Appendix to item 22.6

FIG Commission 6 on Engineering Surveys

Work Plan 2023–2026

1. Title

Engineering Surveys

2. Terms of Reference

- Design of accurate, robust and reliable engineering surveying systems to be applied at construction sites or for monitoring purposes
- Validation of surveying equipment and quality assessment (QA) as well as quality control (QC) of measured data
- Acquisition of static and/or dynamic data for better understanding the behaviour of structures and natural phenomena
- Creation and maintenance of integrated geospatial information systems for engineering applications
- Improvement of advanced statistical and non-statistical methods to derive reliable information on displacements of structures and natural objects
- Transfer of artificial intelligence to engineering surveying tasks
- Increase the use of area wide capturing techniques like aerial and terrestrial photogrammetry, ground and satellite based interferometric radar as well as static and mobile laser scanning in construction sites, visual inspections and displacement monitoring
- Integration of multi-sensor systems and internet of things (IoT) sensors
- Implementation and testing of automated surveying systems
- Contribution with spatial data to BIM, 3D and 4D visualizations, collaborative virtual environments and augmented reality
- Advance point cloud-based spatiotemporal monitoring
- Examine the potential and capabilities of low-cost sensors and systems in surveying engineering
- Application specific (e.g., bridge, dam, high-rise structures) monitoring studies and monitoring of geohazards (e.g., landslides, soil subsidence)

3. Mission statement

The mission of Commission 6 is to:

- Assist engineering surveyors to have privileged access to the newest knowledge, either in the technology domain or the analysis techniques and methods
- Encourage the development of guidelines and good practices as well as to support standardization activities
- Disseminate the benefits arising from the newest engineering surveying techniques among other professionals

- Promote interdisciplinary forums for the exchange of knowledge
- Develop of shared resources and data repositories to encourage rapid research and advancements internationally
- Participate in FIG organizations and cooperate with other FIG Commissions as well as with FIG Networks
- Cooperate with sister organizations, primarily the IAG and ISPRS, including the organization of joint events
- Promote engineering surveying in other organizations using surveying data, e.g. ICOLD, IABMAS, ITA, ION-GNSS

4. General

Nowadays we are experiencing a period of paradigm shifts, several motivated by awareness of the limitations of our planet. Our world is becoming less and less stable. The number of big disasters, whether natural or resulting from human activity (earthquakes, landslides, land subsidence, climate change consequences, etc.) is increasing. Severe weather conditions together with inadequate human interventions on the earth surface, as well as with an increase of inhabitants in several areas of the globe, are leading to a need of engineering surveys in pre, during and post disasters. In this context the commission is linking to the sustainability vision of the FIG Council Work plan serving society for the benefit of people and planet.

Civil engineering structures are ageing and, in many countries, bridges and water dams are reaching the end of their design lifetime. To keep them in service and ensure a safe operation, structural health monitoring (SHM) concepts have to be developed and implemented. SHM is a promising field for engineering surveying as surveying methods play a vital role in SHM systems.

In the domain of civil engineering, rehabilitation is the new rule and sustainability in construction is an undeniable demand. Even if 2D mapping and current practice is still needed, engineers and architects look for 3D solutions in all phases, ranging from the design, to the construction, and throughout the operation phase. Several demand even 4D models now, integrating data from several sources, sometimes in real (or quasi real) time. Furthermore, the augmented and virtual reality approached become more important to generate immersive environments.

The challenges are rapidly increasing. Emerging techniques and requests in new areas of work are challenging the engineering surveyors. FIG Commission 6 will work together with engineering surveyors to provide them information about equipment and methods that will increase their expertise, making them even more valuable professionals.

5. Working Groups

Working Group 6.1 – Deformation Monitoring and Analysis

Policy Issues

Deformation studies in engineering surveying are based on a broad knowledge of suitable sensors and their potential, modern data storage and communication solutions and advanced processing and

analysis methods. Additionally, a thorough understanding of the behaviour of monitoring objects and processes (e.g. large scale structures or landslide effected areas), is essential to set-up and operate an optimal monitoring system. Nowadays deformation tasks are more and more oriented towards real-time, multi-sensor systems, which require automation of data capture and new concepts in data processing, analysis and interpretation. WG6.1's main goals will be to support specialists in deformation studies with state-of-the art solutions and to provide latest developments and future oriented concepts:

- Promoting studies on the potential of existing and new sensors to determine geometric deformation quantities from surveying and adjacent fields;
- Promoting the development of concepts for automated data storage, data transfer and data pre-processing;
- Promoting the adaptation of numerical algorithms to derive relevant deformation quantities in real-time, including concepts from time series analysis;
- Promoting the adaptation of machine learning to detect, localize and classify structural deficiencies;
- Promoting a multidisciplinary collaboration between surveying, structural and geotechnical engineers to understand the behaviour of structures and geotechnical objects;
- Study of modern concepts for data analysis like artificial neural networks, fuzzy logics and generic algorithms;
- Investigate and adopt as required modern analysis techniques (Big Data, IoT, etc.) to cope with large volume data arising from large number of low-cost sensors;
- Study the issues and investigate the challenges arising for using Unmanned Arial Vehicles (UAVs) and robotic mobile platforms for deformation monitoring;

Chair & Co-Chair

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Specific project(s)

- Webinar series

Workshop(s)

- Main organiser for: 6th Joint International Symposium on Deformation Monitoring (JISDM) in 2025
- Supporter of INGEO conferences, which take place about every 3 years.
- Support of special sessions at FIG working weeks resp. FIG Congress

Publication(s)

- Guideline on IoT sensors or Machine Learning in engineering surveying

Timetable

- 2023: Kick-off, Collaboration in Scientific Workshop on Uncertainty and Quality of Multi-Sensor Systems at FIG Working Week 2023
- 2024: Preparation of guidelines
- 2025: 6th JISDM symposium on 7-9 April 2025 in Karlsruhe, Germany
- 2026: Reporting and finalisation

Beneficiaries

- FIG Member Country/Associations (Knowledge, Awareness, Implementation)
- Surveying professionals

Working Group 6.2 – Dynamic Structural Monitoring

Policy Issues

Modern surveying instruments enable the high frequent measurement of geometric changes. Total stations and GNSS receivers are capable of measurement rates of 20 Hz and more. Cameras, profile laser scanners and ground based interferometric radar can record with several hundred Hz. For the first time, engineering surveying can be applied to ambient and forced vibration monitoring of civil structures. WG6.2's main goals will be to exploit the dynamic capabilities of modern surveying instruments in structural monitoring:

- Initiate investigations to extend the range of deformation studies to higher frequencies, which are important in Structural Health Monitoring, i.e. to be able to study oscillations and vibrations and their effects on critical structures;
- Extend investigations regarding time series analysis especially in time-frequency domain analysis, e.g., based on the wavelet transform or the short-time Fourier transform;
- Extending the scope of dynamic Structural Monitoring to quasi-static load tests with surveying instruments in dynamic mode, leading to a better understanding of stiffness parameters of building structures for example bridges;
- Provide best practice guides on how to operate surveying instruments and to analyse dynamic monitoring data;
- Investigate the system performance of surveying instruments in dynamic mode, as most instrument specifications are only given for static modes.

Chair & Co-Chair

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Specific project(s)

Summer school in dynamic monitoring

Workshop(s)

Tutorial at International Course of Engineering Surveying (IVK) - 2023

Publication(s)

Best practice guides on how to operate surveying instruments in dynamic mode

Timetable

- 2023: Kick-off, Tutorial at IVK
- 2024: Summer school in dynamic monitoring
- 2025: Best practice guide
- 2026: Reporting and finalisation

Beneficiaries

- FIG Member Country/Associations (Knowledge, Awareness, Implementation)
- Surveying professionals
- Surveying students

Working Group 6.3 – Applications of immersive technologies in Engineering Geodesy

Policy Issues

Immersive technologies such as Augmented Realty (AR), Virtual Reality (VR), and Mixed Reality (MR) evolved significantly in the last decade and they are now mature to be used in professional applications. Immersive technologies already demonstrated their capabilities in virtual site inspection, geodetic measurement planning and interaction with multi-dimensional measurement data sets. In addition, they have a great potential in the education of surveying students, providing simulations without the requirement of cost intensive equipment, but also in industry and infrastructure projects. These immersive technologies provide an adequate human-computer interface (HCI) for upcoming 3D information models and shared virtual sessions can reduce the necessity of onsite visits and improve the quality of digital meetings.

WG6.3's main goals will be to connect surveying experts interested in immersive technologies, to establish a database of geodetic models needed for relevant applications and to derive best practise examples that will be published in a FIG publication.

Chair & Co-Chair

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Specific project(s)

- Establish a platform where AR/VR/MR objects, e.g. 3D models of total stations can be shared
- Collection of AR/VR/MR related publications
- Creation of simple geodetic virtual application for sharing and demonstration purposes

Workshop(s)

Virtual workshops with interactive parts

Publication(s)

- Catalogue of 3D models of surveying gear that can be used in AR/VR/MR applications
- Basic VR application (e.g. publication on GitHub)
- Joint paper

Timetable

- 2023: Kick-off, Search for interested parties, definition of AR/VR/MR catalogue
- 2024: Virtual workshop I: Catalogue filled with elements, and topic of VR application is set
- 2025: Virtual workshop II: Catalogue is made accessible, and VR application is published
- 2026: Reporting and finalisation, Joint paper

Beneficiaries

- Academic institutions
- Surveying professionals
- Surveying students

Working Group 6.4 – Engineering Surveying Outreach

Policy Issues

Engineering surveying is crucial at every construction project in various phases like staking out, machine control, monitoring during construction and during the remaining lifetime. Nevertheless,

engineering surveying is often overlooked and methods are re-invented by other disciplines although being state of the art in engineering surveying since decades. WG6.4's main goals will be to:

- Enhance the visibility of engineering surveying in other disciplines
- Strengthen the position of surveying professionals in construction projects
- Promote the application of surveying instruments and analysis methods
- Initiate special sessions at conferences organized by civil engineering societies like the International Commission of Large Dams (ICOLD), International Association for Bridge Maintenance and Safety (IABMAS), International Tunneling and Underground Space Association (ITA), International Society of Structural Health Monitoring of Intelligent Infrastructure (ISHMII)
- Giving webinars in webinar series organized by civil engineering societies

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Specific project(s)

Workshop(s)

Special sessions at international civil engineering conferences

Publication(s)

Timetable

- 2023: Kick-off, Identifying relevant conferences and webinar series
- 2024: Special Session I, Webinar I + II
- 2025: Special Session II, Webinar III + IV
- 2026: Reporting and finalisation

Beneficiaries

- FIG Member Country/Associations (Knowledge, Awareness, Implementation)
- Surveying professionals

6. Co-operation with Other Commissions and organisations

- **FIG Commission 1** via WG 6.4 Engineering Surveying Outreach
- **FIG Commission 2** via WG 6.3 Applications of AR and VR in Engineering Geodesy
- **FIG Commission 5** via WG 6.2 Dynamic Structural Monitoring
- **FIG Young Surveyors Network** via WG 6.3 Applications of AR and VR in Engineering Geodesy
- **FIG SDGs Taskforce** via WG 6.1 Deformation Monitoring and Analysis

7. Co-operation with United Nation Organisations, Sister Associations and other Partners

Cooperation with sister associations:

- **IAG** via WG 6.1 Deformation Monitoring and Analysis
- **ISPRS** via WG 6.1 Deformation Monitoring and Analysis

Other cooperation with global organisations:

- **IABMAS** via WG 6.4 Engineering Surveying Outreach
- **ICOLD** via WG 6.4 Engineering Surveying Outreach
- **ISHMII** WG 6.1 Deformation Monitoring and Analysis & WG 6.2 Dynamic Structural Monitoring
- **ISO** via WG 6.1 Deformation Monitoring and Analysis & WG 6.2 Dynamic Structural Monitoring
- **ITA** via WG 6.4 Engineering Surveying Outreach

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