GeoWatch

September 2006, Issue 30

GeoSIG

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Keynote: Some Examples for Seismic Instrumentation of Structures II

Scope:

GeoSIG instruments can be deployed on any civil engineering structure such as bridges, dams, nuclear power plants, railroads, roofs, tunnels, etc. to monitor different dynamic, static or transient cases. We have started to give some examples for the instrumentation of structures with different purposes with the previous GeoWatch Issues. Here we continue to give some other examples of such structures and cases especially utilizing our VE series Velocity Sensors.

Visit Us at 1st European Conference on Earthquake Engineering and Seismology, Geneva, Switzerland, September 2006

The First European Conference on Earthquake Engineering and Seismology will take place in Geneva, Switzerland in September 3-8, 2006.

The European Association of Earthquake Engineering (EAEE) and the European Seismological Commission (ESC) have long traditions of periodic conferences: The European Conference on Earthquake Engineering (ECEE) takes place every four years, and the General Assembly of the ESC every second year, respectively. In 2006, the EAEE and the ESC will join the 13th ECEE and the 30th ESC General Assembly to hold for the first time in common the First European Conference on Earthquake Engineering and Seismology (1st ECEES). *(For more information, please refer to http://www.ecees.org/)*

GeoSIG Ltd. will participate in the conference within the exhibition area, booth #1.

We will be happy to see you in our booth and to provide you with in-depth information on our systems and services.

Railroad Monitoring: *Taiwan High Speed Rail (THSR) Train Operations*, Tainan, TW

The Taiwan HSR line runs approximately 345 km from Taipei to Kaohsiung (Tsoying), passing 14 major cities and counties and 77 townships and regions.

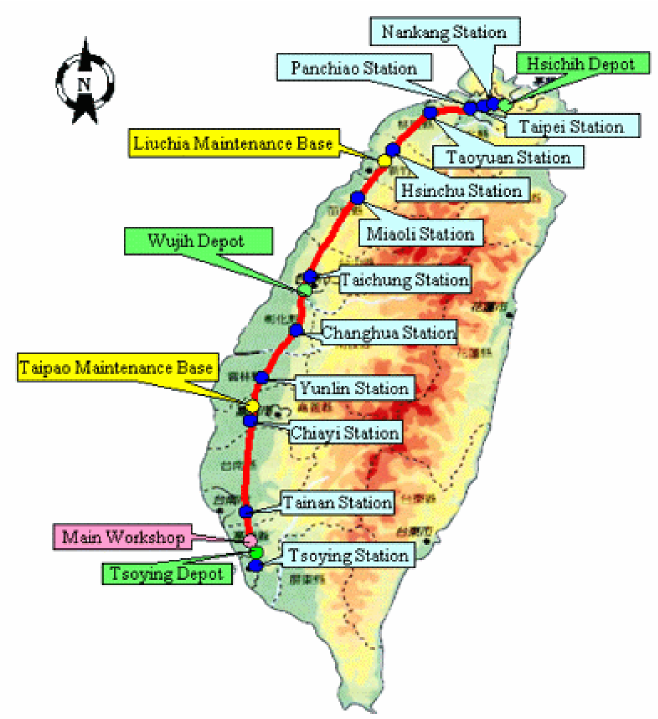

Figure 1. Alignment of Taiwan High Speed Rail (THSR) Line.

The line is a high capacity and high speed railway. It is capable of carrying over 300'000 passengers in a single day of operation. After commissioning, it is expected to reach a normal speed of up to 300 km/h, and ultimately 350 km/h, shortening the north-south journey time to within 90 minutes. (Figure 1).

The Tainan Science Park, located in the Tainan County in southern Taiwan, will be a new location for many vibration sensitive high-tech factories.

Realising that the high-speed rail alignment passes through the Tainan Science-Based Industrial Park (TSIP), the Taiwan High-Speed Rail Corporation (THSRC) has set up design requirements such that during operation, the vertical vibration 200 meters on either side of the rail centreline do not exceed 46 dB in the high frequency range (12.5 Hz) and do not exceed 68 dB in the low frequency range (< 12.5 Hz). Besides these measures to be taken, to satisfy the highly sensitive high-tech factories in the park, TSIP initiated the Vibration Mitigation Project, and the Vibration Measurement for Verification of Vibration Mitigation Effectiveness Project linked to that.

GeoTech Engineering Consultant Co., Ltd., a company who focuses on automated, remote and integrated geotechnical instrumentation monitoring systems as well as the development of corresponding database management software, is assigned by TSIP to accomplish the mitigation project.

The purpose of this project is to obtain instrument-recorded in-situ ground vibration data for verification of effectiveness of vibration-mitigation measures implemented in Tainan Science-Based Industrial Park (TSIP) for reducing ground vibrations induced by the Taiwan High Speed Rail (THSR) train operations. The THSR track passes through the eastern edge of TSIP.

The Vibration Mitigation construction layout is as in Figure 2:

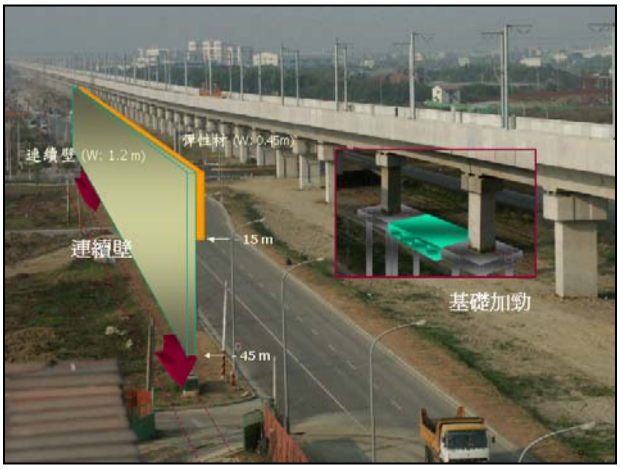

Figure 2. Vibration Mitigation construction layout. (GeoTech)

The vibration mitigation measures constructed in TSIP for reducing high-speed-running-train-induced ground vibrations consist of the following two specific measures:

- Stiffening the elevated guideway structure foundations in TSIP with foundation-stiffening blocks (FSB) that structurally link the pilecaps of the pile-foundations together in the longitudinal direction of the THSR alignment.
- Constructing underground wave-barrier-wall (Diaphragm Wall) at approximately 30 m away to the west of and parallel to the THSR alignment. (Figure 3)

The elevated guideway structure segment in TSIP implemented with the vibration mitigation measures is approximately 4.85 km long from the THSR Chainage TK290+700.000 to TK295+548.716.

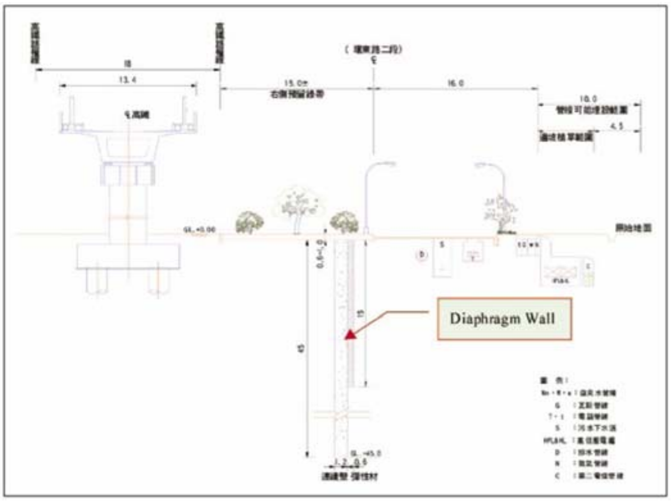

Figure 3. Vibration Mitigation Plan for Tainan Science Park. (MAA Bulletin, Issue 38)

Instrument Recording Stations

Since the THSR trains are not yet operational before vibration mitigation measures are constructed, no measurements of train-induced free-field ground vibrations can be made before implementation of vibration mitigation measures to provide reference ground vibration data to be used for comparison with the corresponding data obtained after mitigation. Therefore, two sites are required for ground vibration measurement.

One site, referred to herein as "Site A", is located in the mitigated structure section in TSIP; the other site, referred to herein as "Site B", is located in the unmitigated structure section outside TSIP but close to Site A.

Site A: Located in Mitigated Section

Site A is located approximately at the middle of a selected approximately 10 consecutive 30-m-long girder-spans section of the mitigated elevated structures in TSIP.

A total of 14 instrumented recording stations, all from VE-13 Triaxial Velocity Sensors, are deployed for Site A. These recording stations are arranged in two parallel-lines perpendicular to and on the west side of the THSR alignment. The two recording lines are selected at approximately the mid-section within the 4.85-km long mitigated section of elevated structures in TSIP. Each recording line is aligned with the transverse centerline of each selected pier, which is pier 287 & pier 289. The two parallel, transverse recording lines are spaced with a distance in the longitudinal direction of the THSR alignment of approximately 90 meters or three 30-m-long-spans apart.

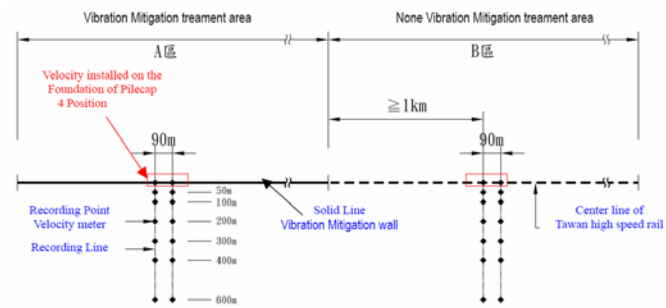

Figure 4. Location of Instrument Recording Lines and Stations

On each transverse recording line, seven (7) VE-13 instrumented recording stations are deployed. One station is located on the pilecap of the selected pile-foundation and the other six are located on the free-field ground surface at distances 70, 100, 200, 300, 400, and 600 meters away from the THSR alignment centerline. There are 3 VE-13 measuring sensors at the station on the pilecap; two out of the three measuring sensors measure y-axis, y-axis & z-axis respectively, where y-axis is the direction of the train path, which is believed to be producing the most vibration.

Site B: Located in Unmitigated Section

Site B is located outside, to the south of the 4.85-km long mitigated structure section in TSIP in subsurface ground condition that is similar to that of the selected recording Site A.

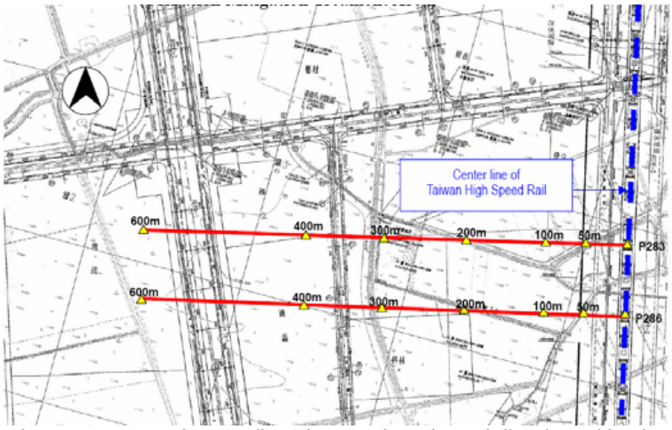

Figure 5. Layout of Recording Lines and Stations. (Vibration Mitigation Treatment Area).

In a one-to-one correspondence to the instrumented recording stations in Site A, a total of 14 VE-13 recording stations are also deployed for this recording site in the same pattern as that for Site A. The selected recording Site B is approximately 4.53-km distance away from the south end of the 4.85-km-long mitigated structure section.

The locations of the 14 VE-13 instrumented recording stations for each of Site A and Site B is shown schematically in Figure 4 and Figure 5. In this figure, the solid line represents the mitigated structure section in TSIP having vibration mitigation measures implemented; the dashed line represents a selected unmitigated structure section outside TSIP without any vibration mitigation measures implemented.

The Result for the dB value from the software is represented by GeoTech as the following figure. (Figure 6)

Also in Figure 7, the frame of the Vibration Mitigation Monitoring System is illustrated. (GeoTech)

Titi Yong, and Johnny Huang, GeoTech.

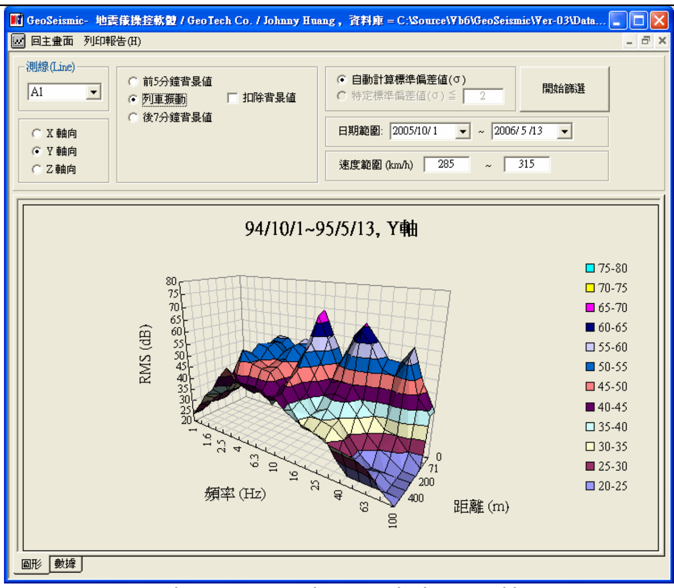

Figure 6. DB Value Result. (GeoTech)

The frame of the mitigation monitoring system

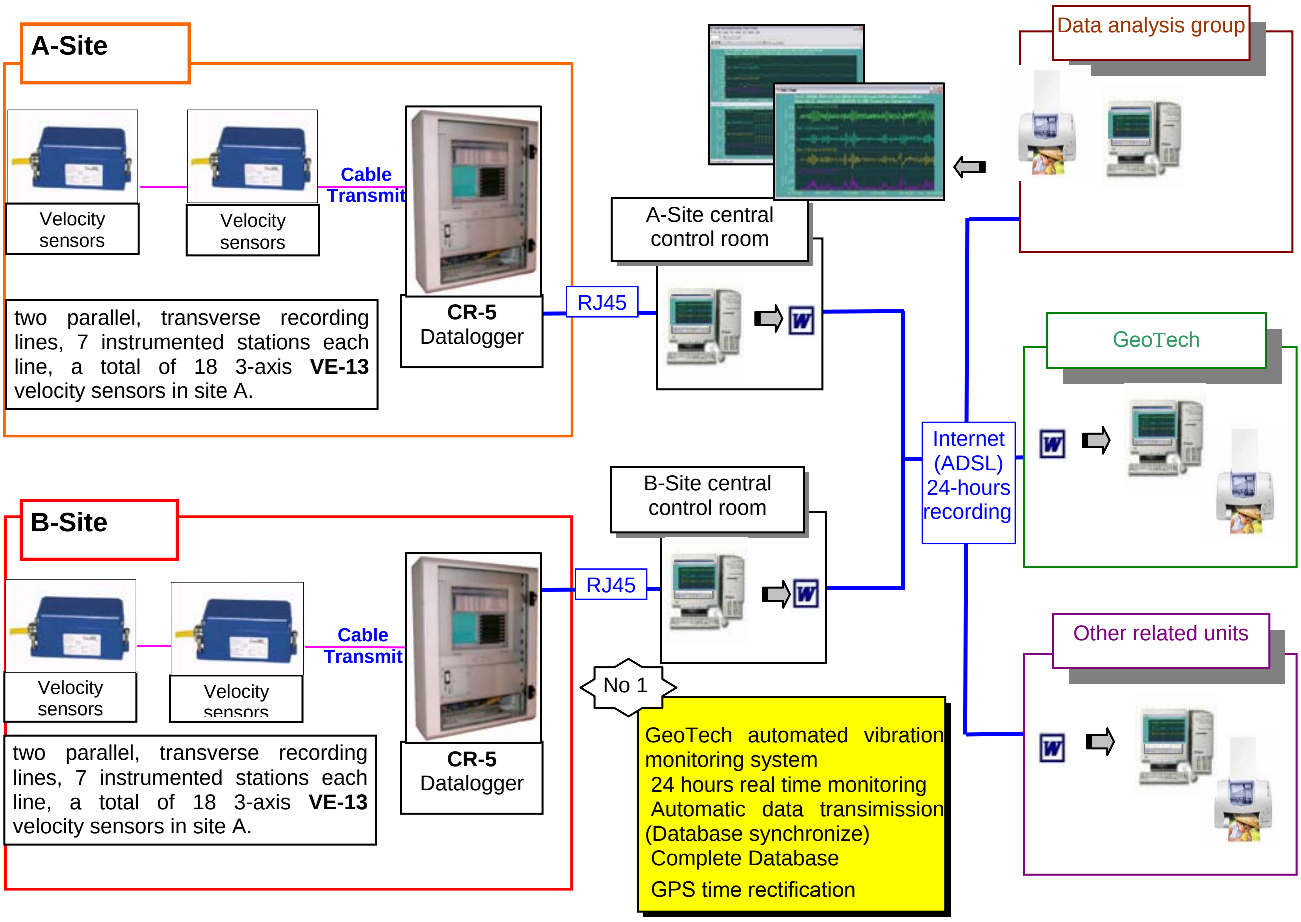

Figure 7. The Frame of the Vibration Mitigation Monitoring System.

Dynamic Monitoring System for the Saaser Tunnel, Switzerland

System Description

The Saaser Tunnel is part of a major road infrastructure project in the East of Switzerland. The valley of Klosters and Davos (world known from the annual World Economic Forum) provides a crucial passage in the region. However, besides the regular commuters, the traffic added during the winter season increases the load above the acceptable level in the area, especially in historic towns with narrow roads. In order to reduce this load, major investments are made for bypassing Klosters and now sequentially Saas.

The key structure is a 2'755 m long tunnel underneath of Saas. Due to the geological conditions the tunnel is excavated using blasting technology. Since just above the tunnel some buildings are located the blasting induce vibration could lead to some damage. Figure 8.

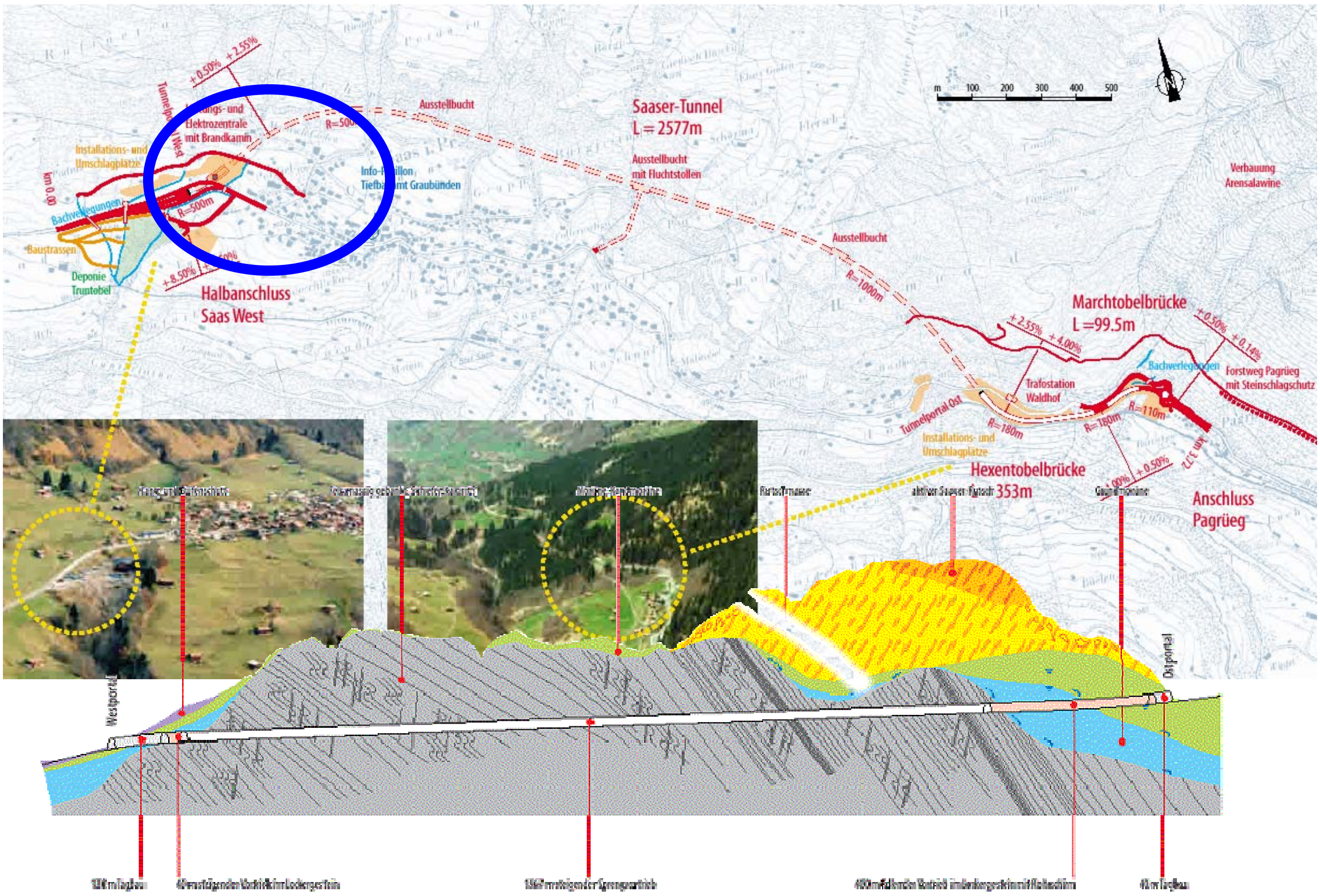

Figure 8. Overview of Saaser Tunnel. The blue circle line indicates the location of the Monitoring System.

GeoSIG was selected to install and operate the dynamic monitoring system supervising the blasting work performed during the construction of the Saaser Tunnel. (Figure 9). As a first installation in Switzerland a dynamic online monitoring system based on the internet as data communication media

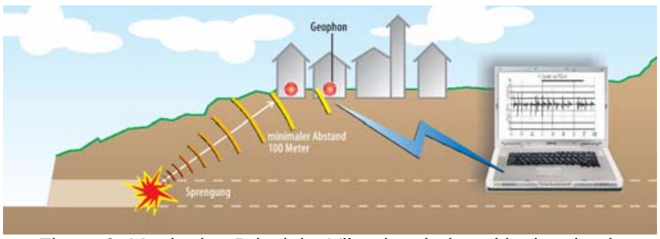

Figure 9. Monitoring Principle: Vibration, induced by basting is monitored.

The project owner, in this case the canton of Graubünden, therefore decided to install a dense monitoring system for the control of 7 buildings. The deployed system is projected to provide the means to understand, avoid and early determination of potential risks associated with the high vibration impact on specific structures due to blasting within the overall project quality management.

The monitoring system, installed by GeoSIG utilises a VE-33 velocity sensor installed at the basement of every building to be monitored. All the 7 sensors are connected through a cable to a CR-5 central monitoring system. (Figure 10).

For similar purposes, several alternative configurations can also be provided by GeoSIG depending on the application:

Alternatives to VE-33:

- Accelerometers AC-23, AC-43, AC-63
- Velocity Sensors VE-13, VE-23, VE-53

Alternatives to CR-5:

- Independent Recorders (GSR-xx or GCR-xx)
- Event Based Central Recording System (GNC-CRxx)

The CR-5 system is an innovative PC based monitoring system. GeoDAS is utilised as the logging and analysis software. All the 21 channels of the 7 triaxial sensors are sampled at a frequency of 500 SPS.

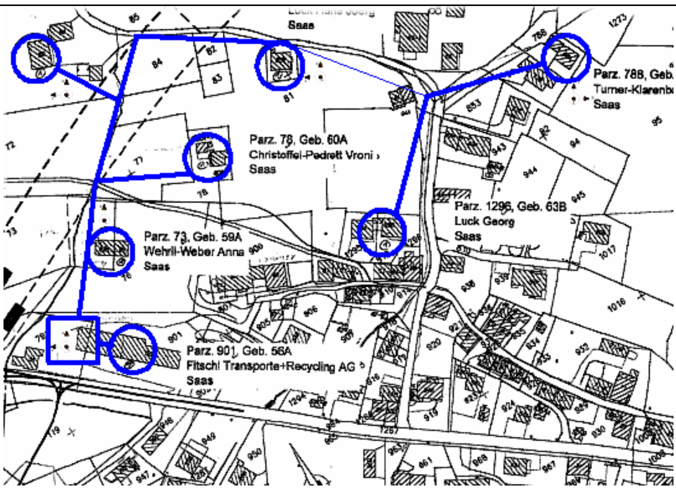

Figure 10. Topology of the Monitoring System.

Figure 11. VE-33 installation horizontal on a foundation wall.

The continuous data streams are stored in an 80 GByte ringbuffer system. Continuous recording of dynamic data requires enormous storage capabilities. Just for one channel, 24 h/day x 3600 s/h x 500 Sample/s x 2 Byte/Sample = 86.4 MByte/day are generated. For 21 channels the total requirement would be 21 x 86.4 MByte/day, i.e. 1.8 GByte/day.

The detailed data is of importance only during short sequences (blasting). Therefore in parallel to the continuous recording, GeoDAS checks for particular network trigger conditions. If at more than 1 site (number is selectable) a level of 1 mm/s is exceeded an event is declared and the data is stored separately.

A further tool is the data reduction allowing a perfect overview about all the channels over a full day. Therefore the minute-peaks of the vector sums are stored. In this case one channel produces only 1'440 data points. The continuous 7/24 monitoring is therefore assured without any lack of data. In case somebody is interested in a special data segment, this can be retrieved from the ringbuffer.

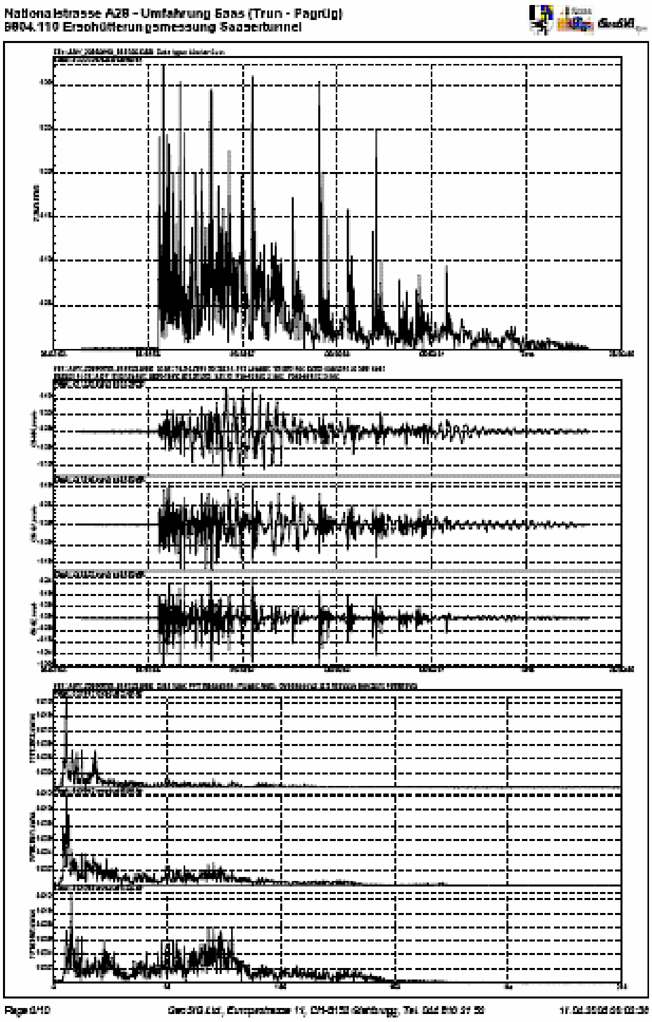

Figure 12. Event Representation from top to bottom: Vector Sum, Time series (x, y, and z), Frequency Content (FFT).

The local recording PC can be contacted through internet via a relay server. The data communication channel is highly secured by means of SSH (secure shell) and allows to have dedicated data links through firewall protected environments. Thus any computer connected to the Internet and running GeoDAS can establish a link to the local recording computer and generate reports automatically.

In the actual system, fully automated standardised daily reports (Figure 12) are broadcasted by email to a list of key persons, consisting of

- list of peaks for every location
- daily vector peak representation
- time series x, y, and z for blasting events with vector sum and frequency analysis

Optionally SMS (Mobile Phone Short Message Service) alerts can be broadcasted in any adverse situation.

Christoph Kündig, CEO, GeoSIG Ltd.

Telemetry - An Excellent Completion to Satellite Transmissions

Wireless solutions get more and more popular: In smaller areas it allows to be free to move and place the equipment without thinking about the cabling or for long distance transmissions while it's useful to avoid high wiring costs.

GeoSIG Ltd. provides a wide range of custom telemetry solutions. Completely independent from any satellites, sensor networks over a distance of more than 100 km are possible (*) and allow data processing and controlling of a variety of equipment from a central control centre. Free of continuous leasing costs and political dependence.

At the beginning of planning, GeoSIG Ltd. assists the customer in finding the right equipment for their project as well as in the evaluation of potential telemetry links. Global terrain data allows us to calculate line of sight profiles anywhere around the world.

In smaller areas, a wireless synchronisation network for GeoSIG Ltd. recorders guarantees a maximum flexibility in choosing and changing sensor positions and having a synchronised network all the time.

Please ask for more details about our customised telemetry solutions.

(*) *Depending on local regulations, frequency pollution and terrain.*

Markus Epp, GeoSIG Ltd.

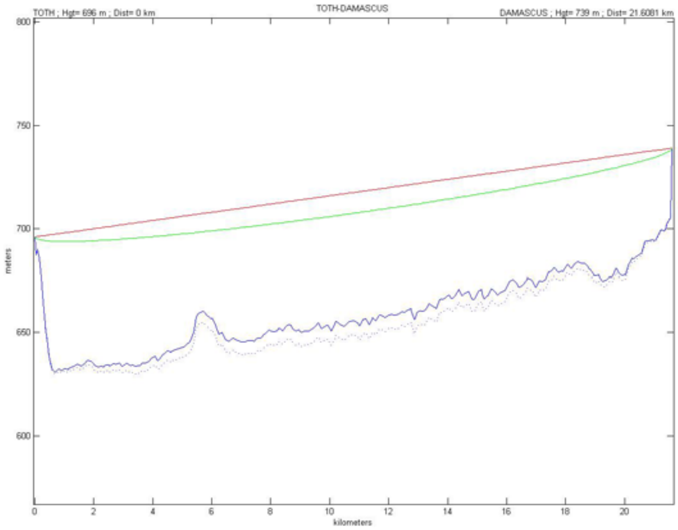

Figure 13. An Example of a Calculated Telemetry Profile. (GeoSIG)

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