

Report to the 34rd General Assembly
FIG Working Week 2011 in Marrakech, Morocco

FIG Commission 6 – Engineering Surveys

End of Term Report 2007–2010

1. General

The field of interest of Commission 6 are traditional the acquisition, processing and management of topometric data and all related information throughout the life cycle of a project (at construction site), quality control and validation for civil engineering constructions and manufacturing of large objects, modern concepts for setting-out and machine guidance, deformation monitoring, analysis and interpretation, measurement of dynamic loaded structures (general), prediction of deformation and movements in engineering projects, mines and areas of geological hazard, automatic measuring systems, construction and industry and multi-sensor measuring systems, terrestrial laser systems, their usage in architecture, civil engineering and industry and standards related to the construction and deformation measurement.

The Commission 6 activities were started with creation of the Working Plan for 2007-2010 and the new Commission 6 team build by WG Chairs and Co-Chairs. Starting the new period, joint these positions 6 new colleagues, former Commission 6 delegates and members. The main topics of the Commission are covered in the former period by five WGs, which structure was completed by the sixth WG oriented for terrestrial laser scanning.

2. Working Groups

WG6.1 – Deformation Measurement and Analysis

Chair: Adam Chrzanowski (Canada); Vice-chair: Cecilia Whitaker (USA)

WG activities were focused on the automation of monitoring surveys, enhancement of geometrical modelling of deformations from integrated deformation surveys, physical interpretation of deformations including numerical modelling and prediction of deformations and back analysis. A main objective of this WG were to propose or improve techniques to analyze historical geodetic data in comparison with modern ones, mostly GNSS-based. This was expected to permit:

- to extend the geodetic information on crustal deformation in larger time and space scales; especially to compare data collected after a certain event (for instance an earthquake) with those collected before it in areas not covered yet by extensive GPS networks.
- to examine whether the pattern of crustal deformation derived from longer term data (tens to hundreds of years) differs from the short-term one, derived mainly from modern, usually satellite data. This investigation is not limited to tectonic and seismic effects (especially the local earthquake cycle) but extends also to volcanic effects and to rather

- surficial effects (for instance synsedimentary faulting in young deposits, sediment consolidation, etc).

The results obtained were presented in several meetings in Greece, Germany, France, Italy, and Turkey also IUGG and IAG Symposiums.

WG6.2 – Engineering Surveys for Industry and Research

Chair: Thomas Wunderlich (Germany); Vice-chair: Peter Kyrinovic (Slovakia)

The main goal of WG activity was to provide the specialists involved in that kind of missions with the latest state of the art concerning the use of adapted survey techniques in industry & engineering, multidisciplinary collaboration between survey engineers, civil engineers, structural & mechanical engineers, R&D scientists - for a better approach of complex engineering survey problems, specific algorithms, instrumentation, equipment and techniques in engineering surveys, high precision measurements and special techniques for the large scale metrology of big equipment or structures, integration of survey & alignment sensors with actuators and/or tools for on-line monitoring and control of a given process (dynamic systems).

WG6.3 – Engineering Survey Data Bases and Facility Management

Chair: Lothar Gründig (Germany); Vice-chair: Vladimir Seredovich (Russia)

WG activity was focused on the role of the surveying engineer as the responsible manager of spatially referenced information, support for the co-ordination of the activities of other disciplines, building concepts of data models for the mapping of relevant 4D or 5D project data, covering 3D geometry, time, and descriptive attributes, exchange, provision and presentation of facility management data in computer networks, data integration for this subject, taking into accounts the presence of redundant data and different sources of information and automation and combination of feasible data acquisition techniques.

WG6.4 – Engineering Surveys for Construction Works and Structural Engineering

Chair: Gethin Wyn Roberts (UK); Vice-chair: Joël van Cranenbroek (Belgium)

The WG was promoted the use of adapted survey techniques in industry & engineering, promoted a multidisciplinary collaboration between survey engineers, civil engineers, structural & mechanical engineers, promoted the understanding of fibre optic sensors, e.g. interferometric sensors, study the use of embedded sensor arrays and the role of advanced surveying techniques for structural monitoring, has created an awareness of surveyors through a task force 'Fibre optic sensors' of the rapidly emerging technology of fibre optic sensors as "non-geodetic" sensors to measure deformations (strain) and temperatures in civil engineering structures.

WG6.5 – Terrestrial Laser Scanners – joint WG with FIG C5

Chair: Maria Tsakiri (Greece); Vice-chair: Rudolf Staiger (Germany)

WG was promoting the usage of laser scanning for geometric documentation in a variety of environments, particularly high risk and environments which benefit of remote measurements (e.g. structures, slopes, underground surveys, structural deformations of cultural heritage monuments), investigate existing and developing terrestrial laser scanner instrumentation for

engineering applications, evaluate and compare algorithms for processing terrestrial laser scanner data (e.g. registration, surface modelling, etc.), investigate and document metrological and quality control issues for laser scanning measurements, investigate the integration of laser scanning measurements with other measuring techniques, such as conventional geodetic systems and photogrammetric techniques.

The special and actual topics in focus of C6 were covered by six **Study Groups**, which activities were oriented to:

- SG 1 '**Continuum Mechanics as a Support for Deformation Monitoring, Analysis and Interpretation**', chaired by Anna Szostak-Chrzanowski (Canada)
- SG 2 '**Optimal Use of Interferometric Synthetic Aperture Radar (InSAR)**', chaired by Linlin Ge (Australia)
- SG 3 '**Crustal Deformation**', chaired by Stathis Stiros (Greece)
- SG 4 '**Monitoring and Analysis of Cyclic Deformations and Structural Vibrations**', chaired by Gethin Wyn Roberts (UK)
- SG 5 '**Fibre Optic Sensors**', chaired by Helmut Woschitz (Austria)
- SG 6 '**Terrestrial-Based RF Positioning Technologies**', chaired by Joel Barns (Australia)

3. Events

The actual application of new developments, theory and methodology were reflected in a large number of conferences covered by C6 members. Parallel to the traditionally organised series of conferences, last two years started conferences oriented to continual deformation measurement, including integrated sensor system development and usage, to navigation of construction and agricultural machines. The newest activity is dated to September 2010 and was oriented to indoor navigation.

International Course for Engineering Surveying is held traditionally in German speaking countries, is well known between the engineering surveying community and is attended by large number of participants. These events are focused through many years to machine-, computer- and robot- vision, to discuss recent scientific and technical advancements and applications for optical static and kinematic 3D measurement techniques. Emphasis was placed in last year at new and emerging technically in precision laser scanning, tunnel construction and the topic fibre optic sensors and their usage in civil engineering structure monitoring (www.iv2010.bv.tum.de).

The longest tradition has between the series of conferences the **International Symposium on Deformation Measurements**, which is traditionally organised by the WG6.1 of C6. The last conference of this series was held in Lisbon (Portugal) in 2008 and the next will be prepared for 2011 in Hong Kong. The topic of these series is covered by more working groups of C6 and for study groups, which deals with the bright field of deformation measurement.

WG6.4 and SG4 participated with the joint session at the international conference organised by the Institution of Civil Engineers in UK and the 5th **International Conference on Current and Future Trends in Bridge Design, Construction and Maintenance** held in Beijing in China 2007. The purpose of this series of conferences was to provide a forum for not only bridge design and construction, but also for measurement of dynamic loaded

structures. For surveyors is very important this cooperation and open new contacts and opportunities of application of the new geodetic technology (mainly for kinematic application).

In Novosibirsk (Russia) was started the series of conferences and exhibition, **International Exhibition and Scientific Congress GEO-SIBERIA**, which is organised by the Siberian State Geodetic Academy and co-sponsored by FIG C6, namely by WG6.3. The congress is organised every year with big interest of Russian surveyors (more than 400 participants), in the field of engineering surveying, information system and surveying technology development (<http://geosiberia.sibfair.ru/eng/>).

FIG Commissions 5 and 6 together with the Siberian State Academy of Geodesy (SSGA) organised in July 2009 a **Workshop on Innovative Technologies for an Efficient Geospatial Management of Earth Resources** on Lake Baikal in Listvyanka (Russian Federation). The conference was attended by more than 50 participants around the world.

In 2007 started the series of **International Conference on Machine Control & Guidance** prepared by Uni Bonn (Germany), with participation of the WG6.2 and WG6.5 members, cosponsored by C5. The last conference was held in 2010 and was oriented to the newest development and application in the field of machine guidance. The series of these events is oriented more to guidance of construction and agricultural machines (large scale and outdoor application - www.mcg.uni-bonn.de).

The first **International Conference on Indoor Positioning and Indoor Navigation (IPIN)** was held 2010 in Zurich (Switzerland), with co-operation of FIG C6, C5, IAG and other professional organisations. The successful conference was attended by 400 participants (250 IT specialists and 150 surveyors) discussed methodology of indoor navigation, possible technology based on WIFI, LAN, terrestrial RF sensors, GSM, etc. According the very positive response of participants was decided to start the new series of conferences (next in 2011, Lisbon, Portugal - www.ipin.ethz.ch).

Between the engineering surveying community is well know the series of conferences on **Optical 3D Measurement Techniques**, which is organised in co-operation with of ISPRS and FIG C6 and C5. The series of these events is traditionally focused to machine, computer and robot vision, model building, image matching with many applications from a variety of working areas. The conference discusses recent scientific and technical advancements and applications for optical static and kinematic 3D measurement techniques. The last conference held 2009 in Vienna (Austria) were devoted to step-motor-driven and servo-controlled electronic theodolites and total stations, high resolution, low cost and smart digital cameras, capabilities for very fast or even real-time processing, visualization, animation and VR techniques are some developments leading to new procedures in photogrammetry and surveying. The next conference will be organised by ETH Zurich (Switzerland) this year.

The traditional seminar on **Terrestrial Laser Scanning** in Fulda (Germany) is organised annually by FIG C5 and C6 together with the DVW and ISPRS. This seminar serves to show the stage of development of the sensors, processing as well as application, furthermore a view of future developments (www.laserscanning.org).

The latest news in theory, methodology, technology, research and application are traditional reflected at conferences which are annually organised on **FIG Working Weeks and Congresses**. The total number of papers on these conferences achieved 800, from which about 20% is devoted to different topics of engineering surveying. These papers are accepted for technical sessions managed by FIG C6 or C5.

Commission 6 has been participated at the FIG Working Weeks in **Hong Kong (China, 2007) and Stockholm (Sweden, 2008)** by technical sessions devoted to the engineering survey topics and the commission annual meeting, which build space for presentation of the progress made by the commission WGs and study groups. The high number of prepared papers underlines, that the year 2008 was one of the most active and very important for Commission 6. The effort included to this event and their preparation was transformed to results, which are important not only for commission members, but all specialists dealing with engineering surveying around the world.

Commission 6 was represented at the FIG WW in **Eilat (Israel, 2009)** by 6 sessions devoted to deformation and land slide monitoring and special engineering applications. It was organised 3 joint TSs of C6 and C5 devoted to terrestrial laser scanning, LIDAR and network and data analysis. Two TSs are organised in cooperation with ISM and ISPRS. Traditional annual meeting of the commission was held during the WW, during this were discussed actual topics of deformation monitoring, analysis and interpretation using continuum mechanics, monitoring and analysis of crustal deformations, optimal use of InSAR technology, terrestrial-based RF positioning technologies, methods and equipment of terrestrial laser scanning for engineering surveying procedures, analysis of cyclic deformations and structural vibrations, monitoring of dynamic loaded structures, application of automatic measuring systems multidisciplinary expertise and co-operation, which lead to integrated survey methods and systems.

Commission 6 participated in the FIG **Regional Conference in Hanoi (Vietnam, 2009)** by 10 TSs in cooperation with Commission 5, 3 and 8. The discussed topics are disaster risk management, GNSS application, mapping, areal surveying and remote sensing, Vision technology usage for monitoring also sensors and data processing in engineering surveying.

C6 was prepared for the FIG Congress held in **Sydney (Australia, 2010)** 16 technical sessions devoted to the engineering survey topics – deformation using GNSS, terrestrial scanning, subsidence and landslides, quality management and standards, LiDAR and InSAR applications, remote sensing and data processing, machine guidance and integrated systems, building measurement and modelling, engineering survey. The commission annual meeting build space for presentation of the progress made by the commission WGs and study groups.

4. Co-operation with international associations

According to the increasing co-operation between FIG and other professional organisations many of the WG and SG members are active in different **ISPRS, ISMS and IAG** commissions, attended regular Congresses of sister organisations. Papers and presentations were prepared for many events – the XIII Congress of the ISMS held 2007 in Budapest (Hungary), XXI Congress of ISPRS held 2007 in Beijing (China), 100 Years ISPRS

Centenary Celebrations including ISPRS TC VII Symposium “100 Years ISPRS - Advancing Remote Sensing Science” held 2010 in Vienna (www.isprs100vienna.org), etc.

5. Conclusion

The high number of prepared events and papers underlines, that Commission 6 is one of the most active and very important in FIG. The effort included to all this events and their preparation will transform to results, which are important not only for FIG commission members, but member of other professional organisations and all specialists dealing with engineering surveying around the world.

Concluding the discussed and presented topics in years 2007-2010 are remarkable new field of interest in engineering surveying. Parallel to the traditional topics (deformation measurement, setting-out, large scale metrology) are discussed new topics (laser scanning, model building, image matching, visualisation, fibre optic sensors, usage of InSAR, RF positioning, indoor navigation, etc.). In many fields are decided that results is needed in real time or with frequency at 0.1 kHz level. Very positive is the active participation of surveyors on this process and development also the bright co-operation together with specialist from other professions.

Papers of all events (conferences, seminars) organised in co-operation are included to the FIG Library, which is e-library positioned at FIG servers (<http://www.fig.net>). This ways are all this papers and the information achievable for all who is interesting in pdf files. The library offers the users searching and analyzing tools, also.

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