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High precision device for diameter rebar control in reinforced concrete products

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Abstract

Modern construction projects are complex engineering structures that vary in purpose, materials, height, the regulatory period of service, purpose and features of operation. Often there is a need for reconstruction of old buildings and structures. All this requires the development of technologies, methods, and special equipment for the inspection of buildings and constructions, quality control not only in the course production but also at the construction site. The use of control devices allows solving problems of contractors non-compliance with the requirements of the project and the consequences of incorrect assembly, which in turn may lead not only to economic losses but also to the damage caused to the health and lives of people. In this article, we have designed a device for measuring the diameter of reinforcement concrete structures. For modeling of individual components of the electronic part of device the system NI Multisim is used. For modeling of electromagnetic sensors for developed the device for measuring the diameter of the reinforcement concrete structures the program Maxwell SV is used.

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Keywords: Valves, control valve diameter, viagratobuy Converter, NI Multisim, Maxwell SV

1. Statement of the problem

Modern construction projects are complex engineering structures that vary in purpose, materials, height, the regulatory period of service, purpose and features of operation. Often there is a need for reconstruction of old buildings and structures [1]. All this requires the development of technologies, methods, and special equipment for inspection of buildings and constructions, quality control not only on production but also on the construction site.

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The use of control devices allows to solve problems of non-compliance by contractors with the requirements of the project and the consequences of incorrect assembly, which in turn may lead not only to economic loss but also damage the health and lives of people. Today there are several types of quality control of building structures. One of the main nondestructive testing (NDT)[2], which allows the measurement of the physical parameters of the objects without destroying them[3 – 5].

Methods of nondestructive testing are widely used and applied not just in the construction field, but also in many other fields due to its versatility. At the moment, for measurement of geometric parameters of conductive objects are devices, which are based on direct contact with the test object, and the device based on noncontact measurement method [6].

2. A description of the method

Description metadataresolver an NDT method based on the analysis of the interaction of electromagnetic field eddy current probe with the electromagnetic field of eddy currents induced in the test object [7 – 10]. Eddy currents are excited in the object by the transducer, which is used as an inductive coil fed by alternating sinusoidal or pulsed current [11]. The basis of the eddy current technique is the induction of electric current in a conducting material. When an alternating excitation current is a vector in the complex plane. The inductive interaction of the coil with the object of control is determined by the system of Maxwell's equations [12] describing the electromagnetic field in a predetermined space and having the form (1):

$$\begin{cases} \mathrm{rot}\overline{H} = \overline{J}_{\mathrm{full}} \\ \mathrm{rot}\overline{E} = -\partial\overline{B}/\partial t \end{cases} \tag{1}$$

where N and E - vectors of magnetic and electric fields [13][14], respectively; B - the magnetic induction vector; t – time; – the vector of density of the total current defined by the expression (2):

$$\overline{J}_{\mathrm{full}} = \overline{J}_{\mathrm{cond}} + \overline{J}_{\mathrm{off}} + \overline{J}_{\mathrm{tran}} + \overline{J}_{\mathrm{third}} \tag{2}$$

where $\overline{J}_{\mathrm{cond}}$ - the density vector of conduction current, $\overline{J}_{\mathrm{off}}$ - displacement, $\overline{J}_{\mathrm{tran}}$ - migration and $\overline{J}_{\mathrm{third}}$ - third party.

3. Block diagram of the device measuring the diameter of reinforcement concrete structures

Block diagram of the device is shown in Fig. 1.

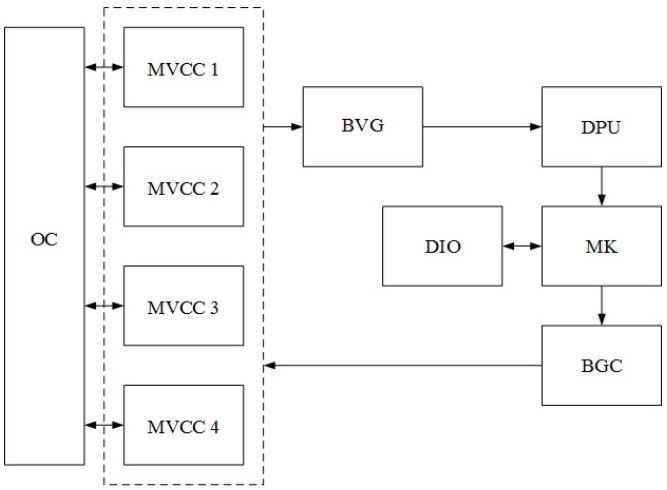

Fig. 1. Block diagram of the device.

The flow diagram shows: DIO – device I / o, designed to set the control parameters and the subsequent output of the received results of measurement of the diameter of the valve; MK – microcontroller block, which is used to generate the excitation signal, the management control process and perform the data processing before output; as block gain current (BGC) is used as a current source controlled by the output voltage of the microcontroller; MVCC matrix eddy-current transducers that communicate with the control object; BVG – gain block voltage – response; DPU – digital processing unit – set analog-to-digital converters [15, 16].

During operation of the device, the microcontroller sets the setpoint frequency current in the generator, the signal is amplified and fed to the switch, where the signal is distributed according to a given algorithm in certain sections of the matrix eddy-current transducers under the influence of the excited coil, an external electromagnetic field interacting with the electromagnetic field of eddy currents induced in the test object this field. The received signals of the measuring coils are amplified and digitized through the switch and to the microcontroller where they are processed and displayed [17 – 19].

4. A schematic diagram of the device

The figure 2 shows a schematic diagram of the signal amplifier and waveform outputted to the virtual oscilloscope

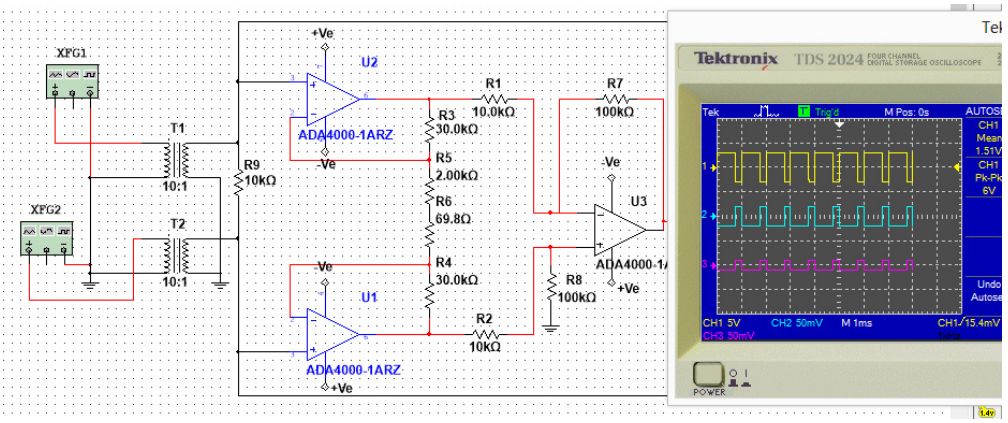

Fig. 2. A schematic diagram of the device.

5. Building a 3D model in the medium Maxwell SV

Building a 3D model of one block of the matrix of eddy current transducer and the relative location of the valve stem with respect to the transducer, in the medium of computer modeling Maxwell SV and set the basic parameters

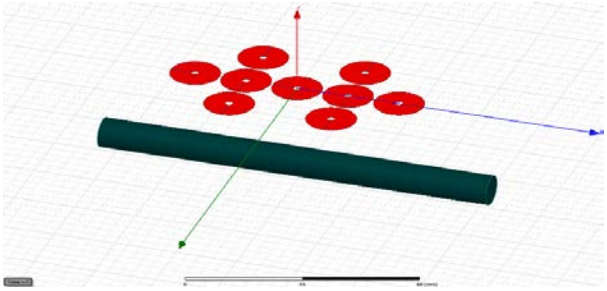

Fig. 3. 3D model of the object in the environment of Maxwell SV.

of the model [20] [21]. The relative dimensions of the coils and the depth of the reinforcement have been described above. The resultant block model matrix eddy current converter is shown in Fig. 3.

The result of the simulation is shown in Fig. 4:

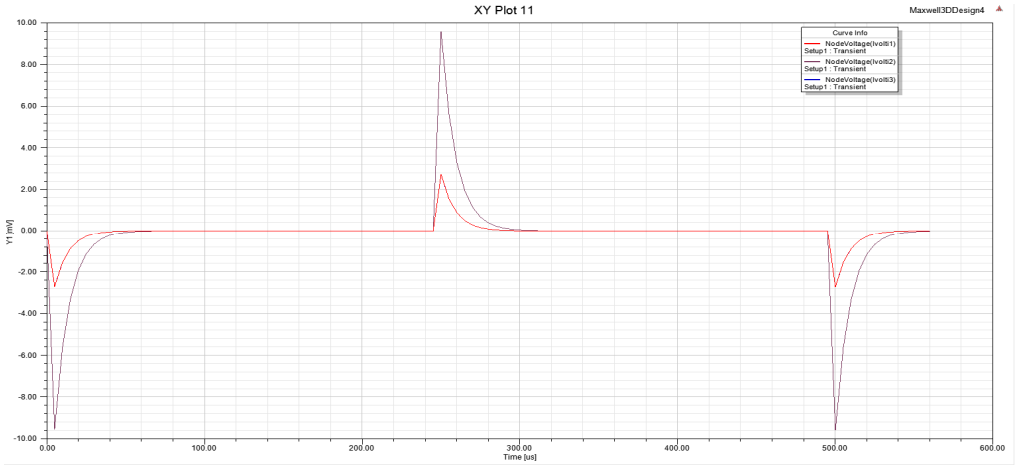

Fig. 4. Result of the simulation.

6. Conclusion

Using the described eddy current methods, it is possible to measure the diameter of the reinforcement of reinforced concrete structures of the electromechanical transducer contactless eddy current type with the appropriate configuration of the electromagnetic field and winding structures.

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