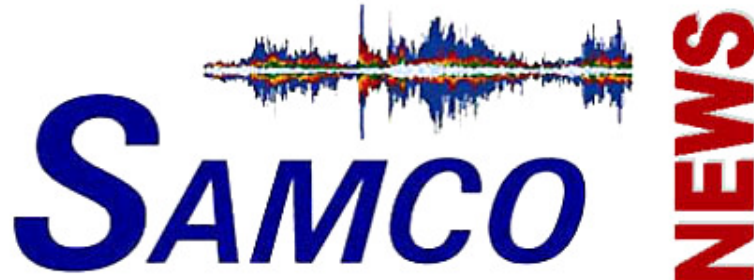




supported by the DG Research of the European Commission



Structural Assessment Monitoring Control

Issue 16 / November 2005

contents

■ SAMCO Research Agenda

page 1

■ Start of SAFE PIPES Project

page 2

■ SAMCO NAS Workshop in Slovenia

page 3

■ SAMCO Summer Academy in Austria

page 4

■ News from Profession & Practice

page 5 – 6

■ Company Profile Smartec SA

page 7

■ Notable Dates, Announcements & Jobs

page 8

Published by VCE.

SAMCO Research Agenda

One of SAMCO's main missions is to elaborate a strategic research agenda defining priorities and roadmaps with the ambition to serve as a reference for the definition of future research plans.

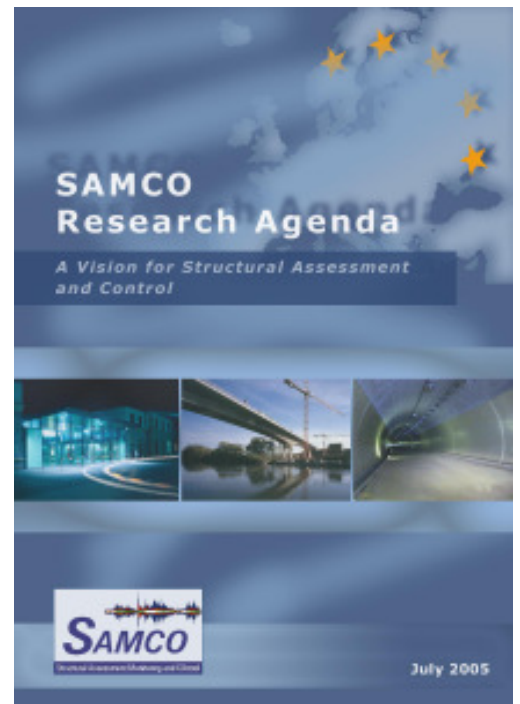
SAMCO in combination with I-SAMCO has brought together all stakeholders involved in structural assessment, monitoring and control to define the necessary research activities for a better future.

The future is among other things characterised by:

- Intelligent embedded systems invisible but most helpful for the user
- Complex decision support systems that relieve the user of routine work
- Diagnostic methodologies that allow a quick assessment of any structure after unusual events
- Information on the lifecycle management of structures in order to enable future planning and budgeting
- Considerable increase of usability and user safety
- A major contribution to security and extraordinary event awareness
- Increasing of the user comfort while reducing the user costs

The competitiveness and sustainability of Europe's industry, transport systems, energy supply and security management will be focused. This process will support the Lisbon criteria and contribute to the Union's goal to become the most competitive and dynamic knowledge based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion.

This initial SAMCO publication reflects the consensus on the vision 2010 – 2020 – 2030 of the SAMCO community respective to the current status.



This strategic research agenda will be elaborated in more detail and regularly maintained with increasing knowledge.

The latest versions can be downloaded from the SAMCO website:

http://www.samco.org/download/research%20agenda/research_agenda_1005.pdf

Start of SAFE PIPES Project

Project Start

The research project SAFE PIPES (Safety Assessment and Lifetime Management of Industrial Piping Systems) that emerged from the SAMCO platform recently had its kick-off-meeting on September 8th in the course of the SAMCO Summer Academy in Zell am See / Austria to start into a 3-year research cooperation. The specific targeted research project under the NMP priority of the 6th Framework Program is coordinated by VCE Holding GmbH and has duration of 36 months.

Objectives

The overall objective is to develop a complete integrated monitoring system that allows to rate industrial piping systems over their whole service life and to increase the general safety. The goal is to reduce investment cost for maintenance, inspection and loss of production as well as to limit accidents, hazardous to mankind and environment.

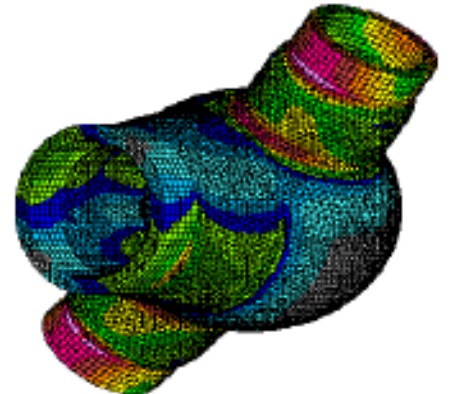
This project addresses important industrial lifecycle issues of the nuclear industry and the sector of chemical plants. The relevance for this project comes from our aging industrial infrastructure that is affecting society, economy and industry in a negative way. Risk assessment and lifetime management gain importance by the progressive aging of industrial installations.

Workpackages

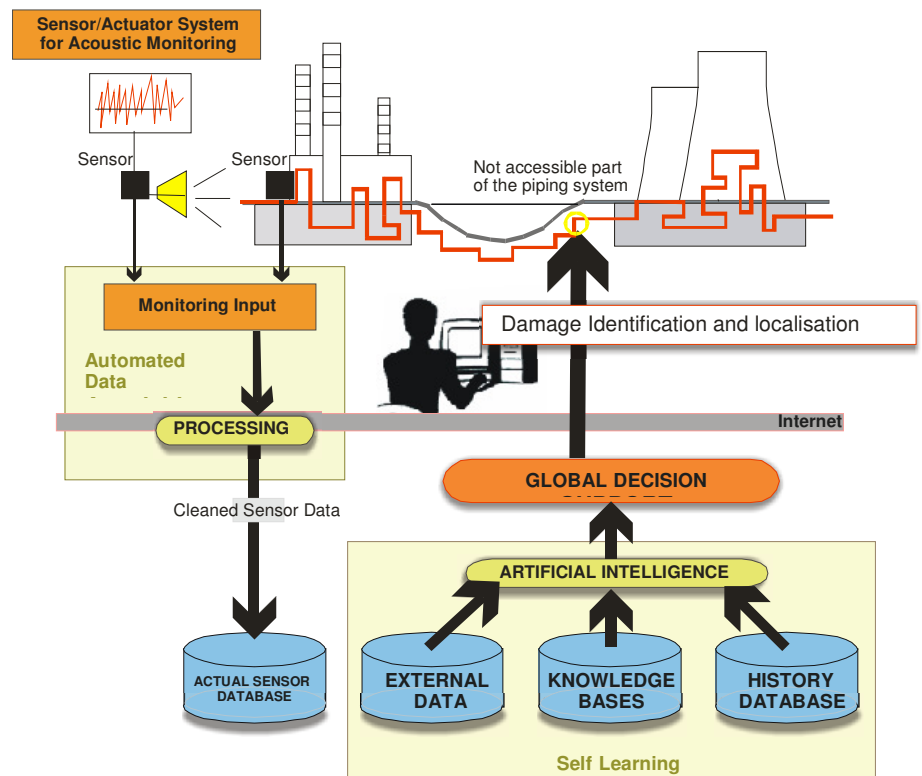
- **WP 1**
Current Practice and Obstacles
- **WP 2**
Mock up, Measurement, Testing
- **WP 3**
Risk Assessment and Lifetime Investigation
- **WP 4**
Sensor / Actuator Development
- **WP 5**
Optimisation of Sealing Technology
- **WP 6**
Structural Health Monitoring System
- **WP 7**
Decision Support System
- **WP 8**
Prototype
- **WP 9**
In Situ Investigations
- **WP 10**
Dissemination
- **WP 11**
Project Management

Partners

- VCE Holding GmbH (VCE)
- Wölfel Beratende Ingenieure (WBI)
- Neue Materialien Würzburg (NMWü)
- CKTI Vibroseism Co Ltd (CVS)
- Materials Testing Institute (MPA Stuttgart)
- Institute for Nondestructive Testing (IZFP), Branch Lab IZFP Dresden
- Johannes Kepler University Linz, Institute for Applied Knowledge Processing (FAW)
- Institute of Fundamental Technological Research of the Polish Academy of Science (IPPT)
- RWE Power AG (RWE)
- DOW Chemical (DOW)
- Electricité de France (EDF)
- Chinese Academy of Sciences, Institute of Mechanics (IMECH)
- International Atomic Energy Agency (IAEA)



Piping (Source: Wölfel Beratende Ingenieure)



Integration of Information and Knowledge

SAMCO NAS Workshop in Slovenia

13th SAMCO Workshop

31 persons mostly from Slovenia participated in the 13th SAMCO Workshop dedicated to the newly associated states (NAS) of the European Union and which took therefore place in Ljubljana / Slovenia from October 10th to October 11th 2005.

The venue was situated in the city of Ljubljana on the premises of the company ZAG (Zavod za gradbeništvo Slovenije), Slovenia's national building and civil engineering institute. It was founded by a decree, promulgated by the Government of the Republic of Slovenia on April 21st, 1994, by transferring a part of ZRMK Ljubljana (the former Institute for Testing and Research in Materials and Structures) into a governmental research and testing institute. ZAG Ljubljana was entered into Slovenia's official List of Companies on March 17th, 1995.

Aim of the Workshop

The aim of the Workshop was at first to bring together experts in structural assessment, monitoring and control from Slovenia and the bordering countries to build connections between the former and the new EU member states and to inform each other about the state-of-the-art in bridge monitoring.



The expectancy regarding this meeting was high, due to the fact that experts from Slovenia were invited to report on the practical experience in their country and to discuss current research activities with people from the former EU member states.



Building of ZAG Ljubljana / Slovenia

In a very fruitful environment the participants had also the possibility to get to know the company ZAG with its research laboratory.

Programme of the First Day

After the introduction of ZAG by the director of the Slovenian National Building and Civil Engineering Institute in the morning of the first day, the SAMCO-coordinator Mr Wenzel and Mr Marcellini of IDPA / Italy spoke about monitoring and control of civil engineering structures.



Participants watching the BRIMOS Equipment

In the afternoon of the first day a practical demonstration of bridge monitoring was carried out on the cable stayed Lubljanica Bridge, the so called "Harfa", by the team of VCE / Austria.

The BRIMOS-Recorder and the BRIREC software, used for ambient vibration measurements and evaluation of bridges as well as the full BRIMOS equipment with sensors linked with the data logger to measure the vibration behaviour of the structure and the BRIMOS software for evaluation and presentation of results as well as the GREEN-Eye – software for conversion of measured data was shown to the participants.



Programme of the Second Day

The results of those measurements (graphs, tables and calculations) were presented and discussed by VCE on the second day of the workshop. As to Mr Wenzel's speech it is unavoidable to improve some construction details of the small cable stayed bridge in order to guarantee the safety of the bridge (see chapter 3).

The lectures of the second day gave insight into the activities of ZAG Ljubljana in the area of structural monitoring and control, such as geotechnical, corrosion or bridge and traffic monitoring or monitoring of buildings.



Research Laboratories of ZAG

In the course of a visit to the laboratories of ZAG, guided by Mr Znidaric and Mr Bosiljkov the participants got to know different practical research applications and testing methods for structures used by the civil engineering institute.

Other topics touched on at the workshop were activities at the University Maribor, the SiWIM bridge weigh-in-motion system, the compensation of environmental influences, decision support systems and future developments of monitoring and control.

Contributions and photos of the 13th SAMCO Workshop can be downloaded from the SAMCO Database within a few weeks:

<http://samco.jrc.it/>

SAMCO Summer Academy in Austria



Second SAMCO Summer Academy

80 persons from 27 nations from all over the world participated in the SAMCO Summer Academy, which took place from September 5th to September 9th 2005 in the province of Salzburg in Austria, to be more precise, in Thumersbach, situated at the mountain lake Zeller See opposite the small town Zell am See.

The venue was the Cultural Centre Lohninghof, a building first mentioned in the 9th century after Christ and perfectly restored in the year 2000. Lectures were partly given in the big auditory, partly in a smaller seminar room with the possibility for the participants to choose the presentations more interesting for their work.



Cultural Centre Lohninghof / Thumersbach

The expectancy regarding this important meeting was very high, due to the fact that top experts were invited to report on their practical experience and to discuss current research activities.

Those expectations were exceeded by far. In a most fruitful environment participants had the possibility to get to know companies and research institutes better and to discuss the future development in their fields.

Those expectations were exceeded by far. In a most fruitful environment participants had the possibility to get to know companies and research institutes better and to discuss the future development in their fields.

Late summer days with lots of sunshine inspired people to hold a lively meeting and to give interesting input and ideas for future projects.

Topics

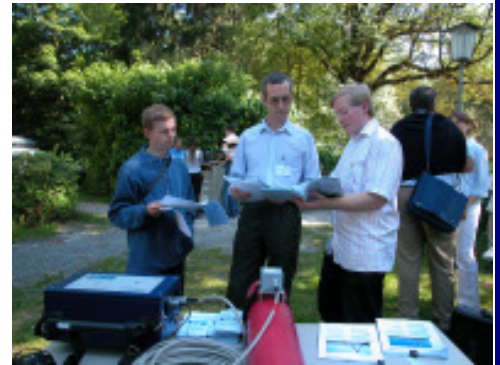
In the course of the Academy the draft of the SAMCO Research Agenda was introduced to the participants by the SAMCO Coordinator Dr. Helmut Wenzel and the European Scientific Officer Dr. Georgios Katalagarianakis outlined the EU Commission's perspective on the 7th Framework Programme.

The first day of lectures gave insight into advanced bridge monitoring, seismic assessment and experimental work, for example the 3-D full-scale earthquake testing facility E-DEFENSE from Japan.

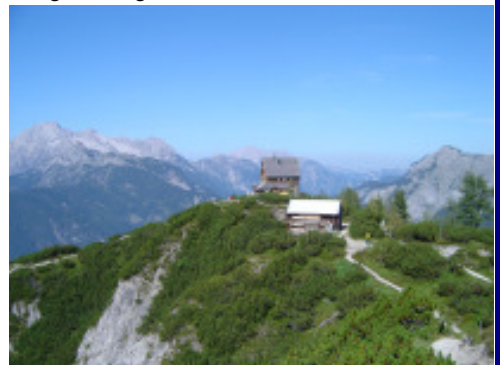


The second day started with lectures on monitoring projects in Japan and the USA and continued with forensic engineering and further speeches on projects carried out by the world's largest test and facility networks.

In the afternoon the Participants had the opportunity to get to know different measuring systems developed by VCE Holding GmbH. Those outdoor demonstrations met with great interest and went off very well thanks to the great weather.



The last day of lectures was dedicated to various topics such as decision support systems, acoustic monitoring, and European research projects as well as to an introduction of the Network for Earthquake Engineering Simulation.



Besides the lectures a range of social events made the Summer Academy an event to remember. On the arrival as well as on the departure day participants had the opportunity to join guided hiking tours in the close mountains or to make a trip to the old town of Salzburg, declared Cultural Heritage of the World by the UNESCO in 1997.

Once in the course of the Academy each guest could enjoy the Academy Dinner, a set meal with Austrian delicacies in the restaurant of Lohninghof.

Those activities also added to the good atmosphere which again abetted networking.

The contributions and photos of the SAMCO Summer Academy can be downloaded from the SAMCO Database: <http://samco.jrc.it/>

News from Profession & Practice

Damage Detection in a Prestressed Concrete Test Beam by Means of FE-Model Updating

Abstract

Decrease of present forces in tendons of prestressed concrete structures leads to impairment of both serviceability and durability. In this paper damage effects subject to prestressing forces in a concrete test beam are considered. FEM-updating is applied using output-only modal identification.

INTRODUCTION

Concrete structures show increasing crack propagation during their service live. In order to avoid this disadvantage and because of cost-effectiveness, prestressed concrete structures become more and more important. The tension forces however can be represented as a decreasing function of the structural duration which could lead to enormous damage effects. As a consequence thereof structural health monitoring and damage detection at the earliest possible stage is of highest importance in the civil engineering.

This paper discusses the application of the so-called "model-based" damage detection approach [1] on a prestressed concrete beam. During the laboratory experiments the strands are relaxed each after other, whereas the vibration behavior of the beam is recorded. Using the measured modal parameters, e.g. resonance frequencies, model update is performed by the commercial software FEMTools [2]. Finally, the obtained results are validated by means of approximated analytical solution.

TEST MODEL DESCRIPTION

A prestressed concrete beam has been designed and built by "Bilfinger + Berger", Germany (Fig. 1a). The model dimensions are approximately $1.0 \times 1.45 \times 30.2 \text{ m}$ and the concrete quality is C35 with $E = 3.4 \times 10^{10} \text{ N/m}^2$. The system boundary conditions (B.C.), tendons geometry and prestressing history are shown in 0b, where the prestressing force in each tendon is $P_{tendon} = 300.468 \text{ kN}$. After each prestressing reduction phase the system vibration behavior due to impact device is measured by accelerometers placed on the top surface.

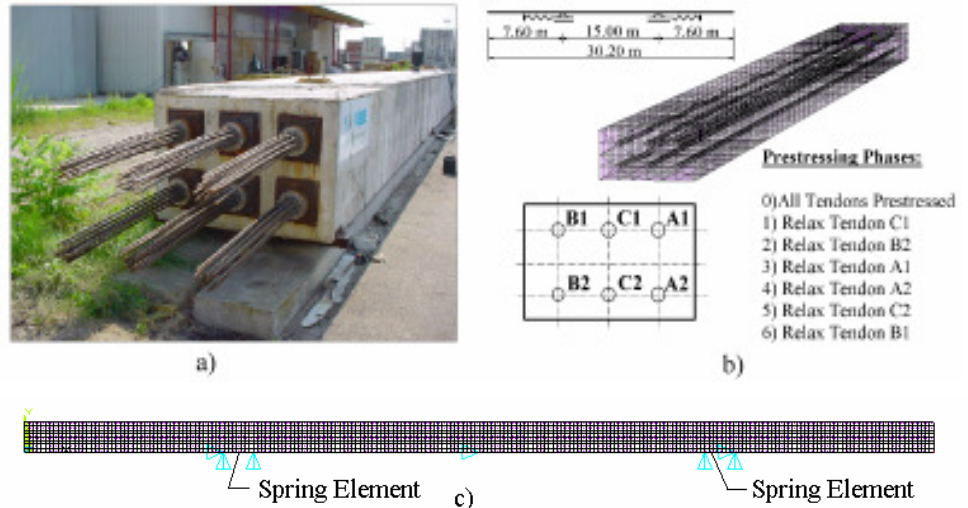


Fig.1 a) The "Bilfinger + Berger" test beam; b) System B.C., tendons geometry and prestressing history; c) 2D-FEM

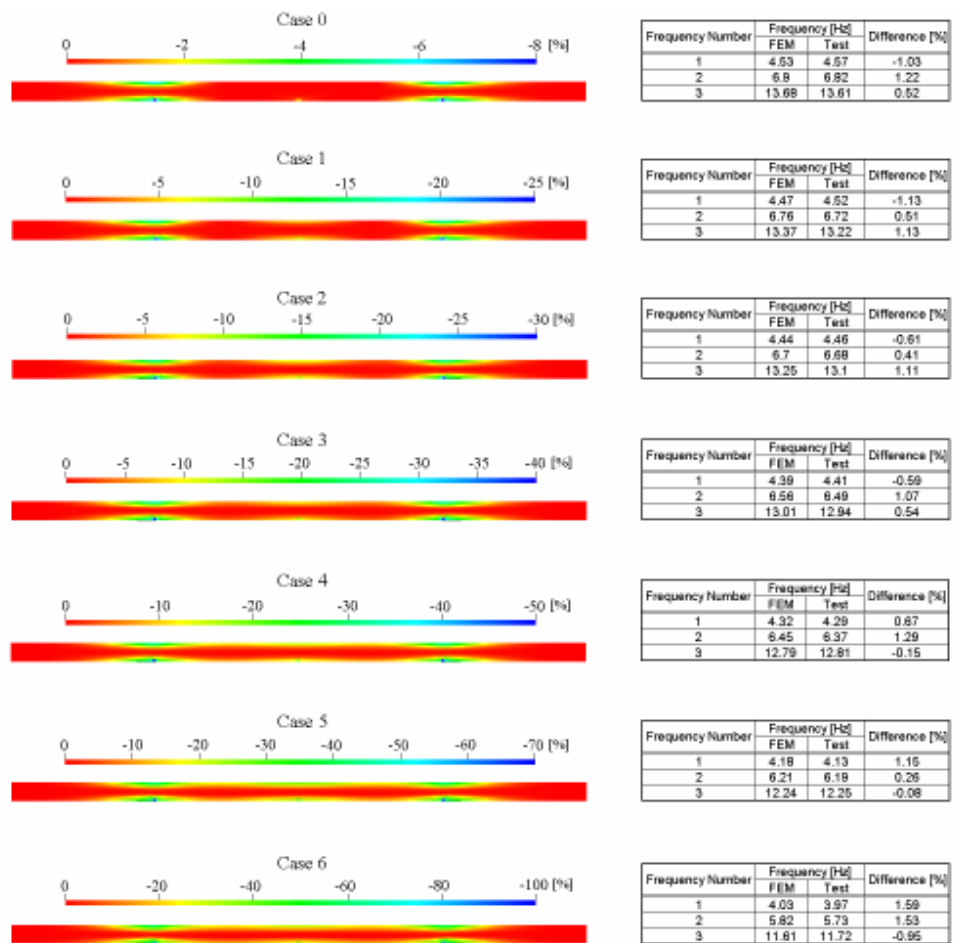


Fig.2 Updated local Young modulus with respect to its initial value [%]

Case	Measured Resonance Frequencies [Hz]			Adapted B.C.-Factors			Prestressing Force [N]	Remaining Young Modulus			E _{mean} [%]
	f ₁	f ₂	f ₃	λ ₁	λ ₂	λ ₃		N	E ₁ [%]	E ₂ [%]	
0	4.573	6.821	13.608	0.136815255	0.166938586	0.235571519	1802808	100.00	100.00	100.00	100.00
1	4.523	6.721	13.219	0.136815255	0.166938586	0.235571519	1502340	97.66	96.99	94.32	96.32
2	4.465	6.677	13.104	0.136815255	0.166938586	0.235571519	1201872	95.01	95.60	92.63	94.42
3	4.413	6.491	12.94	0.136815255	0.166938586	0.235571519	901404	92.64	90.25	90.27	91.06
4	4.288	6.369	12.811	0.136815255	0.166938586	0.235571519	600936	87.32	86.78	88.42	87.51
5	4.131	6.19	12.254	0.136815255	0.166938586	0.235571519	300468	80.88	81.86	80.85	81.20
6	3.966	5.728	11.722	0.136815255	0.166938586	0.235571519	0	74.38	69.99	73.92	72.76

Table 1 Summary of analytical solution

FEM-UPDATING AND SENSITIVITY ANALYSIS

The model-updating procedure presented in this paper is the so-called sensitivity based FEM-updating routine. In other words, the derivatives of the system responses with respect to the model parameters, also known as sensitivity coefficients, are implemented in the optimization function during the update procedure.

Because of the nearly plain tendons geometry its influence is neglected and 2D-FEM is used in the analysis as shown in 0c. In general the damage effects can be represented by changing of the local mass, damping, and stiffness properties of each finite element. In this study only update of the Young modulus is considered. Assuming no damage is occurring in 'Case 0', firstly the stiffness of the horizontal springs is updated to $K_x = 780.305 \text{ kN/m}$, without any changing of the local elements stiffness. Next, the Young modulus is updated for the entire prestressing history with respect to its initial value. The required local stiffness reduction which leads to the best match between FEM and test frequencies is plotted in 0.

ANALYTICAL SOLUTION

Considering the classical Euler beam theory the global Young modulus can be calculated as 0

$$E = \left[\rho A \left(\frac{\omega_n}{\lambda_n} \right)^2 + N \right] \frac{1}{J \lambda_n^2}, \quad (1)$$

where ρA is the distributed structural

mass per length, ω_n is n -th natural circular frequency, λ_n is a coefficient representing the sensitivity of the n -th mode shape against the B.C., N is the total pressure force applied from the tendons anchor plates on the concrete, and J is the moment of inertia. Again 'Case 0' is used to adapt the B.C., e.g. λ_n , without damage effects. Then the global Young modulus in accordance with the prestressing case is evaluated (0).

CONCLUSIONS AND OUTLOOK ON FUTURE WORK

The obtained results proved the expected phenomenon, namely relaxing of the tendons in prestressed concrete structures leads to an increase of crack propagation.

Future work will be devoted to the extension of the structural model to three dimensions, consideration of structural damping changing, and to the implementation of test mode shapes into the presented update procedure.

Acknowledgements

The authors thank "Bilfinger + Berger", Germany for the good cooperation and for making the laboratory tests possible. Financial support by the European Commission within the frame work of the research project IMAC (G1RD-CT2000-00460) is gratefully acknowledged.

References

- [1] Lauwage, T., Sol, H, and Dascotte, E.: Damage identification in beams using inverse methods. International Seminar on Modal Analysis (ISMA). Leuven, Belgium. September 16-18, 2002.
- [2] FEMTools. <http://www.FEMTools.com>. Dynamic Design Solution NV.
- [3] Clough, W. R. and Penzien, J.: Dynamic of structures. McGraw-Hill. Second edition. 1993.

Contact

VCE – Vienna Consulting Engineers

Dr. Helmut Wenzel
and Konstantin Savov
Hadikgasse 60
1140 Vienna
Austria

t: +43 / 1 / 90292
f: +43 / 1 / 90292 / 5000
m: wenzel@vce.at
savov@vce.at

Company Profile



Smartec SA

Smartec SA was founded in 1996 as result of a research project carried out at EPFL (Swiss Federal Institute of Technology Lausanne) and in close collaboration with Swiss industrial partners. Today it is a leading company active in the field of structural health monitoring.

Based in Manno - Switzerland, Smartec markets a new generation of products and services, developing, producing and commercialising structural monitoring systems, which are especially applied in the field of civil engineering, but also in other fields, such as the oil & gas and automotive industries and for the monitoring of earth movements.

Smartec's product range consists of sensors (fiber optics, GPS and conventional), data acquisition systems and software for data management and analysis and engineering support services.

Smartec's professionalism has grown above all thanks to its constant commitment to total quality management. Smartec strives to further consolidate its leading position in the market of structural monitoring by setting the pace in research and development, according to a variable strategy for a more complete offer to respond to market needs.

An offer based on product and services of high quality, where the main criterion of selection is the reliability and precision of the measurements as well as the quality of

the components, together with a careful analysis of the client requirements, these qualities allow Smartec to propose always original solutions, efficiency and effectiveness, responding to a multiplicity of needs.

Applications and Services

Smartec monitoring systems provide precious information on the real health of the structures and are applied in the field of civil engineering and more precisely for the monitoring of:

- bridges, piles, anchored walls
- geostructures
- dams
- tunnels
- concrete structures
- heritage buildings / structures



SOFO® SDB View Software data display

Smartec services also include the oil and gas industry (extraction and oil transport), automotive industry, the mechanical industry besides the monitoring and control of large-scale earth movements.

In particular, systems and services are provided for:

- earth movements
- geology
- mines
- oil pipelines, gas pipelines and tanks
- off-shore structures
- down-hole

Technologies

Smartec has developed and commercialises the **SOFO®** technology based on monitoring using fiber optic sensors. Research and development during the past years have enlarged the product range based on this technology.

The **SOFO®** technology is particularly suited to monitoring and quantifying deformations, continuously and automatically, for the long and short terms, providing important information on structural changes. The **SOFO®** sensors concerned are fiber optic deformation sensors which can be embedded in concrete or surface mounted.

To the sensors are added the fiber optic cables, measurement systems and software management and analysis.

Over the last few years, the new spread strategy and collaboration with other leading companies (Omnisens, Micron Optics and GeoDev) have led to the integration, distribution and commercialisation of new monitoring systems based on different technologies:

- **DiTeSt-Brillouin** system: distributed temperature & strain monitoring by means of a single optical fibre cable.
- **MuST**: Fiber Bragg Gratings for static and dynamic measurements.
- **3 DeMoN-GPS** system: 3 dimensional movement monitoring system based on GPS (Global Positioning System) technology.



DiTeSt System Pipeline Strain Monitoring



SOFO® System Dam Monitoring



SOFO® System System Bridge Monitoring

Contact

Smartec SA

Mr Roberto Walder

More info: www.smartec.ch

email: walder@smartec.ch

Notable Dates

Jobs

2005

DECEMBER

■ 5 - 7

SAFEPIPES Workshop

Location

Wölfel Engineering / Würzburg
(Germany)

Theme

During this workshop each project partner will give a presentation on his current practice and a definition of the problems to be solved.

■ to be specified

SAMCO NAS Workshop

Location

Hungary

Theme

The aim of the Workshop will be to bring together experts in structural assessment, monitoring and control from the new EU member states with those of the bordering countries and to inform each other about the state-of-the-art in bridge monitoring.

Contact

VCE Holding GmbH

Dr. Helmut Wenzel
(SAMCO Coordinator)

Hadikgasse 60
1140 Vienna
Austria

t +43 (0)1-90292
f +43 (0)1-8938671
email samco@vce.at
URL www.samco.org

DECEMBER

■ 12 - 14

1st International Conference on Structural Condition Assessment, Monitoring and Improvement

Location

Perth, West Australia

Organiser

School of Civil and Resource
Engineering / University of Western
Australia.

Theme

The conference will deal with the recent development in condition assessment and health monitoring systems for building, transportation, marine, underground and other civil infrastructures.

further information and registration on:

<http://www.cipremier.com/ciframeset.htm?announce/shm05.htm>

Contact

The Conference Director (SHM05)

CI-Premier Pte Ltd

150 Orchard Road
Orchard Plaza, #07-14
Singapore 238841

t (65) 6733 2922
f (65) 6235 3530

email cipremie@singnet.com.sg

Announcements

Book and CD available

Role of Structural Engineers towards Reduction of Poverty

IABSE Conference New Delhi,
February, 2005

Book and CD available in 'pdf' format
on the IABSE website:

<http://www.iabse.org/press/index.php>

Contact

Sissel Niggeler

Marketing and Communication
Manager

IABSE

ETH Hoengerberg
CH-8093 Zurich

t +41-44-633 3150
f +41-44-633 1241

email niggeler@iabse.org

Position Available at EPLF (CH)

Post-Doc Researcher

The Applied Computing and Mechanics Laboratory (IMAC) at EPFL - the Swiss Federal Institute of Technology in Lausanne has an opening for a young researcher who already has a PhD and who is willing to work hard in the area of IT and sensor applications in Civil Engineering.

Current projects are both industrial and scientific in nature. There will also be opportunities to teach aspects of computer-aided engineering in the Doctoral School. Research and teaching will be performed in English.

This position is offered initially for one year with possibility for renewal.

Starting salary will depend on age, experience and family situation. It will be approximately \$60,000 per year.

Start date: from December 2005.

EPFL is one of the two top-tier national engineering schools in Switzerland and consists of 10,000 people; 6,000 undergraduate students and 4,000 teaching and research engineers including doctoral candidates.

Located on Lake Geneva (30 min from Geneva) Lausanne benefits from its proximity to both the lake and the Alps as well its centrality to many locations in Europe.

Further information about EPFL (in English, French and German) can be found on the web site:

www.epfl.ch.

If you are interested please send a CV and references to:

Contact

Prof. Ian Smith

IMAC, Station 18

EPFL

CH-1015 Lausanne
Switzerland

t +41-44-633 3150
f +41-44-633 1241

email Ian.Smith@epfl.ch