Report

of practical session held on 07.02.2017

During the training school of application of ground penetration radar in civil engineering problems held in Osijek, Croatia, 06th-09th of March, 2017

in the frames of the COST Action TU1208 financed by H2020

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1. Short introduction in the COST action TU1208 and the training school in Osijek

This COST Action TU1208 focuses on the exchange of scientific-technical knowledge and experience of Ground Penetrating Radar (GPR) techniques in Civil Engineering. It also aims at promoting throughout Europe the effective use of this safe and non-destructive inspection method. The Action is establishing and strengthening active links between universities, research institutes, companies and end users working in this field, fostering and accelerating its long-term development in Europe.

The Action highlighted the advantages and limitations of the available GPR equipment, survey procedures, and electromagnetic/numerical methods useful for the interpretation of experimental data; these studies will lead to the identification of open in issues and gaps in knowledge and technology. The COST Action organized a high level of training program and dissemination activities where mobility of early career researchers will be encouraged. One of this activities was the Training School on "Ground Penetrating Radar for the assessment of transport infrastructures," held in Osijek, Croatia on March 6-9, 2017. This Training School is targeted to Early-Career Investigators, PhD students, Master students and engineers interested in Ground Penetrating Radar (GPR) and its civil-engineering applications. The main focus was on the use of GPR for the non-destructive assessment of roads, bridges and railways, as well as for the detection of utilities in urban areas. Several practical sessions took place. Further on this report the practical session held on the 7th of March at the basement of the faculty (Figure 1) is described.

Figure 1 Archeological site at the basement of the faculty of civil engineering in Osijek

2. Description of the equipment used in the practical session held on 07th of march at the Faculty of civil engineering in Osijek

During the practical session held on 7th of march at the basement of the Faculty of civil engineering in Osijek, two types of ground penetration radar were used which characteristics are explained further in section 2.1. and 2.2.

2.1. Equipment owned by the Faculty of engineering in Osijek

The ground penetration radar is pulsed GPR and air-coupled/ground-coupled antennas by IDS Ingegneria dei Sistemi, with dual antennas with frequency of 200 and 600 MHz, 900 Mhz as well bipolar antennas with 2 GHz (Figure 2). It is used at the faculty for ~ 5 years mostly in structural elements application and archeological application. The measurements were performed by prof. Damir Varevac and prof. Ivica Gulajic.

Figure 2 The ground penetration radar by IDS Ingegneria dei Sistemi owned by the Faculty of civil engineering in Osijek

2.2. Equipment owned by the Faculty of civil engineering in Novisad, Serbia

The ground penetration radar is produced by GSSI with antennas with frequency of 400 MHz and 900 MHz and is used for approximately 14 years mainly in project for definition of utilities, landslide definition of slope of failure etc. (Figure 3). It is interesting fact that the wheel of the radar is produced in the faculty of Novisad and it looked quite practical and useful considering

the fact that the wheel from the producer costs 10 times more! On the following pictures some additional parts of the equipment are presented. The measurements at the practical session were performed by Aleksandar Ilic and Milan Vrtunski from the Faculty of Novisad, Serbia.

Figure 3 The ground penetration radar by GSSI owned by the Faculty of civil engineering in Novi Sad

3. Selection of the location, profiles and objects for measurements

Due to the weather conditions and the limited use of the ground penetration radar in wet conditions, the previously planned measurement of a 100 m long section on the main road in front of the university building, the practical session was transferred in the basement floor of the Faculty building. The floor is consisted of tiles and there is archeological site presented by stone pavement and soil cover where the columns are placed.

The two equipment's were divided and planned the following measurements:

Team No 1 – equipment from Osijek:

- One profile on the tiles pavement (Figure 3) using the antenna with 200 and 600 MHz
- One profile on the stone pavement of the archeological site
- Measurement on the wall using the antenna of 2 GHz
- Measurement on the concrete structure using the antenna of 2 GHz (Figure)

Figure 4 The measurement on the profile of team no. 1

Figure 5 The measurement on the stone pavement of the archeological site of team no. 1

Figure 6 Measurement with the bipolar antenna of 2 GHz of team no. 1

Team no. 2 - equipment from Novisad:

2 profiles on the tile pavement and on the stone of the archeological site using both antennas first the one with 400 MHz and second the one with 900 MHz.

Figure 7 The measured profile on the floor by the equipment no. 2

Figure 8 The measured profile on the stone pavement of team no. 2

Figure 9 The measured profile on the stone pavement of team no. 2

Figure 10 Changing of the antenna of team no. 2 to 900 MHz

Figure 11 Measurement of the profile with the 900 MHz antenna of team no.2

4. Conclusions

Ground Penetrating Radar method is one of the most powerful electromagnetic tools for imaging subsurface area. Depending on what we expect to image, we have to carefully choose antenna frequency which is directly connected to the depth of survey and resolution.

However, even though the GPR is an excellent em. wave method, in some cases it is useless due to high conductivity of shallow subsurface layers, wet or strong saline ground, where wave is strongly attenuated. It is important to remember that GPR method has restrictions and in some cases we cannot apply it. Survey is the first step of GPR imaging. The next most important thing is processing and interpretation of the data. Processing uses advanced algorithms to filter coherent and non-coherent noise, signal gain, spherical divergence compensation, frequency filtration, FK analyses and many others. Final step is migration, which is the most advanced computational method to move reflection to proper position on the radar sections.

Interpretation mostly covers recognition and description of what we actually imaged. We can present data in a flexible way in B-scan and 3D distribution, generate cross sections of whatever we want, timeslices and many other spatial plots.

This method is commonly used in environmental engineering, geology, archeology, forensic investigation, mineral exploration and others, where the need to use non-destructive method arises. GPR is a fast and efficient method which can be used instead of, e.g. expensive and destructive drilling methods. This method is constantly under dynamic development, as it can be seen by the increasing number of manufactures producing GPR equipment and the numbers of scientists involved in researches. Year by year, we can see the rapid growth of market and many new commercial purposes.

The training school in Osijek was an excellent opportunity to understand the possible application and limitation of the geo-radar in civil engineering practice. We would like to sincerely acknowledge the provided opportunity from the COST Action to participate in this event and we sincerely believe that it will be beneficiary in our future academic and professional carrier.