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# Full-Scale-Model Tests of Reinforced Structural Elements

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**Abstract**

Modern construction projects represent complex engineering structures that vary in purpose, materials, height, the regulatory period of service, purpose and features of operation. Oftentimes, there is a need for reconstruction of old buildings and structures. It requires the development of technologies, methods, and special equipment for the inspection of buildings and constructions, as well as for the quality control not only in the course production but also at the construction site. The use of control devices allows solving problems of contractor's non-compliance with the requirements of the project and the consequences of incorrect installation which in its turn may lead not only to economic losses but also to the damage to the health and lives of people. The paper deals with the diameter of the control task rebar for reinforced concrete structures by adopting the full-scale-model test approach. The main method of the non-destructive testing of the selected eddy current. As a result of the algorithm application, a full-scale-model test approach was developed with a simulated "drive-object control" line in the package Ansys Maxwell XV.

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*Keywords:* Valves; control valve diameter; viagratobuy Converter; full-scale-model tests; Maxwell SV

## 1. Introduction

Over the past few decades, the construction industry has made a significant step forward. Building technology is developing at a very fast pace. Control of the current state of buildings, made of reinforced concrete composite materials, is very topical issue at the moment [1,2]. Every year, improved control standards that must be followed during the construction of building structures. During the construction of the structure, compliance with the geometric parameters of reinforcing bar is key [3]. Diameter mismatch can lead to premature failure in service object [4]. At the same time, it is imperative to use non-destructive testing methods to obtain information about the

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structure and composition of an object, without the use of penetrating tool [5,6]. Control of the technical state of the object is a separate area, which covers a huge range of issues associated with the maintenance, diagnosis and maintenance of buildings and structures. For the development of measures to restore the performance of structures necessary to carry out control operations surveys to identify the causes of premature wear and reducing their load-bearing capacity. In this regard, urgent is the development of methods and control approaches of these parameters, as well as perform visualization of rebar [7,8]. Approaches based on the eddy current method, which relates to non-destructive testing methods [9].

All NDT methods have one important advantage - the absence of mechanical damage to the facility during his examination [10]. They are based on an analysis of the effects of radiation on the controlled object, nature study, propagation in it of electromagnetic and elastic vibrations, study the structure of materials by conventional and electron microscopes. NDT methods are based on the observation, recording and analyzing the results of the interaction of physical fields (radiation) or substances subject to control, and the nature of this interaction depends on the chemical composition, structure, structure of the state of the controlled object, etc [11]. The use of non-destructive testing equipment to solve the problem of non-compliance by contractors of the project requirements and the consequences of improper installation [12].

By the nature of the interaction of non-destructive methods are divided into active and passive [13,14]. In the first case, the registration is performed waves arising in the object [15]. The second measurement is the intensity of the transmitted or reflected by the object of the acoustic signal. The most common and promising are active methods. Depending on the physical phenomena underlying the methods of active control, they are divided into four main types: acoustic, magnetic, eddy current, radio wave [16,17]. In the work as the core, eddy current method is adopted. Its main advantages are high performance control, accuracy and penetrating power.

Operation of this method lies in the threading of the object control the electromagnetic field, while in the control object are excited by the eddy currents and the removal of the results of the measuring coil (Figure 1). The alternating current that passes through the selected frequency of the exciting coil creates a magnetic field around it and fixed the measuring coil. When the coil is placed near a conductive object excited by the eddy currents. The parameters of the magnetic field recorded by the measuring coil are the initial data for determining the diameter of the rebar [18,19].

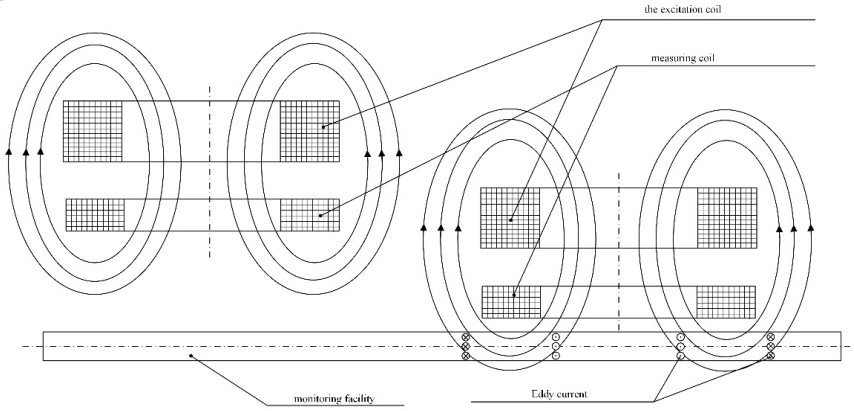


Fig.1. The principle of the eddy-current converter.

## 2. Statement of the problem

The object of research and monitoring in this study is the rebar's [20]. Rebar rolling-metal bar made of hot-rolled products, used to reinforce concrete by the perception of tensile stresses during operation. Geometric model of interaction eddy current converter is shown in Figure 2.

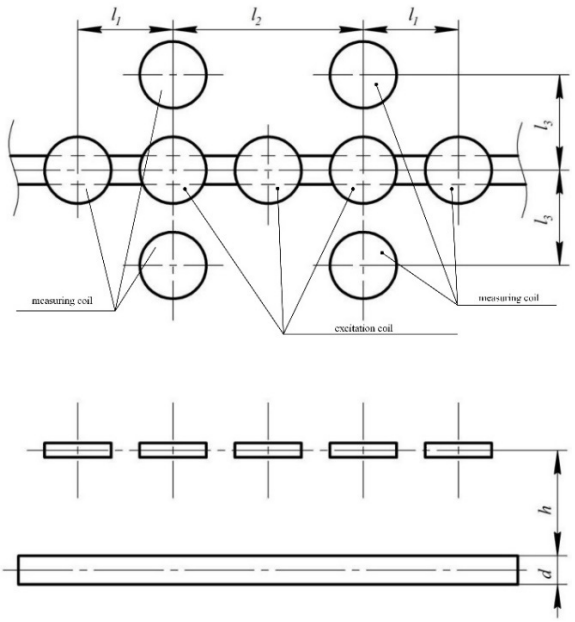


Fig.2. The geometric model of the object of study

The configuration of coils in figure 2 is made in such a way that when it detects a reinforcing bar in overlying concrete matrix eddy current sensor positioned so that its longitudinal plane was perpendicular to the plane of the transverse control object [21,22]. Thus at the measuring coils lying on both sides of the object of control flows, and thus the readings are equal, and the measuring coils lying directly on the object, they will also be equal to control.

## 3. Development of the measuring device

To implement the chosen method of non-destructive testing is suggested to use a measuring device, a block diagram is shown in figure 3.

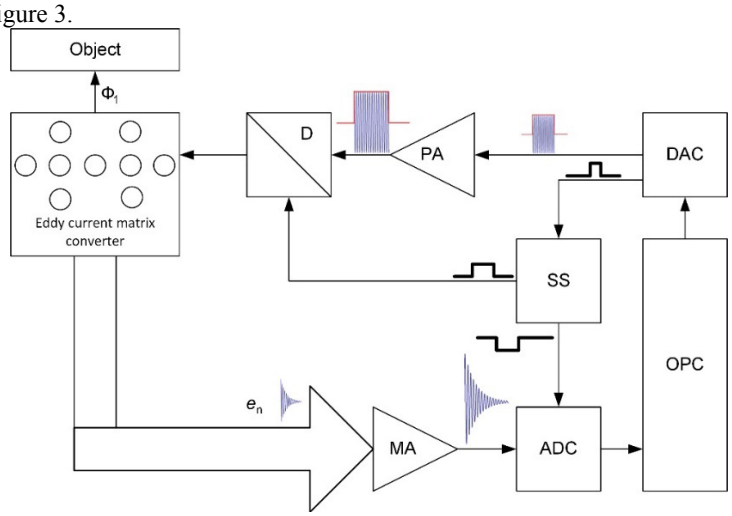


Figure 3. The block diagram of the measuring device.

The measuring device includes: OPC - mini PC for controlling the measurement process and store measurement data for later processing, DAC - DAC that implements the functions of the master oscillator of the probe signal, PA - power amplifier provides an amplified signal to the DAC output to the required level , D - a switch for selecting the radiating coils of the matrix precision electromagnetic converters (Magnetic System), MA - multichannel measuring amplifier emf signals received from the coils outputs unused for an electromagnetic radiation field, ADC - a multi-channel analog-to-digital converter for converting the electrical signal is digitized to record the OPC in the memory. In addition, the timing diagram shows the structural element SS, intended for synchronizing the operation of the digital to analog converter DAC, the switch D, analog-to-digital converter ADC.

## 4. Development of the algorithm for determining the full-scale-model tests

Given the lack of a number of specific parameters, such as the electrical conductivity of the concrete, the real gap h (Fig. 2) between the eddy current transducer and the object under test, as well as the diameter of the rebar, it is proposed to solve the problem to use full-scale-model tests approach implementation [23], which allows you to perform processing so as to be adequate to the experimental results. In accordance with the task algorithm for full-scale-model tests it has been developed, is shown in Figure 4 [24,25].

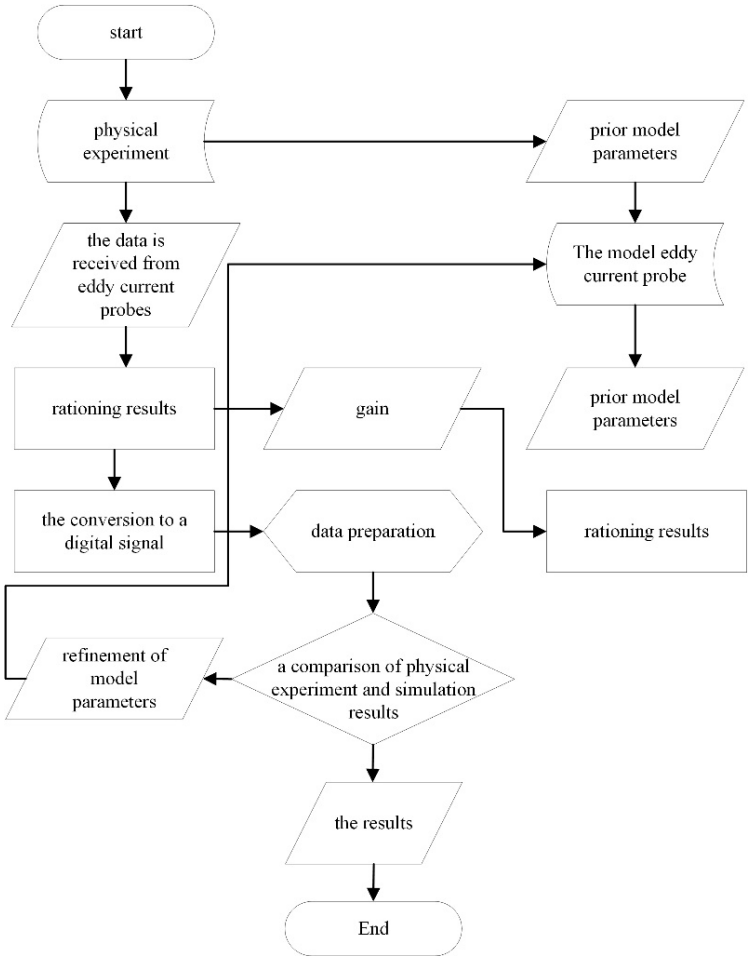


Fig.4. The algorithm implementing the method of full-scale-model tests

The algorithm implementing the method of full-scale-model tests experiment to determine the diameter of the reinforcement bars of reinforced concrete structures allows to perform the calculation under the conditions described in the absence of data on the diameter of the test object and the distance between the eddy current probes and rebar[26,27]. To implement the proposed algorithm, the model of the electromagnetic system "drive-object control" shown in Figure 5.

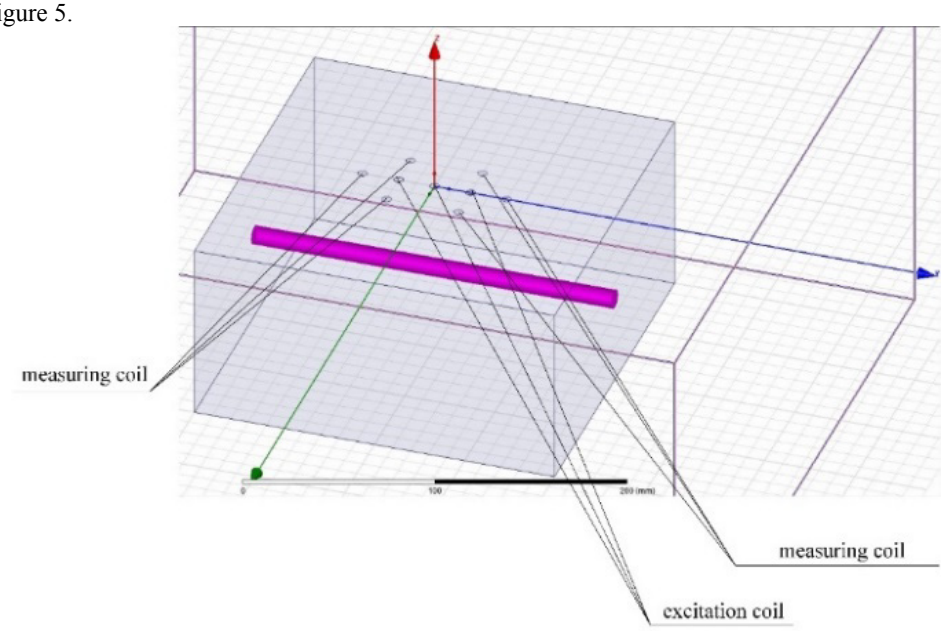


Fig.5. The model of the electromagnetic system "converter object-control"

An example of the simulation results when the diameter of the object of control are shown in Figure 6.

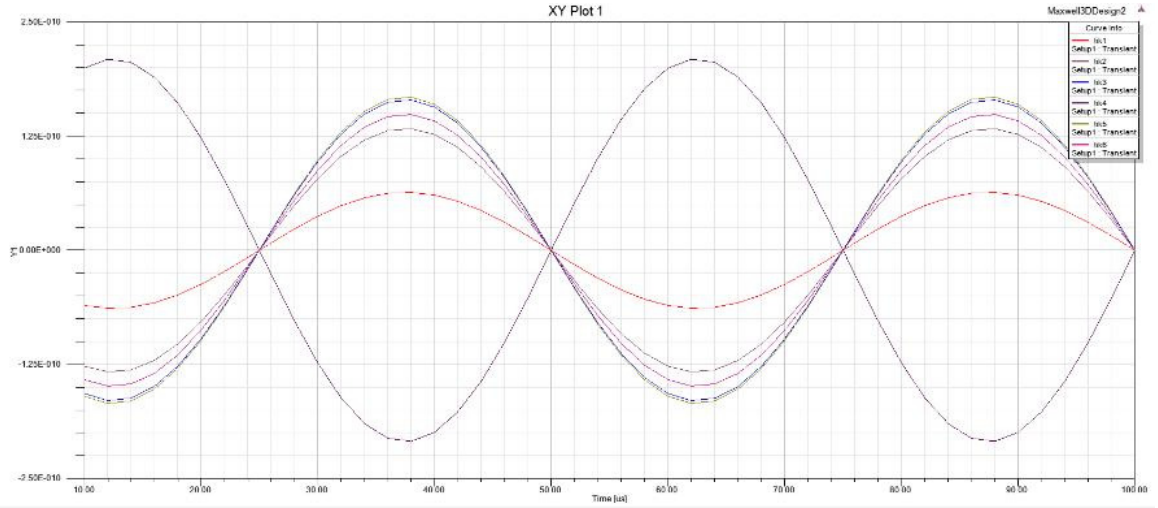


Fig.6. An example of simulation results of the object control

## 5. Conclusion

The algorithm of realization of full-scale modeling approach as the basis for program and device for determining the diameter of reinforcing bars in reinforced concrete elements of building constructions. To obtain primary information about the electromagnetic field is proposed and studied the original design of the magnetic system, representing a matrix of high-precision electromagnetic transducers. The measurement results are processed in a computer model, which is configured so that the result of simulation of electromagnetic fields in the points of sensors location coincide with the results of direct measurements.

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