DETECTION STEEL OF CONCRETE REINFORCEMENT - TEST OF SELECTED EQUIPMENT

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ABSTRACT

At the rapid pace of construction currently under construction, there is a great deal of pressure on the contractor on the part of the investor. Adherence to endorsement dates is a priority but often only one contractor is assigned to a particular building by the contractor. Such a reassessment of the forces of the construction manager or his assistant may lead to construction failures. In the event of a breach, it is difficult to determine its origin - the cause. Examples are concrete structures where it is not easy to determine whether the reinforcement was made according to the design documentation. There are two possibilities of verifying the rigidity of the reinforcement, either destructively or using non-destructive methods using detector devices. The article describes the current possibilities of detecting reinforcement in already constructed constructions using selected detectors.

Key words: *steel reinforcement, detection, devices*

1 INTRODUCTION

Only concrete reinforcement and connecting materials that match up to STN and project documentation (PD) may be used for reinforcement concrete structures. The marking and storage of these materials have to allow to be reliable identified. The requirements for concrete reinforcement, its properties, transport, storage, treatment, inspection and testing are set down by relevant regulations of STN EN 10080 and STN EN 13670. The features of concrete are determined by STN EN 206 which also applies to its production and testing. For making concrete construction applies STN EN 13670. Special attention should be paid to storing of the reinforcement to avoid exchange (reliable identification of species and deliveries has to be ensured). It is necessary to prevent a local corrosion of a higher degree (more than slight rusting) to prevent the reinforcement from coming into contact with an acidic or alkaline environment and so on. It is necessary to prevent welding be near to the restressing reinforcement without adequate protection against drops of molten material. The handling with the reinforcement has to be on clean surfaces that don´t cause any contamination or mechanical damage. [4]

The induction electromagnetic test is performed according to STN 73 2011. It is used to set down the position, diameter, the amount of reinforcement and thickness of the cover layer over the reinforcement in the concrete´s structures and parts. The obtained results can be verified after the approval by direct measurements of the search parameters in destructive probe after the concrete layer is removed. Non-destructive tests of concrete are determined by STN 73 2011 and STN 73 1370 [6, 7] and other related standards. Non-destructive testing of concrete can only be performed by competent people. In the case of arbitration examinations, the non-destructive tests are performed by an accredited test room or an independent professional institute.

2 MEASURED CONSTRUCTION

Measurement using the above-mentioned instruments and comparison of their results (where their correctness was verified in executed reinforcement construction) was performed on the wall

construction of the elevator shaft of a polyfunctional building. This reinforced concrete construction was reinforced on both sides. The exact position of wall reinforcement was measured and logged before the construction of second wall form and fill with concrete was performed. The measured position serves as the reference position of the reinforcement. The reinforcement is stressed while concreting which may result in its deflection. In case of test it was considered to be undamaged. The diameter of rods of tested reinforcement is 12 mm and the horizontal and vertical gaps are 200 mm in diameter. Figure 5 shows the reinforcement of the wall before concreting. Measurement is shown in the picture below. Based on the measured values of the actual status of reinforcement, the design of the reinforcement position was made by using Cad-program. Measurements were repeated three times to provide adequate results.

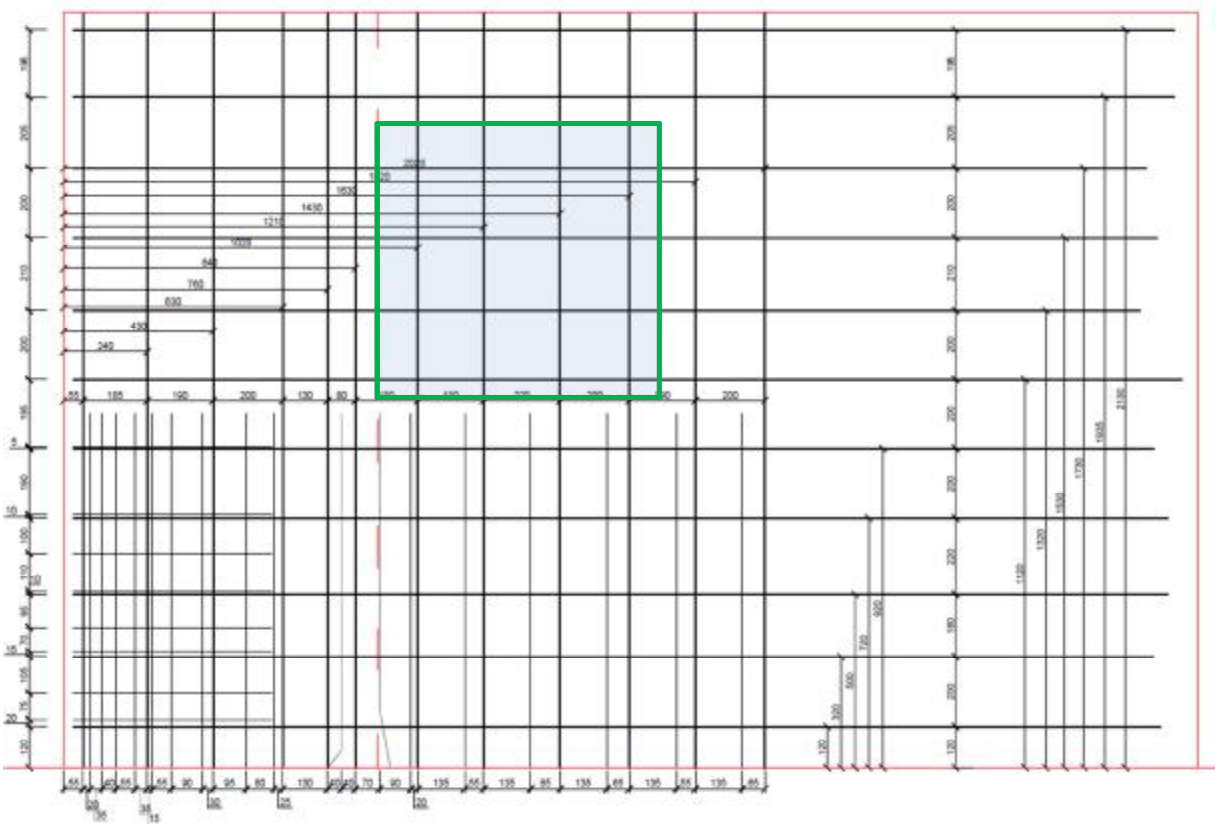

Fig. 1 The reinforcement is drawn after its positioning and positioning, in the green frame the detected area is marked

Fig. 2 To the left of the reinforcement before casting, to the right after casting

3 REINFORCEMENT DETECTION BY NON-DESTRUCTIVE METHODS

For reinforcement detection of reinforced concrete construction, we can find different types of Instruments in the current market. The measurement method is mostly based on similar principles, the difference is in their correctness of measurement, the range of measurement, the method of delineation the outputs and the measurement possibilities directly on the constructions. The geophysical method of GPR (georadar) or profometer is used to find the location and depth of the reinforcement cover in the concrete structure. The GPR method is based on the principle of emitting an electromagnetic signal in the examined environment and its subsequent registration. The resulting signal is analyzed and then interpreted. The position of the first reinforcement layer and the approximate thickness of the cover concrete layer can be measured. The limitation of the measurements increases and the corectness of the measurements decreases towards another layer of reinforcement and towards the core of the concrete structure. In case of absence of the project documentation of the object respectively of the construction we can use this method to define the approximate position and basic parameters of the examined reinforcement in the construction. If the project documentation is available, we can use this method as a control method to verify the designed status.

The Measurement by the Profometer is based on the principle of electromagnetic pulse induction. In the device there are coils into which electrical pulses are periodically emitted during the measurements. This process generates a magnetic field. Surfaces of electrically conductive materials which are in the primary magnetic field produce secondary whirling streams by the activity of the magnetic field. These streams induce the magnetic field of the opposite direction. The change of the magnetic field is logged up, due to this change results in measurement – research. The method is ineffective in the research of all non-conductive materials (for example concrete, plastic, wood, brick, etc.).

On the market we can find devices based on the principle of using ultrasound or X-ray radiation. This group of devices has a great disadvantage. It is their complexity to use IN-SITU especially for their dimensions and financial costs. Testing measurement on the building was made by using inductive - electromagnetic instruments from various producers. These were provided by the company engaged in the monitoring and detection of buildings - INSET s.r.o..

3.1 Selected reinforcement detection devices and their outputs

Devices offer different patterns of outputs. All of them show IN-SITU measurements directly on construction and allow to measure cover reinforcement, gaps - position and diameter of the reinforcement. Initial setting of estimated values and the way of outputs is necessary. From the available devices for comparison and approximation of detection possibilities for the concrete reinforcement the following instruments were used:

- Hilti PS 1000,

- Proceq Profometer,

- Hilti PS 200,

- Hilti PS 38.

The surface of the reinforced concrete wall was measured by using devices and the measured values were then processed. The outputs are interpreted in graphical form and we can read position and the diameters of reinforcement. When the measuring device is set up correctly it is possible using the device to draw individual /rods/ on the construction. The tolerance of the device is stated by the provider, but the tolerance can also be affected by the thickness of the reinforcement, the reinforcement diameters, the cover and also the features of the construction. The first three devices provide outputs editable by computer. After the delineation by computer it is possible to get better picture of the position and its dimensions.

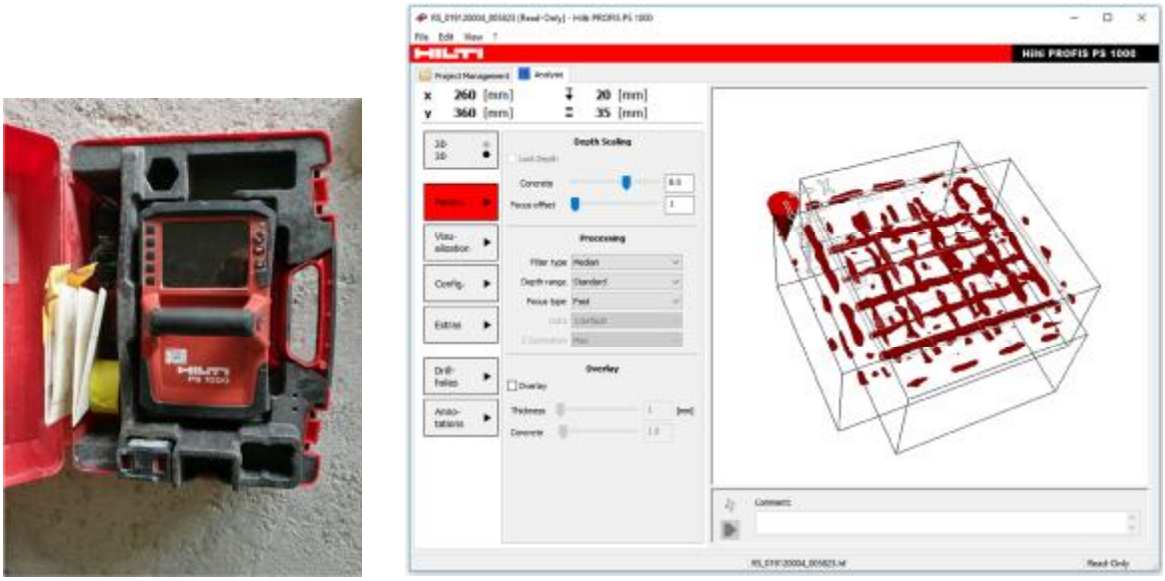

Fig. 3 On the left-hand side of the Hilti PS 1000, right on the software output

3.2 Measurements results

Measurements were realized by each of these devices and the position of the reinforcement was verified horizontally and vertically direction too. For measurements it is necessary to follow the manual and instructions contained in it because the devices have predefined measurement methods. During measurements with individual devices all measured positions of the reinforcement were delineate on the construction wall and then compared with the results of other devices. The measurements have confirmed the influence of the vertical reinforcement on the detected reinforcement. By parallel measurement of similar constructions with thicker reinforcement, the results were also distorted. Vertical reinforcement that do not pass through the entire height of the

wall, but only up to 1100 mm, was also hard to detect for the devices. This was mainly due to the higher reinforcement density and the greater thickness of the reinforcement cover. Figure 11 shows the measured vertical reinforcement positions and figure 12 shows the positions of horizontal reinforcement. The dispersion of the measured values varied (compared to the measured reinforcement position before the concrete was placed in the form) from 5 to 25 mm.

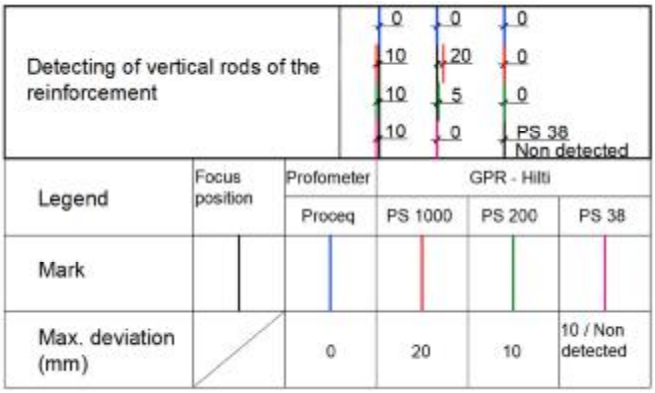

Fig. 4 Output from vertical reinforcement measurement

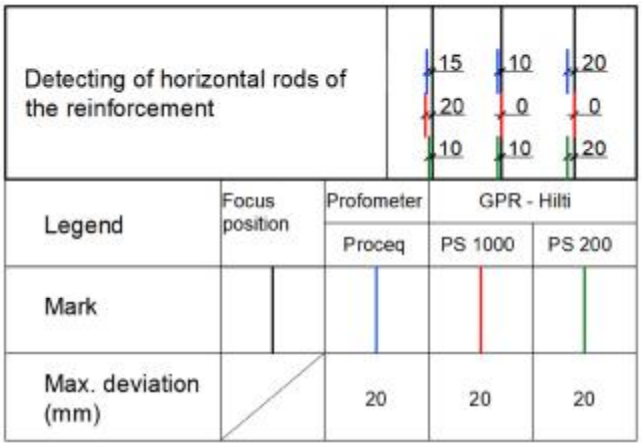

Fig. 5 Horizontal reinforcement measurement output

4 CONCLUSION

Under ideal conditions respectively on the theoretical level it would be possible to say that the measurement - verification of the reinforcement position is simple by using these devices. The problem occurs in practice when the measurement result depends on a large number of factors. The described methods of detection of reinforcement position in the reinforced concrete construction belong to non-destructive methods, more precise determination of measurement error of devices is subject to comprehensive study. As it is not always possible to perform destructive tests, usually experts, structural designers or construction supervisors have a challenging task to determine the reinforcement position. Although the current market offers a many of devices with different functions, technologies and different prices, the process of verifying reinforcement position is a challenging and complex process. The results are not always ideal and often fail the detection requirements. Therefore, it is best to choose the most appropriate device regarding the accuracy of the results, the dimensions, the software support, the possibilities of using the INSIT and the price. It is also necessary to consider the depth range - the depth of detection to verify the possible second series of reinforcement. The

devices, that were tested, could be used and detected reinforcement with the support of company INSET s.r.o., the Žilina division.

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