Name of course: Application of non-destructive methods in civil engineering

Coordinator of course: prof. dr hab. inż. Andrzej Garbacz

Preliminary requirements:
Basics of geology and geotechnics, mechanical properties testing methods, basic knowledge in concrete technology

Purpose of course:
Lecture: to familiarize students with Non-Destructive Testing (NDT) methods used in civil engineering as well as principles of analysis of results obtained with these methods
Tutorial: investigations of building substrate and engineering structures using selected non-destructive methods

Contents of education:
The course covers a wide range of non-invasive methods used in civil engineering, geology and geotechnics. Non-destructive testing is a group of research methods that provide information on the properties of the investigated construction or building substrate, without affecting their strength and performance. When conducting those investigations, the object / ground is not damaged as opposed to destructive tests. Non-destructive testing allows verification of the condition of the existing structure and making on this basis a forecast regarding its durability, assessment of the quality of workmanship and safe use.
The subject includes the following NDT methods used in civil engineering: deflection sensors, ground penetrating radar, thermography, sclerometer, impact-echo and ultrasonic method.

The following issues will be discussed during the course:
• Bridge load tests (deflection sensors): legal regulations, research project, research process (measuring instruments, results collecting, results analysis)
• Thermal imaging methods (thermography): introduction to the method, application possibilities (including military and energy industry, civil engineering and transport), description of diagnostics of a building object using thermovision measuring methods (verification of the correctness of performance and assessment of the energy efficiency of the facility);
• Application of the ground penetrating radar (GPR) in geology, geotechnics, and infrastructure engineering:
- introduction to the method, physical properties of rocks and soils that determine geophysical properties, types of antennas and frequencies used, advantages and disadvantages of the method,

application of the GPR, theoretical foundations including data acquisition, processing and interpretation;
- diagnostics of road surfaces: thickness of road construction layers, control of the position of dowels in concrete pavements;
- diagnostics of tunnels and bridges: moisture test, railway track diagnosis;
- the investigation of concrete slabs with well-defined reinforcement and artificial defects;
- use of the GPR in the study of the construction substrate: determination of the thickness of individual soil layers, determination of geological boundaries, GPR anomalies, depth to the groundwater table, location of voids and underground infrastructure
- practical tasks: processing of received geophysical data from field measurements, their interpretation and subsequent development (depending on atmospheric conditions, selected geophysical measurements are planned to be done in the field)
• Schmidt's hammer (sclerometer): measuring the change of mechanical energy before and after the rebound, which occurs during the impact of the tested surface - introduction to the method, principle of operation, application and presentation of the device
• Impact-Echo and ultrasonic methods: the investigation of concrete slabs with well-defined reinforcement and artificial defects

Methods of evaluation:
- Continuous evaluation – presence and activity during classes
- Report on conducted research and / or presentation

Literature:
1. Karczewski J., Ortyl Ł., Pasternak M., 2012. Zarys metody georadarowej. Wydawnictwo AGH
2. Daniels D.J., 2004. Ground Penetrating Radar. The Institution of Engineering and Technology, London
3. Benedetto A., Pajewski L., 2015. Civil Engineering Applications of Ground Penetrating Radar. Springer Transactions in Civil and Environmental Engineering
4. Birks A.S., Green R.E., McIntire P., Ultrasonic testing, Columbus: American Society for Nondestructive Testing, 1991
5. Sansalone M.J., Streett W.B., Impact-Echo - Nondestructive evaluation of concrete and masonry, Bullbrier Press, Ithaca, N.Y.
6. Adamczewski G., Medyński J., 2019. Diagnostyka termowizyjna w ocenie jakości ocieplenia nowoczesnych hal. Nowoczesne hale 1/2019
7. PN-S-10040 „Obiekty mostowe. Konstrukcje betonowe, żelbetowe i sprężone. Wymagania i badania”
8. PN-S-10050 "Obiekty mostowe. Konstrukcje stalowe. Wymagania i badania"
9. Materiały szkoleniowe Bundesanstalt für Materialforschung und prüfung (BAM), NDT&E Advanced Training Workshop, 2016, Berlin
10. M. D.Tomkins, J. J.Huck, J. M. Dortch, P. D. Hughes, M. P.Kirbride, I. D. Barr, Schmidt Hammer exposure dating (SHED), Quaternary Geochronology, 2018, Vol. 44, Pages 55-62
11. A. E. Mir, S. G. Nehme, Repeatability of the rebound surface hardness of concrete with alteration of concrete parameters, Construction and Building Materials, 2017, Vol. 131, Pages 317-326

Number of hours of student’s work to achieve learning outcomes:
Together 50 godz. = 2 ECTS:
Lecture - 15 godz.
Tutorial - 15 godz.
familiarization with literature, preparation for classes - 10 godz.
preparation of a report/presentation - 10 godz.

Effects of education

W1: Student knows the individual non-invasive methods used in civil engineering and transport

Verification: Continuous evaluation – presence and activity during classes; Report on conducted research and / or presentation

W2: Student has a knowledge of the connections between fields of science and scientific disciplines, relevant to the studied field of study with other fields of science and scientific disciplines of the area or areas from which the studied field of study has been separated, allowing integration of perspectives appropriate for several scientific disciplines

Verification: activity during classes

U1: Knows how to independently analyze the collected scientific material, interpret the obtained research results and draw appropriate conclusions based on their own experience and the latest literature data.

Verification: Continuous evaluation – presence and activity during classes; Report on conducted research and / or presentation

U2: Student performs field measurements using selected NDT methods

Verification: Continuous evaluation – presence and activity during classes; Report on conducted research and / or presentation

U3: : processes, interprets and develops results obtained in the field using NDT methods
Verification:activity during classes; Report on the research and / or presentation at the end of the class

K1: Student is aware of the responsibility of the construction engineer
Verification: presence and activity during classes

Teachers:

prof. dr hab. inż. Andrzej Garbacz /

dr Anna Lejzerowicz

dr inż. Grzegorz Adamczewski

dr inż. Wojciech Karwowski

dr inż. Kamil Załęgowski