Issue 8 January 2003

newsletter

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www.samco.org

contents

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SAMCO NEWS

Structural Assessment Monitoring and Control Issue 8 January 2003

The new Research Landscape in FP6

The 6th framework program for research and development of the European Union has brought drastic changes in approach to the subject. The new instruments of integrated projects and network of excellence require a strong effort not to be sidelined for the next 4 years. In the 1st call for the NMP program (priority 3) 260 Mio. € will be available for these instruments. We will have to face reality. There will be less money for more focussed services. The connection to national funding will be one of the main challenges.

The questions are: "Is the national R&D level prepared for that?" and "Are we prepared for that?" Within our integrated project proposal E-Moi (refer to www.samco.org) we are trying to take up this challenge. It seems to be difficult to identify excellence and special expertise in subjects not yet covered by our usual work. We therefore asked our readers to support us in identifying the missing links to be able to submit a successful proposal.

Yours Coordinator

▼ Pictures from SAMCO Benchmark Test „Highrise" (page 2-3)
from left to right: Commerzbank, Commerzbank, Deutsche Bank, Deutsche Bank, Dresdner Bank, Dresdner Bank.

First Results from SAMCO Benchmark Tests

SAMCO Benchmark Test "HIGHRISE"

Acceleration Measurements on Three High-rise Buildings in Frankfurt on Main, Germany

Acceleration Measurements

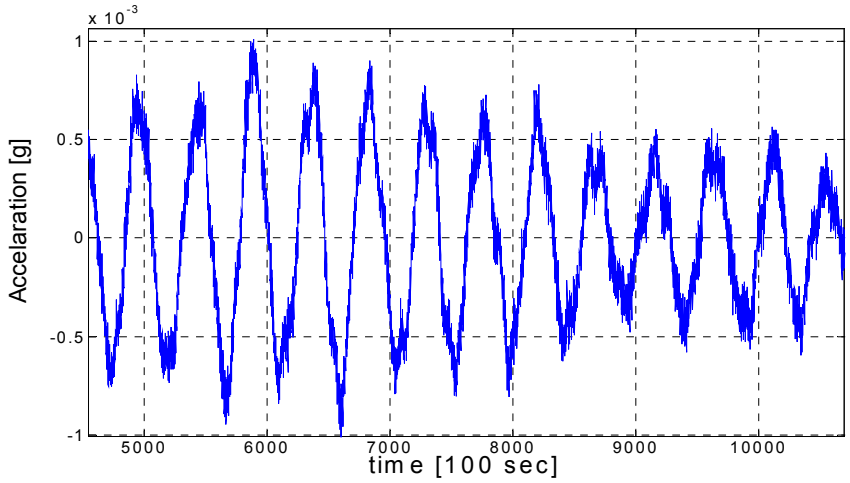
In order to extend the knowledge concerning wind-induced motions of high-rise buildings measurements of accelerations at the top of three skyscrapers in downtown Frankfurt on Main are carried out by the Institute of Concrete Structures and Matarials Darmstadt University of Technology (TUD) in cooperation with Vienna Consulting Engineers (VCE) within SAMCO. A short description of the measuring equipment as well as the buildings monitored has been given in SAMCO newsletter Issue 3.

Full Scale Wind Velocity Measurements

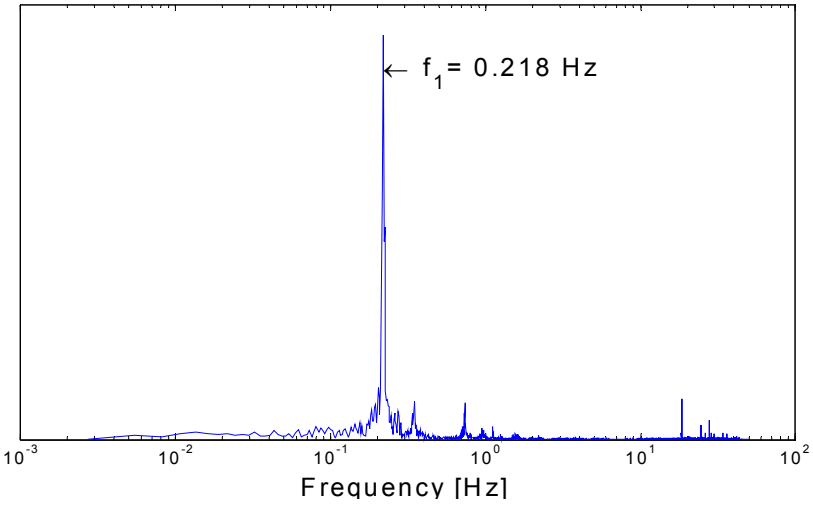
For correlation investigations between wind velocity and direction as well as temperature at the one hand and the resulting building reaction at the other hand, several sets of meteorological data are gained. First of all TUD itself runs a propeller anemometer device at the antenna of the Commerzbank building at altitude 275m above street level for 5 years. This wind measuring point is unaffected by any other building, because it is the highest one in this vicinity. The interference influence of the antenna itself on the recorded wind flow has been quantified by a wind tunnel test. Unfortunately the sampling rate of 0.2 Hz is quite low. Furthermore data of wind and temperature are gained by a meteorological station 10m above ground at Frankfurt International Airport approximately 8 Kilometres away.

Determined Eigenfrequencies of the Three High-rise Buildings

Eigenfrequencies of the three buildings investigated can be identified very clearly already in the time domain. Actual eigenfrequencies has been calculated by a transformation into frequency domain using Fast Fourier Transformation (FFT). Due to different stiffness the eigenfrequencies for various directions of motion have to be different. During one acceleration measurement the oscillation direction of a building and therefore its eigenfrequency is nearly constant. A comparison between nominal eigenfrequencies assumed for the dynamic calculation of the structures and the actual values obtained by the measurements has been carried out.



▲ Figure 1: time domain of sample acceleration file recorded at Commerzbank on 2002-01-24 (X-direction only)

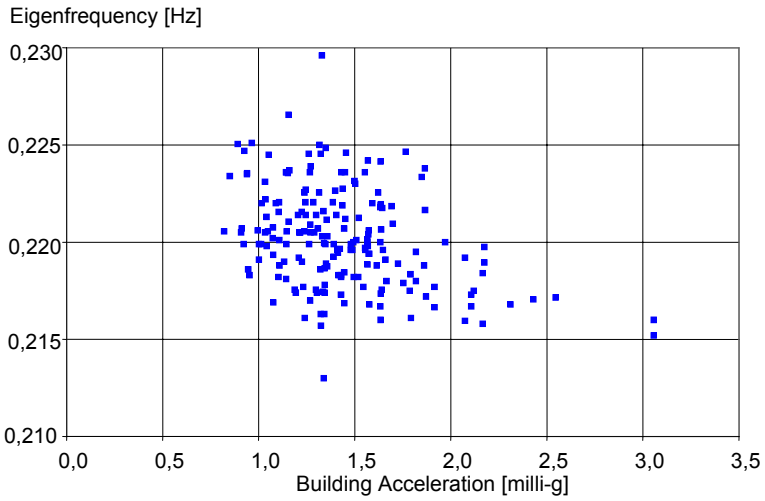


▲ **Figure 2** - Frequency domain of the same sample acceleration file Commerzbank

Also some years after completion of the building the hardening of concrete continues and therefore its actual stiffness is much higher than expected during design. This has to be result in an increase in the eigenfrequency. At the other hand a higher eigenfrequency causes a lower degree of energy within the wind spectra to be incorporated in the frequency range of the buildings eigenfrequency and therefore a decreasing dynamic excitation of the structure due to wind loads.

Measured eigenfrequency tends to decrease with increasing maximum of top acceleration due to wind as can be seen in figure 3. The reason for that phenomenon is the decrease in the stiffness of the structure due to cracking as well as the increase of structural damping with rising amplitudes of motion.

No correlation could be found between eigenfrequencies and temperature as known for bridges. All structural members of a modern high-rise building are embed by the facade and its temperature gradient is therefore rather low.



◄ Figure 3: Determined eigenfrequencies of all Commerzbank measurements versus its acceleration maximum

Building	Design Value	Measured Value	
		Mean value	Standard deviation
Commerzbank	0.17 Hz	0.2202 Hz	0.0026 Hz
Dresdner Bank	0.18 Hz	0.2784 Hz	0.0033 Hz
Deutsche Bank	0.28 Hz	0.3834 Hz	0.0067 Hz

▲ Table 1: Comparison of designed and measured first eigenfrequencies

Maximum Building Accelerations and User Comfort

The maximum building accelerations detected within the first year of monitoring are summed up in table 2. The maximum associated wind velocity measured at Frankfurt airport is a 10min mean value of 22.2m/s at 10m above ground. That velocity can be estimated to have a 10 years return period according to the regulations in Eurocode 1.

Acceleration is a suitable parameter in order to evaluate the users comfort at the top of high-rise buildings during oscillations. The threshold of motion perceived by the occupants differs very subjectively. The level of perception of most people is in the range of 5 milli-g denoting 0.05 m/s^2. There is no limit value of building top acceleration indicated in current wind codes. As can be seen from table 2 all measured accelerations on these three high-rise buildings in Frankfurt are much lower then the threshold of perception.

Correlation of Wind Direction And Direction of Motion

During realistic oscillations of buildings the modes for translation as well as rotation are coupled. Therefore all directions occur within a certain time interval. This phenomenon can be recognized clearly within the gained data. Prevailing direction of motion for every acceleration measurement file has been discovered by means of a frequency distribution for all instantaneous acceleration values. These directions can be reduced to the corresponding angles up to 180°, summing up two directions opposing each other. Building motions caused by wind are monitored as of a certain acceleration threshold. Wind direction

Building	Acceleration [milli-g]	Date
Commerzbank	3.06	2002-10-26
Dresdner Bank	1.92	2002-10-27
Deutsche Bank	2.62	2002-10-27

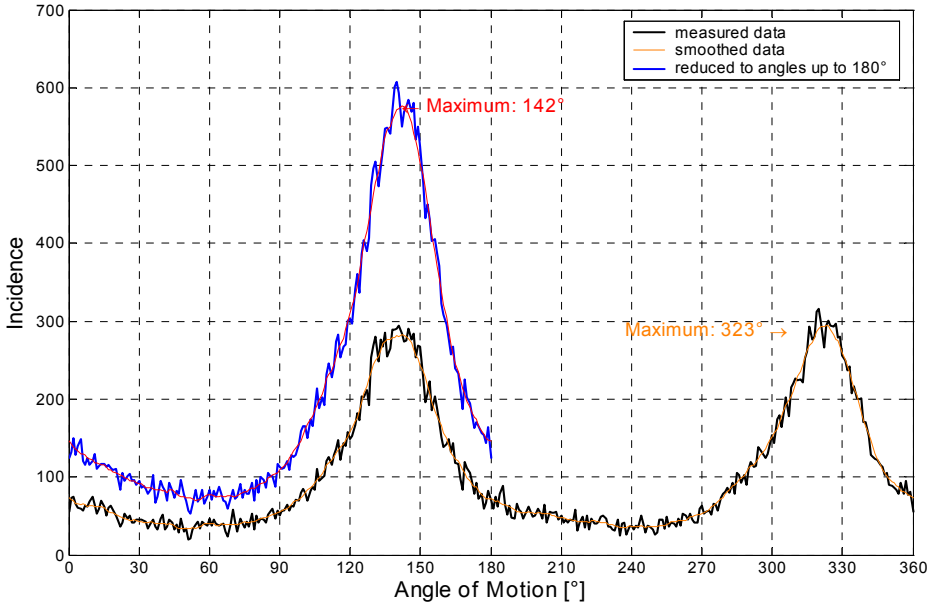
▲ Table 2: Maximum peak acceleration measured

of severe storm events in the Frankfurt area is restricted to southwesterly wind directions only. Therefore acceleration measurements for these wind directions exclusively are available. Very often the direction of motion detected doesn't suit very well with the incoming wind direction, the scattering is rather high. Further investigation is necessary.

Outlook

The first year of measurement has been completed, analysis has just been started. Gathering of more storm data and consequently acceleration files are to be expected during autumn and winter, the season of main wind activity in Europe.

The observation described is intended to run several years in order to develop damage detection techniques by permanent monitoring as already known for bridges. For a more sophisticated analysis of wind-motion-correlation wind data sampled with a higher rate are necessary in order to incorporate wind power spectra in the analysis.



▲ Figure 4: Frequency distribution of current oscillation directions of a sample Commerzbank file

Editorial Comment:
Raw data are available in the SAMCO database (http://samco.jrc.it)

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Monitoring of the Semi-Floating Dock of "La Condamine" Harbour - Monaco

Description of the Dock

The Condamine Marina in Monaco is enlarging its surface area by 60.000 m² by building a semi floating dock. This floating dock is a double hull structure 352.72 m long, 28 m wide (44 m at the bottom slab level) and 19 m high (24,5 m with building superstructures included). This 167.000 tons caisson was built by Elaboración de Cajones Pretensados (a joint venture with strong participation of Dragados) in a dry dock prepared for this purpose in Algeciras Bay (Cádiz) (Figure 1). It was towed to Monaco in August 2002 (Figure 2).

A four level car park with a capacity of 380 vehicles occupies 192 m of the dock, and another 136 m will be used for storing cargo and small boats in two levels, 6 m high each. There are twelve cells, distributed in both sides of the structure (Zones X and Z), to contain the liquid ballast (water) needed to control the floating level of the caisson (Figure 3).

Purpose of the Monitoring

The dock was equipped with a complete monitoring system developed by GEOCISA (www.geocisa.com) with the collaboration of OSMOS Deha-Com. It was designed to control and record the evolution of the caisson during the launching and specially during the transport process.

The contractor had specific interest in controlling the water level inside the liquid ballast tanks and in evaluating and recording the bending moments induced by sea action during the whole transport process. On the other hand the owner consulting engineering assistance was also interested in controlling the hydrodynamic pressure applied by sea waves during transport. Accordingly, a monitoring system was designed as summarized in the enclosed table. The main goal of the strain control was not the strain measurement in itself but the evaluation of longitudinal bending moments in the instrumented sections.

Description of Instrumentation

Measuring points were mainly concentrated in the three transversal sections (A, B, C) indicated in Figure 4.

Strain has been measured by means of OSMOS fibre optic sensors with a measuring length of 2 m. (Figure 5 left).

Each sensor is connected through a standard optical cable to an opto-electronic unit (Figure 5 right) which transforms these signals for measuring and processing via computer or data-logger through standard interfaces.

This measuring system provides an extremely effective way for measuring strains, due to its great stability against environmental changes and total electromagnetic neutrality. The bending moments were calculated from these measured strains by means of a special purpose software developed by GEOCISA.

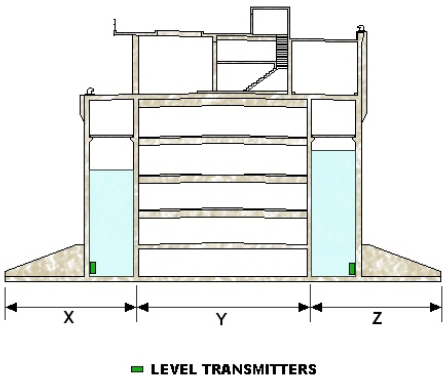
Each section (A, B, C) was instrumented with 13 optical strands each (Figure 6), totalling 39 strain sensors, all placed in longitudinal direction.

In order to detect the periods of maximum movements during the transport induced in the caisson by the sea waves and to measure them, two servoclinometers for measuring rotations in vertical planes, both in longitudinal and transverse directions, were installed in each section (A, B, C).

Relative pressure sensors were installed in the bottom of the liquid ballast cells (Figure 3) to control the water level inside each cell. Similar sensors were used on the external surface of the caisson for measuring the draught.

▲ **Figure 1**: The caisson during the controlled flooding of the basin

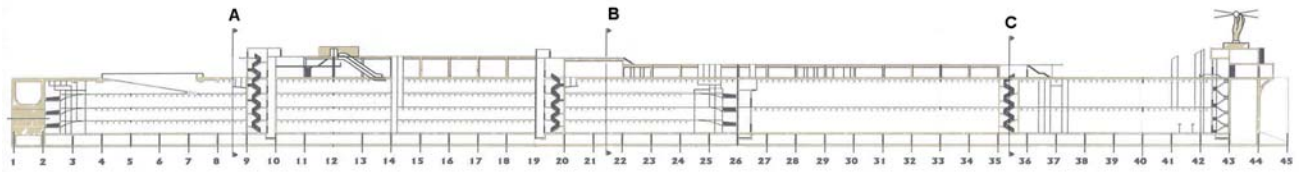
▲ **Figure 2**: The caisson during the transport to Monaco



▲ **Figure 3 .-** Typical transversal section of the caisson. Position of water level sensors in ballast cells

Magnitude controlled	Strains	Rotations	Water level in ballast tanks	Draught	Hydrodynamic pressures	Temperature in concrete surfaces
Nº of sensors	39	6	12	6	18	16
Sensor type	Fibre optic	Servoclin.	Pressure sensors	Pressure sensors	Hydrodynamic pressure sensors	Pt-100
Sampling rate (nº/sec)	10	10	1	1	10	1

▲ **Table1**.- Instrumentation Summary Table



▲ **Figure 4**.- Instrumentation sections

▲ **Figure 5**.- OSMOS fibre optic strain sensor (left) and Optobox (right)

Hydrodynamic pressure sensors were placed in various locations to record the dynamic pressure effect of sea waves on the external surface of lateral and top slabs. Finally, all the above mentioned instrumentation was complemented by temperature measurements on concrete surface made by means of Pt-100 type sensors.

All sensors installed were connected to a PC based data acquisition and recording system (DAS) installed in the dock. This system performed in an unattended mode the continuous measuring of the 97 sensors. Taking into account the frequency of sea-waves and the dynamic or quasi static character of the evolution of the different controlled magnitudes, different sampling rates were established for them as shown in the Instrumentation Summary Table. This DAS was connected via radio, during the transport, with a second computer installed in one of the auxiliary ships.

Taking into account the huge amount of data that the information collected would represent after several weeks, some statistical data files were generated in order to identify the most significant values of each channel and the time when they took place. Accordingly, the system, besides recording all the 97 dynamic files of every 10 minutes period, calculated the maximum, minimum, average and standard deviation values registered in each period for each channel and stored them in a historical record, permanently updated every 10 minutes.

Results and Conclusions

The monitoring has allowed having a complete history of the bending moments induced in the caisson during the transport. Maximum movements took place some hours before noon on 19th August (Figure 7). Figure 8 shows the dynamic evolution of bending moments in sections A and B, calculated from strain measurements recorded at those instants (between 8:33 and 8:43 a.m.). As shown in the diagram, maximum values obtained were almost negligible in comparison to maximum expected values in case of storm, as corresponds to the calm situation registered during the whole journey, even at these moments of maximum movements.

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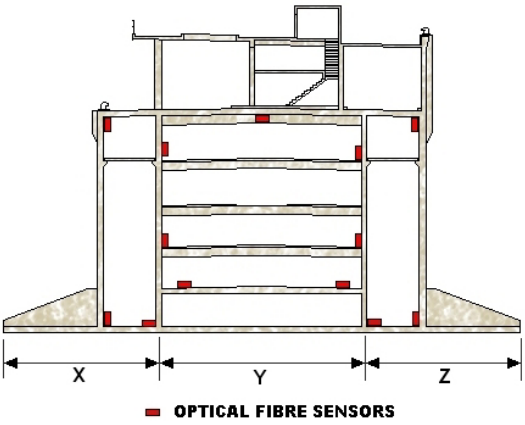
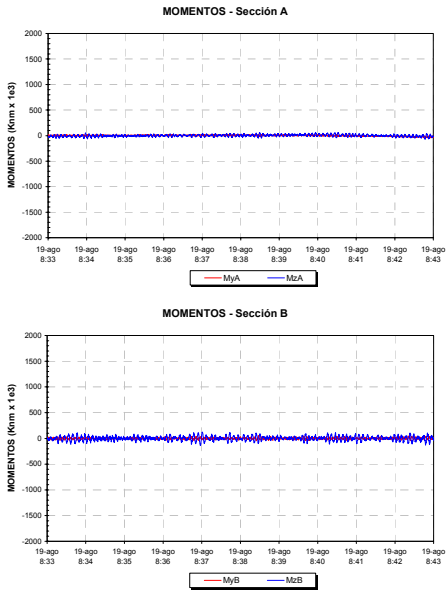
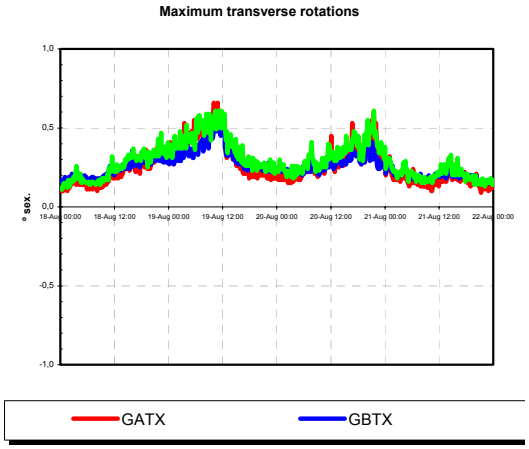
Figure 7.- maximum rotations every 10 minutes ►



▲ **Figure 6.-** Position of fibre optic sensors in each section



▲ **Figure 8.-** bending moments at sections A and B on 19th August (8:33-8:43 a.m.)



Company Profile

TUD - Darmstadt University of Technology
Institute of Concrete Structures

Department of Civil Engineering

Darmstadt University of Technolgy hosts one of Germnay's leading departments in civil engineering. 12 Institutes are devoted to all fields of building, construction and photogrammetry.

Institute of Concrete Structures Prof. Dr.-Ing. Graubner

The Institute of Concrete Structures and Materials is involved in teaching as well as research and development in the scope of concrete design, construction and analysis, building materials, chemistry and physics. A large laboratory offers state of the art testing facilities of various kinds.

Objects of Research

Safety and Reliability of Concrete Structures

A sophisticated safety format has been developed based on probability theory using Monte-Carlo simulation. It is proper applicable for analysis using non-linear calculation methods.

Full scale Wind measurements on high-rise buildings

Measurements of wind velocity as well as resulting building reactions are carried out at different high-rise buildings in Frankfurt on Main/Germany. Aim of this research project is to enhance current wind load provisions regarding large structures in conurbations. It comprises wind-statistical investigations, development of mean wind profiles for inner-city regions as well as descriptions of the dynamic properties of the wind flow. Building reactions at different skyscrapers are monitored within the SAMCO project.

Self-Compacting-Concrete

The aim of the present research work concerning Self-compacting concrete (SCC) is to evaluate the influence of the aggregates (form and size) on the required lime volume. Also knowledge about the formwork pressure and the de-air behaviour is of interest in order to ensure the successful application of SCC into practise. A research project to apply SCC to a tall structure was carried out recently.

Gas Explosion Modelling

Gas is extensively used in buildings and the effect of gas explosions is higher than other accidental loads, constituting a problem for the structure. Flame Acceleration Simulator (FLACS) is an effective software tool for the modelling of ventilation, gas dispersion and explosion in complex process areas. Numerical studies can be used to develop statistical moments for a risk based design concept.

Sustainable Construction

For some years questions concerning the environmental impact of our buildings as well as the economic efficiency of building constructions over the entire life cycle become even more important. Regarding these future requests of modern buildings, a software tool named ***bauloop*** was developed within a research project that concentrates on the assessment of the sustainability of building constructions. The aim of the research is to optimise building constructions in terms of its sustainability.

◄ Analyse tool for the sustainability of buildings

Service Engineering

The interaction of structural design and service engineering is under investigation.

Masonry

Various research projects for the construction and design of reinforced and unreinforced masonry are being carried out. A realistic model for the calculation of the shear resistance as well as non-linear design equations for the buckling safety proof of slender walls have been developed in our latest projects concerning the design of unreinforced masonry. Furthermore steel and textile reinforced masonry structures and wall constructions are being examined. Our membership to several German and European standardisation committees enables us to implement our research results into the building industry.

Contact

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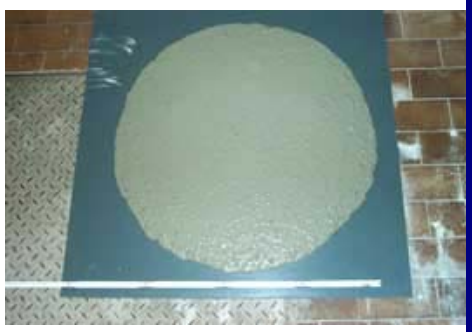
▲ Wind Measurement on high-rise building Commerzbank in Frankfurt on Main

▲ Full scale Experiment of Gas Explosion



▲ Slump-flow test to evaluate the flow-ability of Self-compacting Concrete

▲ Textile-reinforced masonry test-beam

More information

http://www.c-a-graubner.de/

Announcements

DAMAS 2003

5th International Conference on Damage Assessment of Structures

Date: July 1-3, 2003

Location: Southampton, University

Organizers: University of Southampton

This is the fifth in a series of biennial international conferences, which aim to bring together the expertise of scientists and engineers in academia and industry in the field of damage assessment, structural health monitoring and non-destructive evaluation.

The DAMAS conference is now established as a major forum for discussion and dissemination of recent advances in damage detection, assessment and quantification, following the four previous conferences in Pescara (1995), Sheffield (1997), Dublin (1999) and Cardiff (2001).
The conference will cover activities relevant to damage assessment of engineering structures and systems including signal processing of sensor measurements and analytical techniques as well as experimental case studies. The conference themes are as follows:

- Damage assessment
- Advanced methods of NDT
- Recent advances in signal processing and algorithms
- Structural integrity
- Damage mechanisms
- Fatigue damage
- Damage location and quantification
- Sensors and measurement strategies
- Intelligent materials
- Knowledge-based systems
- Condition monitoring
- Biomedical damage detection and analysis
- Case studies

More Information

http://www.isvr.soton.ac.uk/damas03/

SMART'03

AMAS/ECCOMAS/STC Workshop on Smart Materials and Structures

Date: September 2-5, 2003

Location: Jadwisin on Zegrzynski Lake (http://www.owjadwisin.pl/)

Organizers: Institute of Fundamental Technological Research, Warsaw, Poland

The objectives of the Workshop SMART'03, directed to researchers and designers working in the field of mechatronics, are:

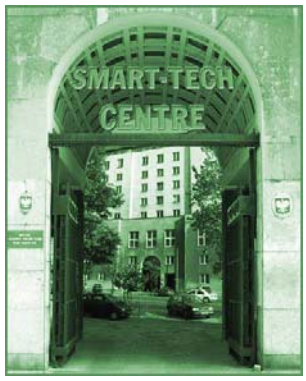
- to present the up-to-date state-of-the-art in the field of mechatronics
- to present the actual trends in this field
- to verify the academic viewpoint vs. industrial needs
- to search for potential, joint, academia-industry innovative initiatives.

The Workshop will last four full days. Invited researchers working recently on vital basic and application topics will give 11 keynote lectures. The proposed thematic sessions are the following:

- Sensors and Structural Identification
- Active Materials and Actuators
- Structural Health Monitoring and Signal Processing
- MEMS and Structural Control
- Vibration Control
- Adaptive Crashworthiness
- Software Tools and Optimal Design
- Various Applications
- Demonstrators

More Information

http://smart.ippt.gov.pl/



fib 2003

Concrete Strutures in Seismic Regions

Date: May 6-9, 2003

Location: Athen, Megaron Concert Hall

Organizers: *fib* federation

The Symposium will be held from Tuesday, May 6, 2003, morning, to Friday, May 9, afternoon. It will be preceded by the *fib*-Technical activities day, on May 5, for the presentation of the outcome of recent work of *fib* Task Groups, of the developments in the *fib* Model Code 2005 and in a possible Seismic Annex, as well as for the presentation of the 2003 *fib* awards to young Engineers for construction design and for research.

An integral part of the Symposium will be the site visits on Friday, May 9, the main event of which will be the visit of the 2.2km cable-stayed Rion-Antirrion bridge, near the city of Patras. Post-Symposium tours will start from Patras, on Friday afternoon.

General Themes

- Seismic design (innovative design and code developments)
  - Bridges
  - Buildings
  - Foundations
  - Modelling for design
- Construction in seismic areas (innovative construction materials and techniques for earthquake resistance)
  - Materials
  - Connection techniques
- Behaviour of concrete structures in past earthquakes
- Rehabilitation of concrete structures for earthquakes:
  - Rational methods of assessment of individual structures
  - Innovative rehabilitation materials and techniques
  - Rational design of repair or strengthening, at the level of components or entire structures

More Information

http://www.fib2003.gr

Calendar Of Events

FEBRUARY 2003

■ **3-6.** IMAC Conference and Exposition on Structural Dynamics; *Kissimmee, Florida.*
URL: http://www.sem.org

■ **5-8.** EERI Annual Meeting; *Portland, Oregon.*
URL: http://www.eeri.org/news/Meetings/eerimeet.html

■ **9-12.** Grouting and Ground Treatment Conference; *New Orleans, CA.*
URL: http://www.nzsee.org.nz/pcee

■ **13-15.** Pacific Conference on Earthquake Engineering; *Christchurch, New Zealand.*
URL: http://www.nzsee.org.nz/pcee

■ **18-20**. Performance of construction materials in the new millennium; *Cairo, Egypt.*
URL: http://www.ucalgary.ca/~icpm

MARCH 2003

■ **5-7.** 5th International Symposium on Steel Bridges; *Barcelona, Spain*
URL: http://www.ascem.org/5symposium-steel-bridges/info_eng/Marcos_eng.htm

■ **10-12.** Urban transport 2003; *Crete, Greece*.
URL: http://www.wessex.ac.uk/conferences/2003/urban03/

APRIL 2003

■ **18-20.** 4th Asia Pacific Transportation Development Conference; *Oakland, California.*
URL: http://www.ictpaweb.org

MAY 2003

■ **4-8.** 55th UITP World Congress; *Madrid, Spain.*
URL: http://www.uitp.com/exhibitions

■ **6-8.** *fib* Symposium; Concrete Structures in Seismic Regions; *Athens, Greece*
URL: http://www.fib2003.gr

■ **8-10.** CIB-CTBUH International Conference on Strategies for Performance in the Aftermath of the World Trade Center; *Kuala Lumpur, Malaysia.*
URL: http://www.cibklutm.com/

■ **7-9.** STREMAH 2003, Structural Studies, Repairs & Maintenance of Heritage Architecture; *Halkidiki, Greece*
URL: http://www.wessex.ac.uk/conferences

■ **12-14.** Fourth International Conference on Earthquake Engineering and Seismology; *Tehran, Iran.*
URL: http://www.iiees.ac.ir/see4/

■ **13-15.** Intertraffic Eurasia; *Turkey.*
URL: http://www.intertraffic.com

■ **13-17.** INTERMAT, International Exhibition of equipment and techniques for the civil engineering and construction industries; *Paris, France.*
URL: http://www.intermat.fr

JUNE 2003

■ **2-5.** ICWE International Conference on Wind Engineering; *Lubbock, Texas.*
URL: http://www.icwe.ttu.edu

■ **9-12.** Fourth International STESSA Conference – Behaviour of Steel Structures in Seismic Areas; *Naples, Italy.*
URL: http://www.stessa2003.unina.it/

JULY 2003

■ **1-3.** Structural faults and repair: extending the life of bridges; *London, UK.*
URL: http://www.structuralfaultsandrepair.com

■ **1-3.** MAIREPAV03 - Third International Symposium on Maintenance and Rehabilitation of Pavements and Technical Control; *Guimarães, Portugal* .
URL: http://www.civil.uminho.pt/mairepav03

AUGUST 2003

■ **22-29.** IABSE Symposium, Structures for High-Speed Railway Transport; *Antwerp, Belgium.*
URL: http://www.iabse.ethz.ch/conferences/Antwerp/Antwerp.html

SEPTEMBER 2003

■ **15-18.** 5th Symposium on Cable Dynamics; *Santa Margherita, Italy.*
URL: http://www.conf-aim.skynet.be/cable/

Imprint

SAMCO News

SAMCO News is a digital newsletter accompanying the SAMCO Network. It is funded by the European Commission in the frame of the GROWTH project SAMCO CTG2-2000-33069. It is an information and communication platform for the participants of SAMCO. It is issued periodically every second month.

SAMCO News is available at http://www.samco.org/news

Funding

The SAMCO Network is funded by the European Commission (http://europa.eu.int) within the *"Fifth European Framework Programme",FP5,* (http://www.cordis.lu/fp5) which covers Research, Technological Development (RTD) and Demonstration activities. FP5 has a multi-theme structure, consisting of Specific Programmes. These Specific Programmes are further divided into Horizontal Programmes and Thematic Programmes. One of these Thematic Programmes is the *"Competitive and Sustainable Growth"* Programme (http://www.cordis.lu/growth/) under which SAMCO is running.

SAMCO is running under the exact term: CTG2-2000-33069
Shared-cost RTD and Demonstration project, Concerted Action/Thematic Network
Duration: 48 months

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