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**APPLICATION OF TERRESTRIAL LASER SCANNING IN THE PROCESS OF MODERNIZATION OF
HYPERBOLOID COOLING TOWERS**

ABSTRACT OF PHD THESIS

The hyperboloid cooling towers, which are considered ones of the largest monolithic industrial buildings, mostly are the main part of industrial process cooling systems in the case of closed circuit. The main structural element of these objects is concrete shell, which has the form of hyperboloid of one sheet with a negative Gaussian curvature. This feature differentiates cooling towers from the others high concrete structures and putting them at the same time extremely high constructional and exploitative regulations. The guarantee of safe use and maintenance of the durability of the hyperboloid cooling towers are appropriate modernization and renovation activities. Proper diagnostics of these buildings is the basis for determining the scope of modernization of their concrete shells and developing methods of its implementation. In addition, low-cost design, low quality materials, faulty construction of most hyperboloid structures and unfavorable factors of industrial atmosphere in the Polish industry oblige to undertake appropriate modernization and repair activities of cooling towels. As a result of the development of new measurement technologies, including terrestrial laser scanning, the acceptance for remote non-destructive solutions that provide comprehensive data about the object in real time of measurement is on the increase in the modern diagnostics of engineering structures. A beneficial trend for combining existing methods and tools into systems is the new quality of object diagnostic, where techniques and algorithms for measuring data are as important as the equipment and methodology of measurement.

The PhD dissertation presents the concept of application of terrestrial laser scanning technology in the process of modernization of cooling towers. The concept was formulated taking into technical standards for object in industry area. The research was carried out for a representative object - a modernized cooling tower. The defined concept includes comprehensive measurement solutions as well as specialized and effective algorithmic data processing procedures, which ensure objectivity of hyperboloid building diagnostics. The methodology of experimental measurements was designed taking into account the specificity of thin-walled shell structures, limitations of industrial areas and periodic measurements, which were determined by the schedule of renovation works. Terrestrial laser scanning data were used for basic diagnostic activities, undertaken in the process of modernization, i.e. research on hyperboloid geometry of the structure, detection of damage of the concrete shell and inspections, which verified the quality and durability of the performed works.

The results of the PhD research allowed to confirm verity of the thesis, that: The properly captured and processed terrestrial laser scanning data provide comprehensive information about the condition of the hyperboloid cooling tower shell before its modernization and also enable verification of the correctness and durability of that works. During the research on hyperboloid geometry of the cooling tower, terrestrial laser scanning allows for reliable verification of the verticality of the structure, detection of shell ovality symptoms, estimation of theoretical structure parameters and analysis of thickness distribution and geometrical imperfections of the concrete shell (taking into account changes, which were results of modernization). What is more, terrestrial laser scanning data provide detection and measurement of concrete shell damage and perforation, which define the degree of its degradation and verify conclusions about the quality and durability of repairs, which should lead up to recreate the protective properties of the concrete shell.

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