

# **ROLE OF ENGINEERING GEODESY IN ENSURING SAFETY OF ENGINEERING CONSTRUCTIONS – GENERAL APPROACH**

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## **1. FACTORS AND CONDITIONS OF SAFETY OF ENGINEERING CONSTRUCTIONS**

The following stages constitute process of building and exploitation of engineering constructions:

- location studies, aimed at finding and assigning to building of appropriate site, which will be suitable for the planned investment, considering spatial location and physical-mechanical properties of ground;
- technical project of the whole construction, fulfilling all exploitation requirements and properly adjusted to local terrain conditions, especially to foundation setting;
- building and installation of construction;
- trial usage of construction, aimed at identification of possible inaccuracies and unwanted exploitation faults
- regular exploitation, which covers usually long-term period (several tens of years or more).

Important factors (conditions) of safety of engineering construction – industrial building, water dam, road, railroad, big apartment house of public building, high mast, tunnel, bridge, etc. – are generally as follows:

- correct technical project, fully adjusted to already selected site of construction and in conformity with physical-mechanical properties of ground, as well as with geological and water conditions in the selected place. Thorough study of ground and surface of Earth crust at the surroundings of the planned construction is indispensable condition of good designing process;
- using for building and installation of construction proper materials, which fulfill technical standards (of durability, resistance to corrosion, chemical standards, etc.) exactly in accordance with the correctly prepared technical project;
- thorough, perfect execution of building and installation of construction, fully compliant with technical project, suitably controlled in the course of building and installation;
- monitoring of state and possible changes in construction and its surroundings with immediate signaling in case of non-keeping standards, through informing technical supervision and other institutions (if needed);
- proper and immediate reaction of technical supervision, construction manager and other services to the warnings of non-keeping standards and other signals of threatening safety of construction and its surroundings.

Experience gained lately in Poland and abroad, concerning breakdowns and building accidents, justified the rules and conditions of safety of engineering constructions, presented in this paper.

## **2. MAIN REASONS OF THREATS OF SAFETY OF ENGINEERING CONSTRUCTIONS**

The reasons can be divided, due to their origin, into two groups: natural, i.e. caused by forces of nature and man-made i.e. errors made by people.

Natural threats can be as follows:

- damage of ground and foundations of construction caused by natural factors: water saturation, flooding, landslide (mass movement of surface ground), tectonic and mine tremors, direct and indirect mechanical damages of construction;
- damages of construction due to strong winds
- excessive snowfall, leading sometimes to changes in structure and durability of roofs due to overloading;
- natural fires;
- slow processes of damaging: metal and rock corrosion, material fatigue, etc.

Man-made threats are as follows:

- non-careful location and technical designing of engineering constructions, caused by lack of knowledge and experience or by carelessness and lack of responsibility of designers;
- non-careful execution of building and installation of constructions, expressed mainly by usage of non-standard materials with worse parameters, as well as by inaccuracy of building and installation works;
- resignation from designing, installing, conducting control measurements and monitoring in relation to engineering constructions, which require such procedures;
- collisions and road accidents caused by people, mainly by drivers and operators of building machines;
- terrorist actions, occurring recently quite often in some countries.

## **3. GENERAL CONDITIONS OF ENSURING SAFETY OF ENGINEERING CONSTRUCTIONS**

- knowledge of designers, constructors and contractors, comprising not only rules, methods and techniques of designing and building of constructions, but also surveying and related techniques of monitoring state and changes of engineering constructions in the course of their building and exploitation;
- knowledge of surveyors working in building industry, concerning building processes, with the special emphasis put to safety of constructions;
- rational cooperation of specialists from building industry and geodesy in designing, building and exploitation of engineering constructions, especially those with high complexity and high threats concerning their safety;
- designing, installation and service of control-measurement systems, monitoring threats of engineering constructions;
- efficient reacting of proper services – first of all managers of engineering constructions – to warning signals;
- preparation, issuing and execution of technical instructions concerning monitoring of engineering constructions at all stages of their designing, building, installation and exploitation. The instructions must combine knowledge and experience of both specialists from building industry and geodesy, as well as

**representatives of other disciplines and technical professions, competent in safety of engineering constructions.**

**It's worth mentioning, that in Poland in seventies comprehensive research works were done, resulting in issuing geodetic technical instructions, related to constructions of heavy industry. Polish engineering surveying has a great experience in this field, confirmed in practice of geodetic measurements and studies of deformations of engineering constructions, highly appreciated by the International Federation of Surveyors (FIG). It is required at the stage of creating rules, which regulate safety of engineering constructions, to have good cooperation between constructors and surveyors; these rules should be approved by respective institutions from building industry, technical and building supervision.**

#### **4. MAIN FORMS OF CONTRIBUTION OF GEODESY TO ENSURING SAFETY OF ENGINEERING CONSTRUCTIONS**

**At the stages of location and designing of engineering constructions the important role of geodesy and cartography is to deliver appropriate geodetic and cartographic materials. At present in geodesy not only conventional maps at various scales and cadastral data are used, but also aerial and satellite images collected in many techniques, at different spectral bands with high ground resolution (if needed better than one meter for satellite images), as well as integrated geoinformation systems, fed with data derived from all disciplines, which are useful for designing engineering constructions. It's worth to mention here, that geoinformation scientific network has been established in 2006; there are 13 institutes in this network (9 branch and 4 PAS institutes), which is coordinated by the Institute of Geodesy and Cartography (initiative institute). Certainly, also some universities have GIS data at their databases, while standard geodetic, photogrammetric, cadastral and cartographic materials are produced and made available by geodetic and cartographic service. This service is mainly located at districts and voivodships with the Main Centre of Geodetic and Cartographic Documentation functioning at the central level.**

**Surveying service of building and installation of engineering constructions is done by commercial geodetic-cartographic companies and by surveyors certified for surveying works on their own. The technical equipment of these companies represents international level and engineering staff has qualifications, which enable to execute the ordered tasks perfectly. It's worth to mention here, that sensible developers do not lower costs of surveying service to the level, which does not guarantee proper quality and can cause problems in the form of breakdowns and accidents. Organization of building and installation must ensure clear responsibility for safety of constructions.**

**Post-executive surveying inventory of constructions is the important stage of the works; it should be done at a proper time.**

**Many engineering constructions, including all objects particularly threatened with breakdowns and accidents, should be equipped with stationary monitoring systems with remote, continuous transmission of information on possible critical state to proper control service and technical supervision. Some constructions can be verified through control measurements only periodically. Geodesy represents adequate knowledge, experience and technical means in this field, but the crucial point is to have good cooperation of designers, contractors and construction users with surveyors.**