration (reduction of water content and introduction of admixtures). However, these challenges and difficulties can be dominated by environmental benefits of concretes with clinker reduced cements.

Life cycling assessment (LCA) showed that substitution of Portland cement clinker with limestone can significantly reduce the environmental impacts during cement production processes. Concretes with low water-cement ratios made of cements with high limestone contents exhibit the same or comparable performance (compressive strength and durability) in comparison to the reference mixtures, while possessing better values in most of LCA categories. For instance the global warming potential (GWP) of concrete with 50 M.-% limestone cement is about 25 % less than average of German EPD-cements (Figure 1).

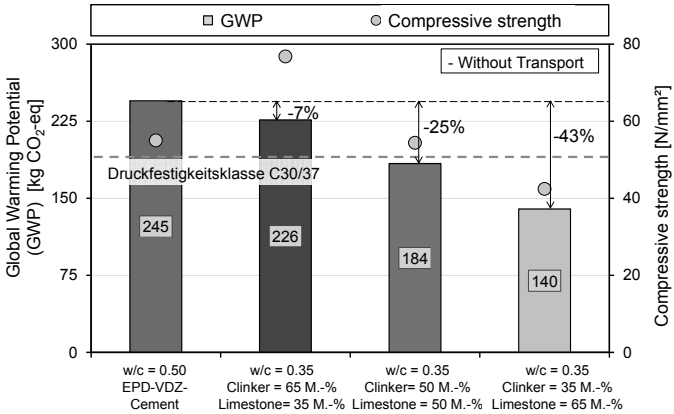



Figure 1: Comparison of global warming potential of concretes with clinker reduced cements with average of German EPD-cements

# FROST-THAW RESISTANCE OF CONCRETES WITH HIGH AMOUNT OF LIMESTONE POWDER

Moien Rezvani, Tilo Proske

In practice, depending on the region of application, hardened concrete may undergo sever freeze-thaw attack during its service life. Damages due to frost-thaw attacks are known in two terms; surface mass loss and the loss of dynamic modulus of elasticity. Mass loss of the specimens can be determined by determining the scaling materials against different frost-thaw cycles. Internal damage is determined using non-destructive method, where the change in ultrasonic pulse wave velocity across the specimen is monitored during different frost-thaw cycles. The mass loss of 2000 g/m³ and loss of dynamic modulus of elasticity up to 75 % are known as the acceptance limits for concrete under XF1 exposure class (1).

In this study, the durability of nine concrete mixtures with different compositions against freeze-thaw attack was investigated. For this purpose two specimens for each mixture were prepared. The variables were the water/cement-ratio, limestone content of cement (35, 50 and 65 wt. % of cement) and type of limestone powder (RK with $CaCO_3$ = 98 wt. % SE4 and SE5 both with $CaCO_3$ = 75 wt. %), limestone fineness (SE4 and SE5) as well as the partial substitution of limestone with fly ash (FA). The experiments were conducted on the 100×100×100 mm³ cubes in accordance with DIN CEN/TS 12390-9: "Cube-test-procedure". At the age of 28 days, the specimens were stored in water for one day. Thereafter, the specimens were placed in freeze-thaw chamber for 56 cycles. Within test period, the scaling materials as well as relative dynamic modulus of elasticity (RDM) were determined weekly (each 7 cycles). The results of mass loss and relative dynamic modulus of elasticity are depicted in Figure 1. The dashed line shows the limits of exposure class XF for external- and internal damages. The results indicate that freeze-thaw resistance of

specimens is highly dependent on the mixtures compositions. The influence of the water/cement-ratio seems to be crucial.

Increase in the limestone content from 35 to 65 M.-% resulted in a significant increase of scaling materials. All the samples with limestone content of 50 M.-% and w/c-ratio of 0.35 had lower RDMs and mass loss than the reference concrete. Interestingly, introduction of fly ash to the mixtures led to a remarkable improvement of both RDM and mass loss of the specimens. This is probably due to the pozzolanic effect of fly ash and improvement in pore size distribution in cementitious matrix. Despite slight lower compressive strength, mixtures with SE4 and SE5 exhibited a good resistance against frost-thaw attack due to their higher air content. However, all concretes with 50 wt. % limestone and w/c-ratio of 0.35 had acceptable resistance against XF1 freeze-thaw attack.

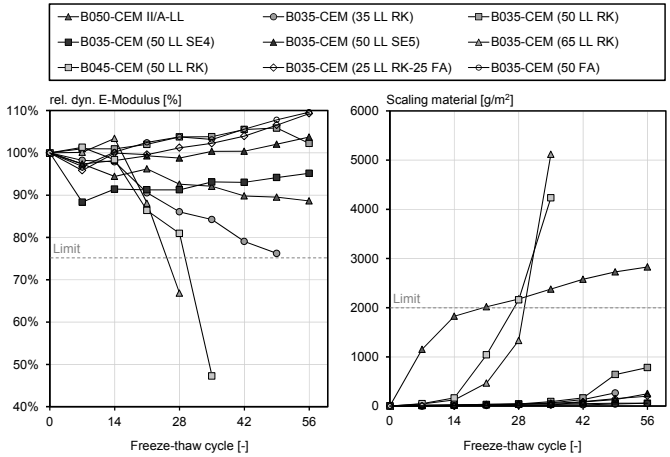



Figure 1: relative dynamic modulus of elasticity (left) and cumulative scaling materials of specimens up to 56 freeze-thaw cycles (right)

(1) Deutscher Ausschuss für Stahlbeton, Übertragbarkeit von Frost-Laborprüfungen auf die Praxisverhältnisse - Heft 560, Berlin, Beuth Verlag, 2005.

# SUSTAINABILITY OF SMALL RESIDENTIAL BUILDINGS MADE FROM MASONRY

Sebastian Pohl, Carl-Alexander Graubner

Targeting a sustainable development gives a key role to the construction and real estate industry as a material and energy intensive sector, especially concerning residential buildings as an important typology. Herein, masonry constructions are market-leading. So the masonry industry is able and has to do one's bit for sustainability.

Against this background the Institut für Massivbau analysed intensively the sustainability quality of residential buildings made of masonry. The analysis chose a life-cycle covering approach and considered qualitative and quantitative aspects of the three classic sustainability dimensions as well as specific cross-sectional qualities (see figure 1). These sustainability aspects were simultaneously related to an assessment with the appropriate German certification system for small residential buildings (DGNB-system NKW12).

By investigating masonry constructions along small residential buildings' life-cycle step-by-step the Insitut für Massivbau identified numerous benefits relevant for sustainability: beginning with the supply chain and processes of masonry production (i.a. natural raw materials, local supply | substitution of industrial primary products, closed loops), continuing with the construction and operation phase (i.a. material savings of composite component mortar, low-emission material | thermal comfort and noise protection, safety level) and finishing with the end of life (i.a. high recyclability and recycling rates).

Since the methodology of the system NKW12 is strictly related to the entire building it is not possible to derive a final assessment for delimited structural elements. So there are e.g. no separate benchmarks for walls.

To be nevertheless able to create a sustainability assessment for small residential buildings the Institut für Massivbau performed exemplary certifications for different model home versions made of the four market-leading brick types as well as a comparison alternative of a wooden frame construction.

Especially the life-cycle analysis (LCA) results are of crucial interest. Along the life-cycle you can discover, that - concerning the environmental impacts of constructing the walls - a general statement for the ecological quality of the model home versions is not possible. But if considering other construction components and their life-cycle too, the influence of the walls relativises significantly. At the level of overall results including the operating heat and electricity demand the results of all versions are even on the same height, i.e. all versions are characterised by a comparable LCA-quality (see figure 2).

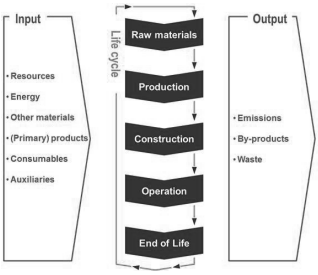



Figure 1: Life-cycle approach

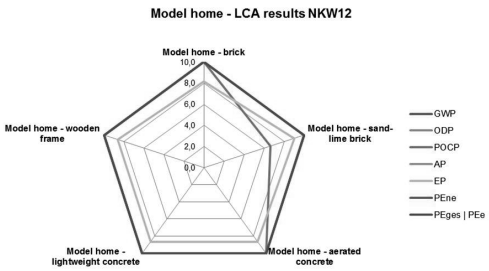



Figure 2: LCA results

Summing up the investigation verifies that masonry walls either lead immediately to high assessments or create mediately the necessary prerequisites. Thus small residential buildings made of masonry provide a high sustainability quality especially by direct comparison with other constructions.[1]

[1] Actually the Institut für Massivbau enlarges its considerations towards the sustainability quality of large residential buildings. The first part of the investigations presented above was published at impulse-fuer-den-wohnungsbau.de.

# SUSTAINABILITY ASSESSMENT OF ROAD BRIDGES

Peter Ramge, Carl-Alexander Graubner

Since a few years besides the sustainability assessment of buildings, the evaluation of sustainability of infrastructure works is also a well-established research topic at the chair of Concrete and Masonry Structures. Following a first research project funded by the BASt (Federal Highway Research Institute) in 2010, in which an evaluation system for road bridges similar to the DGNB system was developed for the first time, several subsequent research projects were worked on at the IfM. Currently, a project dealing with the preparation of a guideline for "sustainable roadway infrastructure" is in process.

The current project especially focuses on the identification and quantification of sustainability potentials resulting in the choice of building materials, building processes and construction type for roadway infrastructure constructions. Besides the subsystem "bridge", which is dealt with at the IfM, the subsystems "tunnel" and "street" are dealt with by external project partners.

The main issue of the quantification of sustainability potentials lies in the separation of the influences originating in the different sectors "building materials", "building process" and "construction type". Comparing for example the Golden Gate Bridge to the Kochertalbrücke one would compare different building materials (steel versus pre-stressed concrete), different construction types (suspension bridge versus beam bridge) and subsequently different building processes. However, the evaluation result would not allow any insight which contribution to the actual result was due to each of the regarded sectors. The final result of a sustainability assessment, expressed as the degree of fulfillment between 0% and 100%, does not a priori allow the conclusion that the influences of the different sectors building materials, building processes and construction type are equally

developed. Likewise a negative influence in one of the sectors could have been compensated by an above-average positive influence of another sector and thus caused the same average positive final result that could have been achieved, if all sectors showed an equal average positive influence. For the identification of sustainability potentials generated by the adequate specification of parameters in one of the sectors, it is necessary to compare constructions that differ only in criteria of the respective sector that is to be examined (for example the building material of the bridge beam).

For the evaluation in the ongoing project the road bridges were therefore grouped into several clusters of bridge types. Hereby the clusters type 2 (bridge over a country road) and type 3 (bridge over a motorway) represent bridge types that are very common in practice. According to the current project status an integral pre-stressed concrete construction seems to be the most sustainable alternative for these bridge types. The determination of sustainability potentials is, however, strongly dependent on the evaluation systematic involved. This is caused by the fact that only those aspects, which are explicitly considered in the evaluation system, can provide a contribution to the potentials being quantified. Currently the LCA-related impact of the building process for example is only considered through global factors. Therefore no potential can be determined for the ecological impact of the building process. In the sector of building materials, the ecological quality is influenced by the technical state of the art. The development of new advanced production technologies may reduce the environmental impact of a certain building material and thus possibly shift its ecological quality. Furthermore the economic impact of building materials is marked by a strong dependency on the actual commodity prices.

By a refinement of the current evaluation system – a respective project is applied for – the force of expression of the determined potentials will be increased, however, the general dependency on the development and evolution in technology and commodity prices will still be at hand.

# PROBABILISTIC LIFE CYCLE COSTING OF BUILDINGS WITH UNCERTAIN UTILIZATION

Gökhan Uysal, Carl-Alexander Graubner

There is a rising need in the construction industry to identify the technology related cost risks over the entire life cycle in an investment decision (1). However, opposing to construction costs, the life cycle costs of buildings are largely unknown at the time of the calculation. Important parameters such as cost trends, lifetimes of components or energy consumptions can only be determined with a certain inaccuracy. Currently, uncertain input data goes into the life cycle cost calculation as an estimate based on expert knowledge. Through this deterministic approach in important guidelines like BNB-Richtlinie 2.1.1 and the GEFMA-Richtlinie 220-2, cost risks of construction projects cannot be addressed. Statements about the robustness of the cost calculation or the probability of occurrence are also not possible.

Another factor of uncertainty in the current calculation models arises from the fact that the construction costs are very high weighted in the investment decision because of the commonly used discounted cash flow model. Therefore it can happen that measures to improve the sustainability and constructive provisions to increase the flexibility are not adequately evaluated regarding their cost reducing effects in the utilization phase.

To address the described uncertainties and to quantify cost risks over the entire life cycle, currently a method is being developed at the chair for concrete and masonry structures to calculate life cycle costs with a probabilistic approach. This allows for the first time to combine the two target fields of economic sustainability "life cycle costs" and "convertibility" in one costing model. It improves also the holistic approach in terms of

sustainability and makes it possible to evaluate the impact of the convertibility to the life cycle costs. As seen from Figure 1, the concept is basically a 5 step procedure:

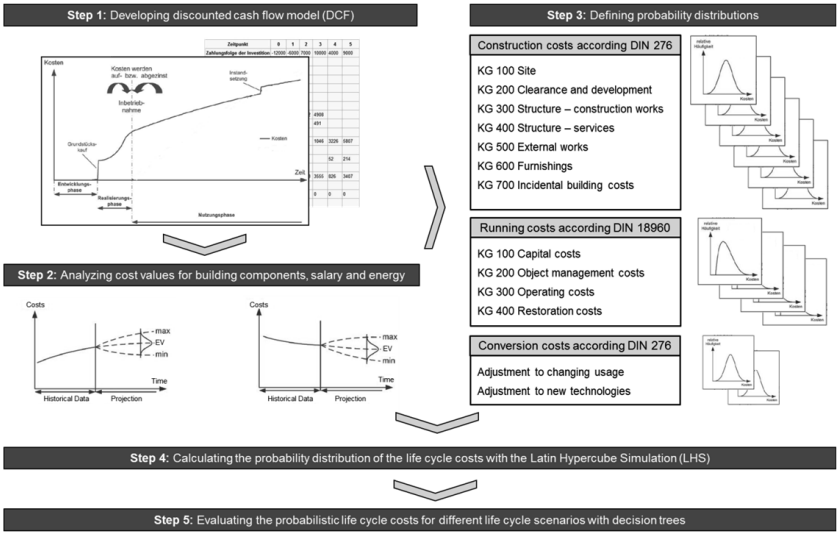



Figure 1: Probabilistic life cycle costing

First results show that it is possible to describe the life cycle costs of a building approximately with a Weibull-distribution. Furthermore with decision making criteria under uncertainty such as the μ-σ-criterion the construction alternative which matches the risk profile of the decision maker can be identified. This allows finally dealing objectively and consciously with cost risks over the entire life cycle of a building.

(1) Girmscheid, G. / Kapp, M. (2005): Risikobasiertes probabilistisches LC-NPV-Modell - Bewertung alternativer baulicher Lösungen. In: Bauingenieur, Vol. 80, 06/2005, S. 1–13.

# WHIT EXCURSION
# TO THURINGIA, SAXONY UND SAXONY-ANHALT

Valentin Förster, Peter Ramge

This year's Whit Excursion of the Section of Concrete and Masonry Structures took place from May 21st to May 24th. Since 2004 this excursion-series is organized together with the Institute of Concrete Structures and Structural Design and the Institute of Steel Structures of the Technical University of Kaiserslautern. That being said, we could proudly celebrate the 10th jointly organized excursion with this year's event.

The destinations of this year's excursion were located in Thuringia, Saxony and Saxony-Anhalt. Among other activities, we toured the bunker museum Frauenwald, two tunnel construction sites of the new ICE railway line Leipzig-Nuernberg, a pre-cast concrete plant with pre-stressing bed, as well as a steel construction plant. It is self-explanatory that we also paid a visit to the Naumburg Cathedral, one of the most renowned pieces of late romanesque architecture in Saxony-Anhalt, as well as to the world's largest brick bridge, the Göltzsch Viaduct in the Vogtland area, which was constructed over 150 years ago from about 26 million bricks. The bridge was opened to traffic on July 15th 1851.

A comprehensive cultural program, such as a visit to the one-man play "Faust, ein Alleingang" in Weimar, completed the excursion.

To sum it up, the excursion went very well, which surely can be traced back to a certain extent to our very comfortable housing in the castle of Marienthal and the evenings we spend together at their so-called "Schlossbar".

We are very grateful for the generous financial support for the excursion through the "Association of Friends of the Institute of Concrete and Masonry Structures and Buildings Materials of the TU Darmstadt", wherefore we express our sincere thanks.

Figure 1: The Darmstadt delegation in front of Göltzsch Viaduct

Destination, theme and date of the next Whit Excursion are already fixed: From June 10th to June 13th 2014 interesting spots in and around Duesseldorf will be visited.

Contact for With Excursion 2014: Mr. Dipl.-Ing. Peter Ramge.

# SCHULPROJEKT – „INGENIEURSCOUTS GESUCHT“

Ulf Grziwa, Carl-Alexander Graubner

In collaboration with the Frankfurt Phorms Schule the chair for concrte and masonry structures carried out a three-week summer camp with workshop for pupils. The aim of this summer camp was to inspire the pupils for the profession of civil engineer, in which first constructive foundations in the form of various experiments were brought to pupils. Students of the institute took over the role of the workshop leader. The students should check the knowledge themselves, expand the existing knowledge, study and explain complex subjects understandable.

For each week a main point taken from the broad field of civil engineering has been chosen. Different topics of constructive structural engineering including buildings, bridges and construction materials were discussed. At the beginning of each week, the students gave the pupils the theoretical fundamentals. Hereby e.g. the composition of the concrete, the use of different building materials in civil engineering, the effectiveness of the reinforcement in reinforced concrete components and the load transfer of simple static structures of the building or the bridge were discussed. Though conducting simple experiments (bending tests), the structural behaviour of reinforced concrete components could be represented clearly. To demonstrate how concrete is prepared and steel is produced, a field trip to a concrete plant and a steel processing company was organized. In the practical part of the workshop pupils have manufactured concrete mixes their selves and designed models of buildings as well as bridge structures (see Figure 1). The pupils learned hereby how different materials can be usefully employed in structures, and what structural basics must be considered in the construction of buildings or bridges.

Figure 1: Models of several bridges

Beside the theoretical considerations the craftsmanship is very important when structures should be constructed. Hereto the pupils could acquire a lot of experience by building a small house made of masonry (see Figure 2). On a reinforced concrete base plate, which was organised by the students, a masonry house with horizontal dimensions of approximately 2.0 m x 2.0 m was constructed.

Figure 2: Construction of the masonry house

Based on the very positive feedback of the pupils, their parents and the school management a continuation of the project is planned for the next year.

# EXCURSION TO VIETNAM

Ulf Grziwa, Jaroslav Kohoutek

This year the excursion of the PhD students led us to Vietnam. From Frankfurt our flight took 12 hours to Saigon where we first went sightseeing in the old town. Not far from Saigon we visited the Vietnamese-German University (VGU) and met the university president Prof. Mallon. He explained the aims of the university which was founded in 2008 and the possibilities of the academic exchange with German scientists of the TU Darmstadt.

In Saigon we were welcomed at the Ton-Duc-Thang University (TDTU) and conducted numerous conversations about possible cooperation with the TDTU and shared fields of research. On our way back we visited the tunnels of Cu-Chi and the next day the port MyTho.

Figure 1: Visit at the TDTU and UTC

From Danang we drove to My Son, which is a UNESCO World Heritage Site. Here we could admire the approx. 800 years old temples of the Cham people made of brick without mortar joints. Our excursion further led us to Hoi An and Hue, where we could visit amongst others the former Royal Palace. After all we reached Hanoi.

Our Program at the University of Transport and Communications (UTC) comprised a seminar with the topics concrete technology, sustainability and life cycle engineering, formwork pressure as well as risk and safety. During our visit at the UTC also the possibilities of sending visiting researchers to the TU Darmstadt were discussed.

Figure 2: Vietnam impressions

The last few days we could learn more about the Thai-Culture in the town Ban Lac. On our way we visited the hydroelectric power plant of Hoa-Binh. Highlight of our tour was our sojourn to the island Cat Ba, which is part of the UNESCO World Heritage Site Halong Bay.

Without the gracious support by the Freunde des Instituts für Massivbau, this unique excursion would not be possible. We want to say at this point to all members: Thank you very much indeed!

# CONCRETE CANOE REGATTA 2013 – "FLOTTE MAJA" SETTING SAILS

Peter Ramge

From June 21st to 22nd the 14th German Concert Canoe Regatta took place in Nuremberg on the "Großer Dutzendteich". This time TU Darmstadt put two racing canoes on the grid: "FLOTTE Maja" and "FLOTTE Willi". The canoes were autonomously developed by the students from October 2012 onwards. The students neither came back on an existing formwork nor on a previous construction idea. This time the dominant design and construction element was the hexagonal honeycomb; therefore the relation to "Maya the Bee" and her best friend "Willi". Both canoes consist of a black pigmented UHPC skeleton construction with lightweight concrete fillings. The honeycomb fields are held in various colour shades in yellow and red tones respectively. Starting with a white centre the colour shades increase in intensity towards bow and stern. On the yellow "FLOTTE Maja" the honeycomb structure is only visible from the outside. On the inside "FLOTTE Maja" is completely lined with a dark yellow lightweight concrete layer. Our second canoe, "FLOTTE Willi" was meant to be perfected. Therefore a complete inner coating layer was omitted. Only the actual honeycomb areas were filled with lightweight concrete. Hence the honeycomb structure and the 7-stepped colour shading are visible from likewise the inside and the outside.

Although, at times, it seemed not to be possible, the second canoe was indeed finalized "just in time", virtually in the last minute. But then, one day prior to the regatta, only a few hours before the planned departure, the outrageous happened: a concatenation of unfavorable circumstances, which considered each for its own would not have had the potential to cause much harm, but in combination developed a fatal mix, caused FLOTTE

Willi to break in halves. Only by the undeviating zest of action and will to hold out of a little team remnant (the majority of the team was already on their way to Nuremberg by train) FLOTTE Willi could be saved in a breakneck emergency operation. Well, whatever one can observe from the comic originals could be verified once more: Willi, despite all his kindness, is indeed a constant misadventure that does not leave any brick undropped.

Even though our team was sadly not very successful in the actual racing competition and did also not reach any top score results in the design and construction rating, we still won the "first prize", which was the third place in the T-shirt contest. The results of the T-Shirt contest on Friday evening were announced beginning with place three; hence this was indeed the first price that was granted during this year's concrete canoe regatta.

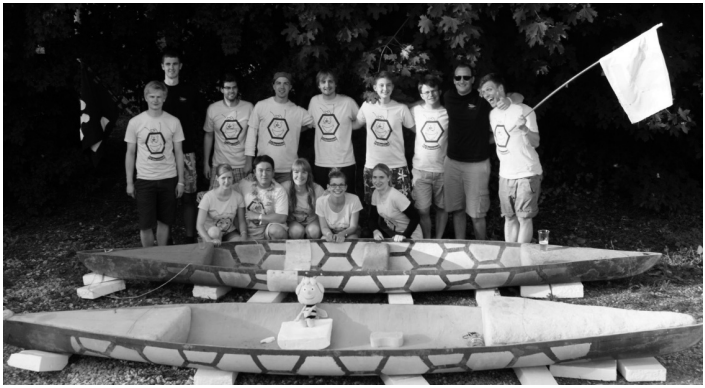


Figure 1: The concrete canoe team 2013 of TU Darmstadt

In the name of the whole team we would like to thank all the sponsors that supported us with donations in either money or kind. Especially the generous support of the "Association of Friends of the Institute of Concrete and Masonry Structures and Buildings Materials of the TU Darmstadt" is to be named in this regard.

# EXCURSION TO THE VOLCANIC EIFEL AND LEIMEN

Enno Steindlberger

The lecture course "Structural Damage-Construction Chemistry" includes an excursion. This took the students from the TU Darmstadt to the Eifel in the vicinity of Mendig from 4-5 June 2013 under the direction of Dr. Steindlberger. The first stop on the program was a tour of a lime plant in Kruft: The Tubag Company manufactures various types of binders such as lime and cement, along with mortar composites. Under expert guidance, the production and filling facilities could be extensively surveyed and the product range was presented. The next stop on the excursion featured the extraction activities of a basalt lava quarry. The material recovered there subsequently is used in stone processing operations for diverse standardized or customized products. Along with tuffstone, basalt lava is the most important construction material of the Eifel and has been used in many situations. The Maria Laach Abbey is a famous medieval monastery. Under the guidance of Father Petrus the actual construction site was discussed with respect to preservation of its historic nature. The second day began with a tour of a former Roman underground mine which is used today as a museum. The extracted tuffstone is the so called “Römertuff”, Fig. 1). The original traces of the excavation are well preserved and emphasize the method of extraction. In the region there are numerous known or suspected chambers that date back to Roman times. In former times, pumice and trass were excavated from the so called „Wingertsbergwand“ (Fig. 2). The manmade steep face still remains. The different types of the volcanic eruption periods including the sedimentation of layers of volcanic ash and bombs can be studied exemplarily. After lunch in the Mendig Brewery, the program continued with the Lava-Dome Museum and the Lava Cellar. Through the years, the basalt columns were excavated extensively by underground mining and subsequently used as building material and, especially, for millstones. Over time, extensive underground “halls”

und tunnel systems developed. Because of the consistently cool climate, the rooms remaining after the excavation were used to store beer. At the conclusion of the tour, the bus brought us first to Heidelberg. After the evening program and overnight, on June 6th we visited the HeidelbergCement plant in Leimen. Besides the processing facilities there was an especially interesting tour of the laboratory. The details were arranged by the assistance of Dipl.-Wirtsch.-Ing. Röser. The excursion concluded with the return to Darmstadt.

We´d like to thank especially the Tubag Company for their generous financial support!

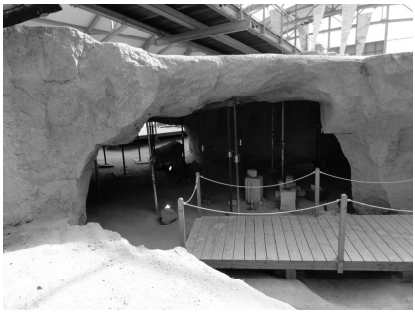


Figure 1: The original traces in the former Roman underground mine.

Figure 2: The participants of the excursion in front of the "Wingertsbergwand".