Structural analysis, rehabilitation and further development of health monitoring program concerning two reinforced concrete chimneys

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Summary

The paper presents some aspects regarding the FE Analyses, structural rehabilitation and structural health monitoring (SHM) program for a pair of reinforced concrete chimneys. The structural rehabilitation was compulsory since the two chimneys presented numerous large vertical cracks. Therefore, the interventions that were designed involved, among others, the replacement of thermal insulation, repairing of horizontal reinforcement and mounting of prestressed horizontal steel belts that are to generate compression stresses into the concrete, thus preventing the re-opening of the cracks. Three main topics are covered in the paper: the structural faults and the solutions for rehabilitation of the chimneys, performed FE Analyses and the implementation of the SHM program.

Keywords: Structural rehabilitation, reinforced concrete chimneys, structural health monitoring, FE Analyses.

1. Introduction

The two chimneys that have been studied belong to an electrical power plant outside the city of Rovinari, Romania. The rehabilitation of the reinforced concrete structure of the chimneys was necessary since it presented numerous large vertical cracks. The major cause of the appearance and widening of these cracks into the structural reinforced concrete layer was the high thermal gradient between inner and outer surface in the context of insufficient horizontal reinforcement. At the same time, the superposition of the effects of thermal gradient and loads generated by variable actions (mostly wind) was underrated in the initial design of the chimneys. The high temperature gradient that was reached was provoked by partial destruction of the interior thermal insulation, thus leading to exposure of the inner surface of the reinforced concrete structure to very high temperatures (the temperature of the burned gases varies between 50 and 200 Celsius degrees). Therefore, a radical intervention was required, in order to replace the thermal insulation and to repair the horizontal reinforcement. Due to the fact that the needed horizontal reinforcement was underrated during the design of the structures, it was decided to supplement the transversal capacity by mounting of prestressed horizontal circular steel belts. These belts are distributed on the entire height of the structures and generate compression stresses, preventing the re-opening of the cracks.

2. General description of the structure

The two chimneys have a tapered structure made of reinforced concrete using climbing technology. The total height of the chimneys is of approximately 220 meters. The technological and structural particularity of the two constructions consists in the fact that the burned gases resulted during the technological processes are introduced into the chimneys only at approximately +100 meters in elevation and not at their base as in traditional solutions. The width of the reinforced concrete wall varies between 90 centimetres (at +92 meters elevation) and 24 centimetres (at the top of the chimney, at +220 meters elevation). The reinforced concrete structures are protected by a thermal

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