MONITOR Process

MODUS
Modular system for automated deformation monitoring

- Identify risks early
- Guarantee maximum safety for persons and buildings
- Fulfil contractual and legal requirements

VMT

MODUS provides you with a modular, scalable solution for efficient and effective deformation monitoring

Why deformation monitoring?

Every construction project measure intervenes directly or indirectly in the soil structure and static and dynamic stresses act on every building. Other environmental influences, such as humidity, temperature changes or aggressive substances, also play a role. Although the effects of such influences can often be calculated using models, uncertainties remain: Not all parameters are known in their later size from the beginning. For example, the effective traffic volume on a road or bridge can be greater than expected or seismic activity can cause additional stress. The consequences can be unexpected damage – not only to the building itself, but also to surrounding structures. This damage causes significant delays in the planned construction progress and therefore immense costs; in the worst case, even human lives are threatened.

Risk minimisation and fast reaction

Responsible project implementation attempts to minimise possible risks. The most effective measure here is a system that identifies potential hazards at an early stage. In this way, you can already take countermeasures before serious damage occurs. It is not without reason that in many cases the use of such systems is contractually stipulated by the clients or insurers today: both during the construction phase and during the later operation of, for example, a tunnel, a bridge, a dam or a tall building.

Keeping track in critical situations – MODUS collects, evaluates and informs

MODUS is a VMT system solution for deformation monitoring with focus on automated geodetic monitoring. MODUS consists of hardware and software components; consulting and service complement the system to a complete solution.

Powerful deformation monitoring places high requirements not only on the hardware and software used. The design and planning of system components (data communication, power supply, etc.) as well as the simulation of the deformation network also require special technical knowledge and a great deal of experience. If required, we not only provide you with all necessary system components, but also support you with our entire know-how from a large number of projects in our almost 25 years of company history. In the case of special requirements, we supplement the system for you with individual modules specified with you.

Our services include:

- Planning and simulation of the deformation network (control variables, selection of acquisition type, acquisition frequency, derivation of calculated sizes, alarm thresholds)
- System planning (sensors, communication, hardware and software)
- Installation of field components and software
- Initial set-up and configuration
- Regular maintenance
- Training of all persons involved in the process

If required, our team of civil engineers, surveying engineers, measurement technology specialists and IT specialists will also assist you during operation – worldwide, regardless of national borders and time zones.

Advantage: Automation

Compared with manual measurements, documentation and data analysis, an automated system for deformation monitoring provides decisive advantages:

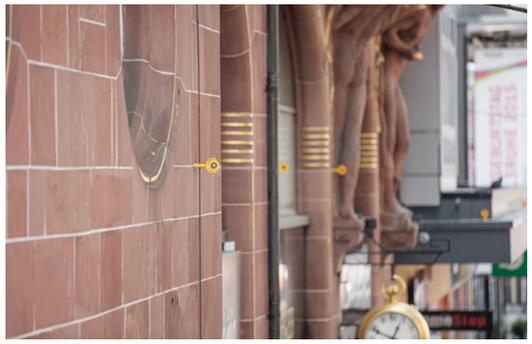
- The measurements and evaluations can be carried out at much shorter time intervals or even continuously without additional effort. This means that the average response times are much shorter in the event of an alarm.
- The personnel costs for the monitoring are significantly lower than for manual monitoring.
- The measurements can also be performed where the deployment of persons is too dangerous.

MODUS creates safety and enables fast response

Automated deformation monitoring with MODUS creates safety for buildings and people – both during the construction phase and during subsequent use. Any deformations are detected right from the start and you can take countermeasures in good time.

Benefits

- **Verification:** Possibility of verification of planning values. Decision basis for current and also future projects. Can also be used in places that are inaccessible or too dangerous for manual measurements.
- **Deformation detection**: Detection of unexpected deformations as well as missing expected deformations.
- **Hazard prevention:** Early detection of potential hazards for monitored buildings and surrounding structures. Avoid endangering persons.
- **Risk minimisation**: Reduction of risks and costs by rapid initiation of precautionary and compensatory measures. Avoidance of construction delays and stops.
- **Acceptance improvement**: Improved public acceptance due to maximum level of protection.
- **Legal conformity**: Compliance with contractual provisions and legal requirements for periodic or continuous monitoring, documentation and preservation of evidence. Optional negative preservation of evidence by setting up the monitoring already before the start of the construction phase (so-called baseline monitoring).
- **Costs reduction**: Minimal personnel costs for the monitoring due to automation.



MODUS | System components

MODUS comprises all components of a powerful deformation monitoring system: Data acquisition, data transfer to a central database, processing, visualisation, archiving, reporting and alarming.

MODUS.connect

MODUS.connect is the field component of the system. It consists of a robust control and communication unit with integrated firmware. MODUS.connect collects data from motorised total stations according to a user-defined measurement plan and transfers these data to a central server for further processing. Transmission is either local via Ethernet cable or Wi-Fi or remote via an integrated cellular modem.

In addition, MODUS.connect has an external meteorological environmental sensor for automatic atmospheric correction of the received measured values.

A web interface with an intuitive user interface allows you to access any MODUS.connect unit from anywhere.

MODUS.connect has several mechanisms to minimise the risk of possible gaps in data acquisition and monitoring:

- Intelligent power management with uninterruptible power supply (UPS) guarantees a temporary power supply in the event of a power failure.
- A local buffer for the collected raw data prevents data loss if the connection to the central server is interrupted. The data transfer continues automatically as soon as the connection is re-established.
- An internal system status monitoring system notifies you immediately in the unlikely event of hardware component failure. You can then arrange for a repair without any loss of time.

MODUS.connect – Field component of the system

MODUS.evaluate

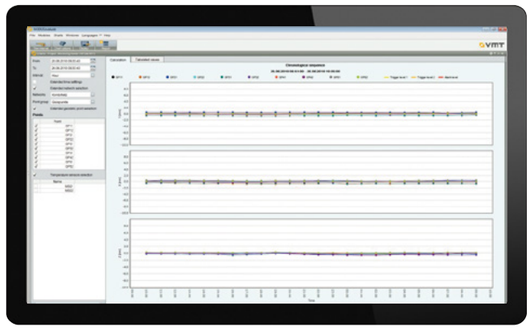
MODUS.evaluate is the central software component of MODUS. It provides a modular solution for the processing, evaluation and monitoring of automatically and manually acquired data. MODUS.evaluate is typically installed on a central project server, e.g. in a commercial cloud.

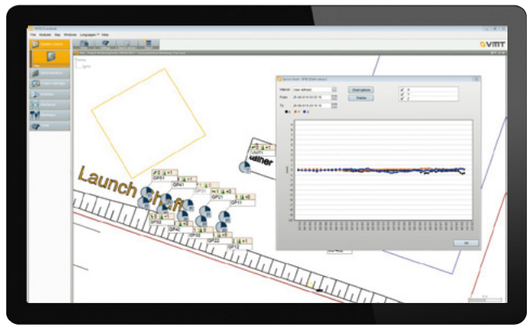
MODUS.evaluate processes and evaluates the values it receives from MODUS.connect units or other sources at user-defined time intervals. This includes a geodetic network adjustment according to the least squares method as well as a statistical quality and plausibility check of the data. MODUS.evaluate then visualises the results on an interactive map, photos or construction plans.

If the values exceed a predefined alarm threshold, MODUS.evaluate automatically sends notifications by e-mail, SMS or as an internal system message to the responsible persons.

In addition, MODUS.evaluate also sends regular or event-driven status reports on request or makes such reports available on an FTP server. Among other things, these reports can be used to fulfil legal or contractual documentation obligations.

MODUS.evaluate permanently archives all data in an SQL database.



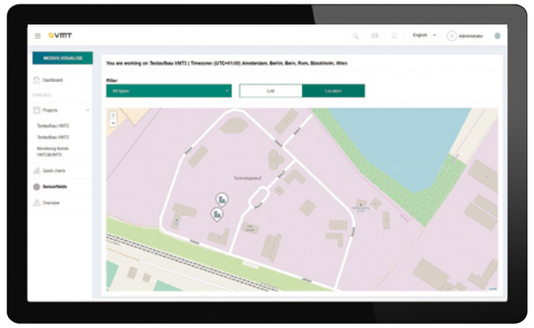


MODUS.visualise

MODUS.visualise allows remote access to the data processed by MODUS.evaluate and makes the results of the deformation monitoring available to other groups of people in a simple and clear form – for example clients, planners and construction supervision.

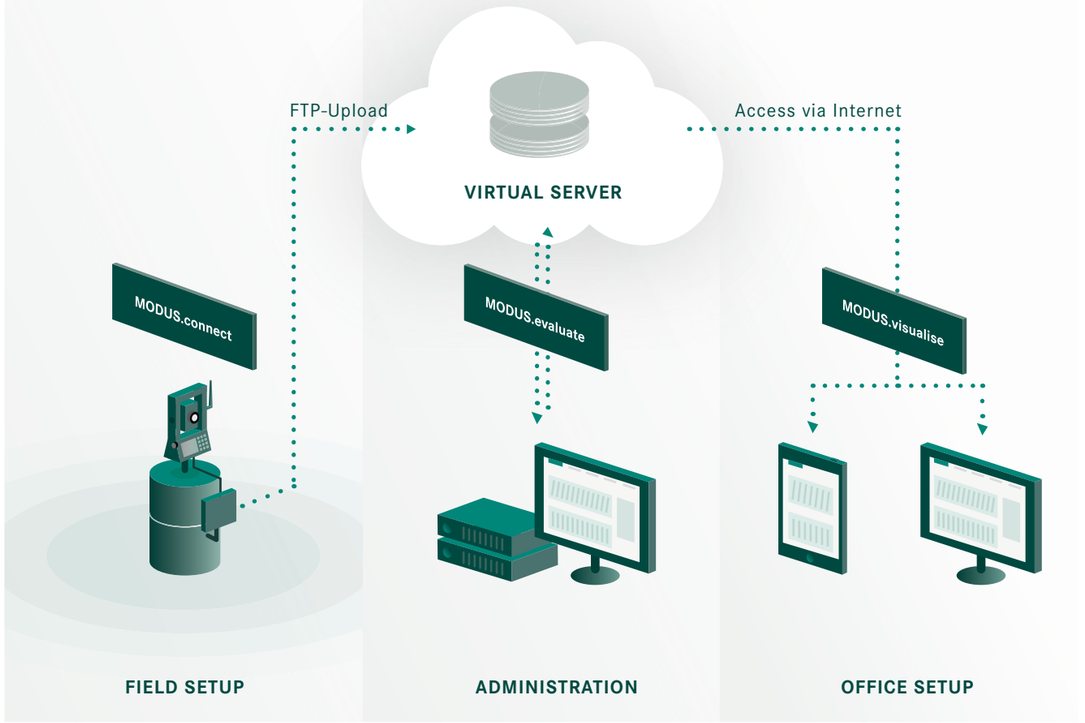
MODUS.visualise provides a variety of intuitive visualisations for this. For example, dashboards as well as various chart types and map views. In addition, MODUS.visualise allows access to the reports generated by MODUS.evaluate.

MODUS.visualise is a web application and runs in the browser without installation. Wherever you have access to the World Wide Web, you also have access to your current monitoring results.



Experience, know-how and cutting-edge technology ensure optimum monitoring for your project

With MODUS VMT focuses on automated geodetic monitoring. MODUS combines robust hardware installed in the field with powerful software for data processing and analysis. Consulting and service such as installation, training and support complete the system to a turn-key solution.



MODUS provides the platform for customised solutions for your projects

The functions implemented in MODUS are based on many years of practical experience and provide the best possible support for your monitoring tasks. Due to its modular architecture and flexible extensibility, MODUS can also be used in projects for which there is no pre-configured solution.

Feature Set / Functions

System architecture and areas of application

- Can be used for monitoring above-ground and underground structures as well as natural terrain formations
- Robust hardware: Field components can also be used under harsh environmental conditions
- Modular and scalable: from one to hundreds of sensors; variably adaptable and expandable
- Open system architecture with SQL database
- Uninterruptible power supply (UPS)
- Local data buffers on internal SD cards; automatic resumption of data remote transmission after re-establishing an interrupted connection
- Integrated system status monitoring

Data acquisition and transfer

- Multi-sensor support Data acquisition of geodetic, geotechnical, structural and any other sensors
- Automated control of motorised total stations
- Possibility of combining automatically recorded data with manually recorded data (with long observation intervals and good accessibility of individual measuring points, manual determination of certain values can be more favourable than automatic sensors)
- Meteorological environmental sensor (temperature, humidity, air pressure) for automatic determination of the atmospheric correction of the measured values for each MODUS.connect unit
- Derived “virtual sensors” can be defined whose values are automatically calculated from other sensor values by the system
- Data remote transmission from the sensors to the field components (MODUS.connect) either locally (Wi-Fi, Ethernet) or remotely (integrated cellular modem)
- Remote access to field components via the Internet
- Data remote transmission from the field components (MODUS.connect) to the central server (MODUS.evaluate) via the Internet

Data analysis

- Automatic geodetic network adjustment according to the least squares method at user-definable time intervals; robust estimation methods can also be used
- Statistical quality control of the recorded measured values; detection of outliers and automatic elimination of their influences
- Graphical and numerical representation of the resulting time series
- Adjustment of geodetic networks with hybrid observation design (total stations, GNSS, levelling)
- Visualisation of the evaluation results on an interactive, georeferenced map or on stored photos and plans

Feature Set / Functions

Reports and alarms

- Automated, time-controlled reporting
- Configurable reports in PDF format
- Autonomous sending of the reports via e-mail to any number of people or regular provision of the reports on an FTP server
- Configurable event management and notification system
- Automatic sending of alarm messages via e-mail, SMS or internal messenger if freely adjustable alarm thresholds are exceeded
- Multiple alarm levels can be defined
- System-wide message and activity log

Integration and collaboration

- RESTful API for the integration in data management systems
- Multi-level user and rights management
- Intuitive Web interface for external persons involved in the process: Display of current and historical data on an interactive map or on embedded photos and construction plans can be used in the browser without installation

References

Switzerland | Hätzingen
New Construction Hydropower Station Rufi

Track monitoring according to the specifications of the Swiss Federal Railways SBB during the tunnelling under the tracks with only 4 m covering.

Project start January 2016

Tunnel length 2,000 m

Key Data 1 total station
45 prisms

Germany | Karlsruhe
Kombilösung

Monitoring of buildings and structures in the inner city area during tunnelling.

Project start June 2014

Tunnel length 2,048 m

Key Data 8 total stations at 32 positions
> 1000 prisms
> 1000 levelling points
130 borehole inclinometers
200 extensometers

Australia | Sydney
North West Rail Link

Monitoring of underground railway tracks in an underground station.

Project start November 2014

Tunnel length 2 × 15 km

Key Data 2 total stations
60 prisms

Israel | Tel Aviv
Metro Tel Aviv, Red Line, Western Section

Monitoring of buildings and surface structures during station excavation as part of the Tel Aviv Metro, Red Line Western Section project.

Project start November 2015

Key Data 7 total stations
250 prisms
500 levelling points
50 borehole inclinometers
50 extensometers

Qatar | Doha
Metro Green Line

Monitoring of surface structures, excavations, shafts and buildings during construction, including the historic White Palace.

Project start January 2014

Tunnel length 6 × 5 km

Key Data 4 total stations
450 monitored points
150 piezometers
850 levelling points
100 anchor lead cells
200 borehole inclinometers
20 extensometers

Russia | Saint Petersburg
Arbitration Court

Monitoring of the construction pit of the new St. Petersburg Arbitration Court and monitoring of adjacent historical buildings.

Project start July 2012

Key Data 5 total stations
400 prisms
400 levelling points

„ ... We were particularly impressed by the adaptability of the software to the special monitoring task, but also by the extraordinarily good support from VMT for such a relatively small monitoring task.“

Dipl.-Ing. Sebastian Horst, publicly appointed surveyor, Vermessungsbüro Horst, Bremen

VMT | Your partner in tunnel building

Navigation and supplementary systems Large Diameter Tunnelling

Navigation systems Microtunnelling

Deformation monitoring

Modular production and logistics management system

Process data management

Industrial measurement solutions

VMT with its measurement systems and services has been a leading provider in tunnelling and industrial measurement for almost 25 years. More than 1,500 successful projects document the capability and innovation of the VMT product portfolio in the areas of navigation technology, production and logistics management, deformation and process monitoring, and data management.

VMT considers itself as competent, reliable partner for customers and contracting company in each phase of a project.

The personal advice, the active support and the full commitment of all VMT employees – whether on-site project engineer or IT developer in the office – have top priority in the company philosophy and are proven every day.

Locations on 4 continents guarantee short paths, local support and independence from national borders and time zones.

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