NON-DESTRUCTIVE TESTING OF BUILDING STRUCTURES

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ABSTRACT

Розглянуто практичний досвід в організації і підтримці належного рівня неруйнівних випробувань будівельних конструкцій. Наведено особливості проведення випробувань різними методами.

Practical experience in organizing and maintaining an appropriate level of non-destructive testing of building structures is considered. The features of different testing methods are presented.

KEY WORDS

Building structures, material characteristics, non-destructive testing, practical experience.

SE NDIBK has many years of practical experience in non-destructive testing and technical diagnostics of building structures, products and materials.

Non-destructive testing as a part of products quality control is based on decisions to accept or reject the products in accordance with the unique indices and performed by the comparison of obtained actual data with the stated quality character.

Technical diagnosis compared with the non-destructive testing is a more complex process by both methodological and technical approaches and information processing and interpreting methods. The main task of technical diagnostics is to determine the integral indices of objects state.

In construction the information about material strength [1-3] and concrete structures reinforcement parameters [4] is obtained and reinforcement tension [5] is determined by standardized methods of non-destructive testing. Most of these methods are based on correlations of measured informative parameters with controlled characteristics of materials or structures.

The individual methods to determine the specific characteristics (for example, mortar or ceramic brick compressive strength characteristics by the ultrasonic method) are developed by such approaches having such correlations. Testing results reliability depends on proper statistical correlations justification, proper methodological and technical developments and determined metrological characteristics confirmation.

The methods of technical diagnostics in construction include the vibroacoustic methods based on complex analysis of elastic wave processes in structures. However, methodological and technical complexity of such analysis is justified by benefits of obtaining the integral structure characteristics and dynamic facility parameters.

One of such methods is shock wave method based on the analysis of acoustic frequency range waves at structures excitation by impulsive loading [6]. Its integral acoustic characteristic is a speed of surface (Rayleigh) wave distributed in plane structure. It allows to calculate the dynamic elastic characteristics (elasticity modulus and shear modulus) and to assess the structure thickness uniformity. Other parameters of acoustic signals for practical use are, for example, their spectra characterizing the plane surfaces response to impulse excitation.

For many years the SE NDIBK non-destructive testing and technical diagnostics laboratory activity are focused on provision of proper methodical, technical and professional level needed to obtain the reliable information about physical and mechanical material characteristics and building structure parameters in manufacturing process and during their operation. The laboratory accreditation includes the testing to determine the following: mortar, brick, concrete compressive strength; reinforcement parameters and defects in concrete and masonry structures; geometrical dimensions of plane and extended structures with one-way access to them; adhesive material characteristics. These and other characteristics are determined by both standard and self-developed methods.

In practical work during the testing the negative factors influencing the results are considered for each method. To minimize these influences the protective measures are used during the preparation, testing and assessment of the results.

Technological characteristics of structures manufacture should also be taken into account. Their differences for precast and monolithic reinforced concrete lie in the distance of concrete mixing stations from the places of structures hardening conditions and formation and can lead to concrete strength non-uniformity in them. So, it is necessary to choose an appropriate method to avoid the structures cross-section and height non-uniformity.

Organizational measures to minimize the negative influences made it possible for laboratory to perform quality works on concrete strength assessment on many complex objects, in particular, in NSC “Olimpiyskiy” upper tier precast reinforced concrete structures, Zhytomyr Central stadium west tier structures.

Among the new buildings of monolithic reinforced concrete (Fig. 1) it is necessary to pay attention to objects on which the concrete strength control in most manufactured structures was performed. They are, for example, construction objects of the International airport in Odesa and office centre on 38 Dmytrivska Street in Kyiv.

The (structural) differences of precast and monolithic reinforced concrete should be considered during the magnetic testing on determination of structures reinforcement parameters. In many cases the reinforcement ratio in monolithic structures does not allow to determine these parameters by technical means within the stated measurement errors. For reliable determination of actual structures reinforcement it is necessary to model their possible variants in laboratory conditions. Similar situations took place during the determination of actual monolithic floor reinforcement of shopping centre “Ashan” in Kyiv and during the examination of reconstructed building flooring on 8 Nestorivskyy Lane in Kyiv.

Considerable amount of work was performed by methods developed in SE NDIBK. On more than 140 objects of reconstruction the actual ceramic brick and mortar strength characteristics in structures were determined. Most of actual data on laying material strength was obtained during the examination of "Art Arsenal" buildings. The used methods were developed on the basis of experimental studies on statistical justification of informative parameters correlations with laying material compressive strength. This allowed to determine the calibration dependencies for different kinds of ceramic brick and mortar and to determine the ranges of these characteristics uncertainty (error).

Developed and certified ТКС-1 and ТКС-2 software and hardware complexes (Fig. 2) with ample opportunities of information processing and analysis are used to study wave processes in structures and to measure their acoustic characteristics in laboratory. They allow to perform diagnostics of shafts quality and to determine their length by resonances appearing in piles after the impulse excitation. Methods are developed to control the quality of driven piles (NSC “Olimpiyskiy” upper tier support foundations) and pored piles (“Boryspil” airport “Д” terminal foundations) in the ground.

Fig. 1. Ultrasonic testing to determine the concrete strength in monolithic structure

Fig. 2. Study of surfacing materials adhesion state using ТКС-2 complex

Effective informative parameters used to assess the covers adhesion state are mechanical and spectral characteristics corresponding to plane structures response to impulse excitation. The combined use of these characteristics helped methodically and technically to improve the technology to assess the adhesion of different kinds of covers with bases by the quantitative indicators. It allowed to find areas with satisfactory and unsatisfactory adhesion and to obtain the necessary parameters to assess the technical state of Cherkasy "Friendship of peoples" culture centre facade external covers which partially lost their adhesive characteristics during the building operation.

SE NDIBK got a status of main organization in solution of problems related to research methods and means, products testing and quality control as recognition of its relevant experience in this direction.

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