GeoWatch

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GeoSIG

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Editorial from the CEO

The last few months changed the world!

After the global impact of September 11, here in Switzerland we have faced further dreadful events. A mad gunman assaulted the Regional Parliament during an assembly, a tragic accident in the alpine-tunnel St. Gotthard took place shortly before the crashing of a Crossair aircraft a few weeks ago, and our national airline Swissair barely pulled back from complete bankruptcy.

Having our head office right next to the Zurich Airport, we observe such events from a closer perspective. Many people living around the airport have lost their jobs now. Jobs at Swissair which had high reputation and which were considered to be completely safe.

During times like these, where the firm foundations start to dissolve, lack of orientation starts in every human being. These are the moments every individual starts to ask very fundamental questions.

Personally, I realized that there are other, and maybe more important assets of life. One's family and real friends stand there. As much as you are able to stand together and to be faithful to each other, it is much easier to handle the discouraging events.

The environment, which one works in, creates also a great influence. Looking into GeoSIG, being now many years in the market, owing to our team work, it is just a bare fact that we are firmly holding our track even in this very volatile times.

I ought to express my warmest thanks to all of our employees, our clients and our suppliers; since there, in perfect solidarity and coordination stands the heart of the perpetual foundations of GeoSIG.

Christoph Kündig

Istanbul is preparing to greet the extensive Early Warning and Early Response System, realized by GeoSIG

The Early Warning and Early Response System Project of Kandilli Observatory and Earthquake Research Institute (KOERI), contracted to Joint Venture Elektrowatt-Ekono AG of the Jaakko Pöyry Group and GeoSIG, is advancing rapidly. The project was explained to some detail in the last issue of GeoWatch. Below are the latest developments.

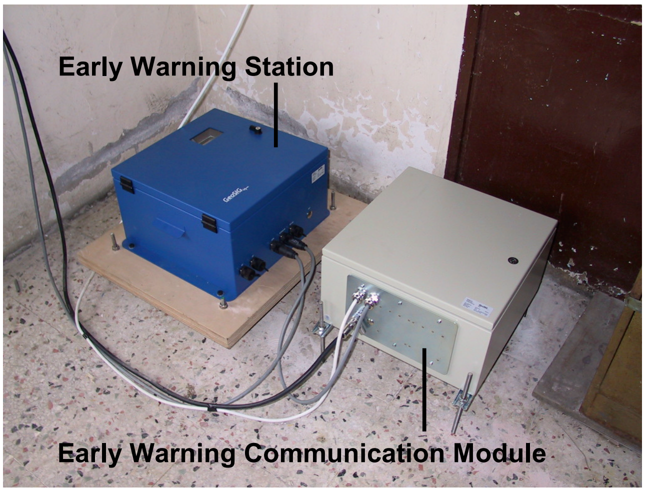
The project is being conducted in parallel with another large-scale job from KOERI; Earthquake Preparedness and Training and Teaching Center Project. Elektrowatt-Ekono has undertaken the overall administrative management of both projects and sub-contacted its engineering part to an experienced seismic shake table manufacturer from Colorado, USA; ANCO Engineers.

GeoSIG has reinforced its project management team with a professional project manager, M. S. Talhan Biro, from Turkey. Mr. Biro has been involved with the project in GeoSIG Head office at Glattbrugg, since January 2001 on all aspects of organization, planning, cost analyses, logistics and coordination.

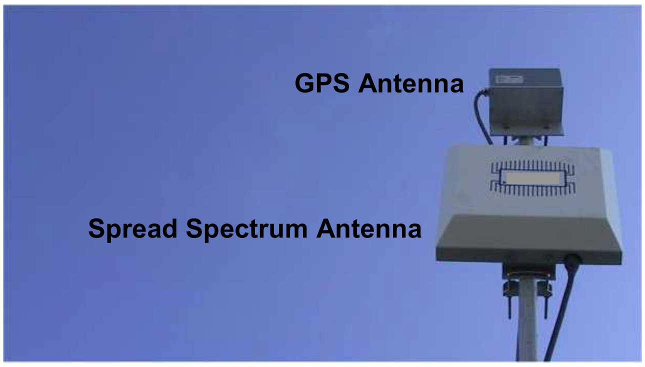
In the context of the Early Warning and Early Response System Project, GeoSIG has presented the system prototype during August 2001, which was receiving many positive feedback and approval from KOERI.

Later during November 2001, a number of test stations were shipped to KOERI. During the successful installation and testing period, 3 online, real-time 24 Bit Early Warning stations with spread spectrum telemetry communication interface, 3 dial-up 18 Bit Early Response stations with GSM communication interface and 2 off-line 18 Bit Structural Monitoring stations were utilized. For testing purposes, a provisional data retrieval and processing center was also constructed in KOERI.

To achieve the maximum performance and quality measures in communications, which is one of the most significant components in the project; an installation agreement is achieved between GeoSIG and Telsan Ltd, one of the best wireless radio companies in Turkey. All installation activities will also be monitored closely by GeoSIG by Electrical Engineer Emre Budak, from Turkey, who joined the GeoSIG project team in October 2001.



A typical Early Warning Station Installation



For the GSM services to be utilized in the project two of the best GSM operators in Turkey, Aria and Turkcell are selected by KOERI, depending on their enthusiasm and professional approaches. A full coverage agreement is expected to be signed between all involved parties during December 2001.

GeoSIG projects to deliver all system components during February 2002. From there on the installations of 10 Early Warning, 90 Early Response stations will be performed. To complete the system as a whole, three spread spectrum telemetry repeaters, one main data center, one secondary data center and four auxiliary centers will be installed. 40 Structural Monitoring stations will be also installed depending on the KOERI decision for locations and need. Further, 2 Early Warning and 10 Early Response stations will be kept ready in KOERI labs, as hot spares for the system.

The projected completion date of the project is June 2002 and there is an immense public interest in Istanbul, also due to the raised safety concerns during the 1999 Kocaeli and Düzce Earthquakes.

Presently being at the half of the project duration, all signs are positive towards a successful completion owing also to the close coordination with KOERI. Efforts of the esteemed technical staff headed by Professor Mustafa Erdik, chair of the KOERI Earthquake Engineering Department, are also highly appreciated.

Further news on the project will follow in the next issue of GeoWatch.

ABB utilizes GeoSIG equipment and expertise for dynamic verification project in Hong Kong

ABB, the well known power and automation technologies company, is conducting a retrofitting procedure under the Castle Peak Substation Enhancement Project in Hong Kong. During the procedure required dynamic response measurements are performed by GeoSIG.

GeoSIG Engineering co-ordinator Mr. Lukas Gaetzi visited the ABB site for conducting the measurements in Hong Kong. He had previously visited the location during May 2001 to perform reference measurements at an earlier phase of the said project.

The measurements are aimed to verify that the retrofitted ABB circuit breaker does not apply any unacceptable forces or displacement on the back portion equipment. The reference measurements before the retrofit will constitute the basis of comparison in the verification process.

Tri-axial acceleration and displacement measurements carried out simultaneously at selected points on the switchgear and peripheral equipment. Required responses are sought by either switching the ABB circuit breaker for response to the actual excitation and by applying low energy impulses with a constant energy impulse hammer for modal response.

The equipment used was consisting of, three tri-axial capacitive beam force balance accelerometers, one 16 channel data acquisition system and one impulse hammer.

A variety of photographs from the Hong Kong site

Displacement data is generated by integrating acceleration waveforms off-line.

Furthermore, the operational and natural mode shapes of the system are determined off-line with the output-only modal analysis software package ARTeMIS. Damping coefficients are determined through time domain analysis.

GeoSIG collaborates with RCI

Geophysics, Structural Dynamics and Civil Engineering: In many cases efficient and customer-oriented problem solutions ask for competence in all of these fields.

Based on personal relationship and coincidence of professional philosophy, GeoSIG started close co-operation with RCI Dynamics, Structural Dynamics Consultants, Duebendorf, Switzerland, recently.

Dr. Reto Cantieni, CEO of RCI Dynamics since the beginning of 2001, looks back on more than 25 years of experience in dynamic testing of civil engineering structures like bridges, buildings, towers and dams as a staff member of EMPA, Swiss Federal Laboratories for Materials Testing and Research.

Being a civil engineer devoted to structural dynamics, his main experience includes Experimental Modal Analysis of Structures, both with using artificial and ambient excitation techniques.

Informal but nevertheless very efficient co-operation with RCI Dynamics enhances GeoSIG's capabilities of offering customer services going well beyond data acquisition and storage.

New topics are e.g. Dynamic System Identification and interpretation of the structural dynamic behavior with regard to a structure's health, a procedure known as Structural Health Monitoring today. The Direct Stiffness Method, developed by researchers at the Royal University of Leuven, KUL, Belgium, allows not only identification but also localisation and quantification of structural damages from mode shape curvature changes.

Dr. Cantieni is the Technical Advisor for European users of ARTeMIS, a software package developed by SVS, Structural Vibrations Systems, Aalborg, Denmark, and also marketed by GeoSIG (see the following special article).

GeoSIG now distributes the ARTeMIS Extractor software package

Are you measuring or monitoring the vibrations of a civil engineering structure like a building, bridge, dam or tower? You should then know that ARTeMIS *Extractor* now allows easy determination of the dynamic characteristics (natural frequencies, associated mode shapes and damping) of structures excited by ambient sources. Determination and/or monitoring of the dynamic characteristics, also referred to as "modal parameters" is especially important when trying to validate a structure's finite element model or when monitoring a structure's health (Figure 1, and case studies mentioned below).

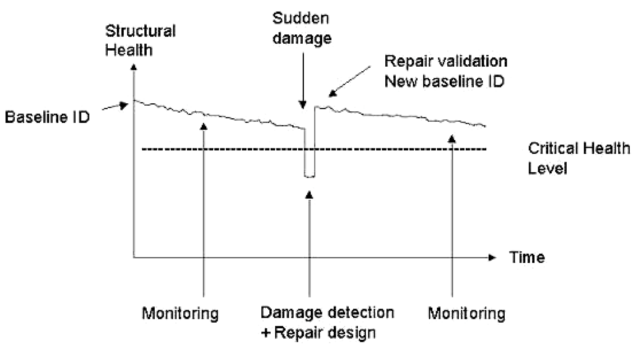


Figure 1. *Application of ARTeMIS Extractor for modal identification through the lifetime of a structure.*

ARTeMIS *Extractor*, developed by Structural Vibration Solutions ApS, Aalborg, Denmark, has been released to the market in 2001. Structural Vibration Solutions (SVS) is a small company spinned-off from Aalborg University and supported by the Science Park NOVI. Recently, GeoSIG has signed a contract with SVS allowing GeoSIG to sell all versions of the new software to its customers.

How does it work

The user performs measurements of the vibrations of a structure excited by ambient sources (micro-tremors, wind, traffic…). GeoSIG sensors and data acquisition equipment will provide the possibility to store data in the required, e.g. ASCII, format. The user specifies the geometry of the structure such as measurement points, measurement directions and lines to be plotted, and reads data and geometry information into the software. The user can also input the response data and the geometry using the well-known Universal File Format.

Modal parameter estimation is then performed using either frequency domain and/or time domain techniques. Validation of the results is then possible by comparing results from different estimation techniques and finite element calculations.

Estimation of the mode shape of the structure is possible for the points where measurements have been performed only. However, if a limited number of instruments are available, the user can use multiple data-sets keeping a few as references and roving the remaining instruments to obtain response data from all points of interest. This allows the user to get detailed mode shape information using a limited number of sensors.

Techniques included

Five different techniques are available: Two versions of the Frequency Domain Decomposition (FDD) technique and three versions of the Stochastic Subspace Identification (SSI) technique.

The FDD techniques are based on simple signal processing and work – as the name indicates - in the frequency domain. These techniques are very user-friendly. The simplest one is a peak picking technique allowing the user to estimate mode shapes and natural frequencies with a single click of the mouse. The more advanced version of this technique, the enhanced FDD, allows the user to estimate natural frequencies and mode shapes more accurately and also to estimate the damping of the structure.

The SSI techniques are pure parametric techniques working in the time domain. The user can specify different model orders corresponding to how many modes he wants to include in the model. The best model is then chosen by validating the model fit in the frequency domain and by specifying different kinds of stabilization criteria. Three implementations of the SSI technique are available: Unweighted Principal Components, Principal Components and Canonical Variate Analysis.

Different versions

Three versions of ARTeMIS *Extractor* are available. They differ in the number of estimation techniques available.

Table 1. Techniques included in the different versions of ARTeMIS Extractor

	FDD, peak picking	Enhanced FDD (with damping)	SSI, Unweighted Principal Components	SSI, Principal Components	SSI, Canonical Variate Analysis
ARTeMIS Pro	√	√	√	√	√
ARTeMIS Handy	√	√			
ARTeMIS Light	√				

User interface

All versions of the ARTeMIS Extractor run under Windows 98/2000/NT and have the same logical user interface with OLE support and on-line help that gets you started quickly.

All versions have capabilities for 2D displaying of spectral densities and for 3D mode shape animation. All plots and tables can easily be exported to other Windows programs such as MS Word and Excel using copy/paste commands. This also helps you produce convincing documentation with a minimum amount of work involved.

The following two case studies are included as examples in the software package.

Case study 1: the Z24 highway bridge

This case describes the modal identification of the bridge Z24 located in Switzerland. This prestressed concrete bridge with spans of 14-30-14 m was demolished in the autumn of 1998. Before demolition, a series of 15 progressive damage tests were carried out.

The structural response to the air pressure waves produced by cars passing under the bridge was measured and the modal parameters were identified using the FDD technique. The results of the investigation is described in detail in Brincker et al [1]. Six modes were identified in the frequency span 0...16.7 Hz and all six modes were identified in all 15 damage cases. Figure 2 shows the first two modes for this case.

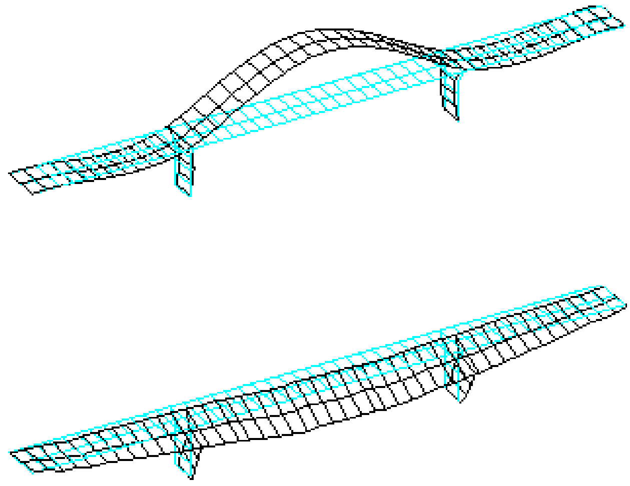


Figure 2. *ARTeMIS Extractor used for the identification of the two first modes of the Z24 highway bridge. Top: bending at 3.88 Hz, bottom: torsion/rocking at 5.02 Hz.*

Case study 2: The Heritage Court Tower Building

The Heritage Court Tower is a building located in downtown Vancouver, Canada. It is a relatively regular 15 story building with a reinforced concrete shear core. The investigation was carried out in order to identify the structural behavior of the building what the effect of the shear core walls was concerned. During the measurements, the building was mainly excited by wind and by traffic on the streets nearby.

Eleven modes were identified in the frequency range 0~10 Hz using the FDD as well as the SSI techniques. The investigation is described in Brincker and Andersen [2]. Figure 3 shows two of the identified modes of the building.

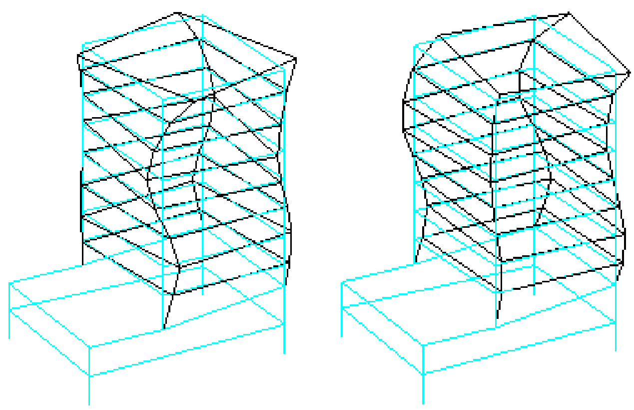


Figure 3. *ARTeMIS Extractor used for identification of two modes for the Heritages Court Tower. Top: torsion at 6.40 Hz, bottom: bending/shear at 7.54 Hz.*

References

[1] Brincker, R., P. Andersen and R. Cantieni: Identification and Level 1 Damage Detection of the Z24 Highway Bridge by Frequency Domain Decomposition. To be published in November/December issue of Experimental Techniques, 2001, The Society for Experimental Mechanics, Inc.

[2] Brincker, R. and P. Andersen: Ambient Response Analysis of the Heritage Court Tower Building Structure. In Proceedings of the International Modal Analysis Conference (IMAC), San Antonio, Texas, 2000

Special offer: ARTeMIS Extractor customer training courses

Application of the FDD, Frequency Domain Decomposition, methods offered by ARTeMIS to extract the mode shapes of a structure from ambient measurements is quite straightforward to every engineer familiar with Fourier Transformation Technologies. This does not apply to the time domain extraction technologies also offered by ARTeMIS. Technologies like SSI, Stochastic Subspace Iteration, can efficiently be applied by well trained engineers only. SVS, Structural Vibration Solutions, therefore offers the possibility of attending a customer training course in this matter. Location and time of such a course, given by the software developers, Prof. Dr. Rune Brincker and Dr. Palle Andersen, SVS, can be adapted to the wishes of actual or potential customers in a very wide range. The number of participants of such a course should however be between five and ten people.

Do not hesitate to contact GeoSIG Headquarters in case you are interested in participating the course planned for February 2002. All inquiries should be received no later than 24.01.2002.

We would like to take this opportunity to announce that our annual winter holiday will be from the 24th of December to the 4th of January 2002.

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