Structural Evaluation of the Greenhill Mine Tipple Structure

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ABSTRACT

The primary rotary tipple structure is a part of the Greenhill mining complex in the Crowsnest pass area of Southwest Alberta, Canada, and is the most important building at the site. The structure is a 40-metre-long, 9-metres wide reinforced concrete frame which is supporting a steel superstructure. At the time of its development in 1914 this type of construction was quite innovative and considered state-of-the-art because of the use of the then new methods and materials (steel and reinforced concrete). In the 1980's, in recognition of the significance of coal mining to the surrounding communities, the Greenhill Mine Complex was designated as a Registered Historical Resource by the Government of Alberta.

The tipple structure shows signs of different types of damage and deterioration. The causes and extent of these deteriorations and possible methods for repair and conservation of the structure were studied. The structure was analyzed to assess its current state and the extent and causes of deterioration. The analysis was performed using SAP2000 structural analysis software using data obtained from the field and laboratory tests and evaluations. In the absence of any construction documents and drawings, visual inspection of the concrete material reveals some useful information about the properties of the material used in the concrete. Field sampling of concrete and several tests such as freeze-thaw durability and compressive strength were performed. Two future use scenarios were considered in the analyses: retaining the structure in its current loading condition as a historic site with occasional visitors and adaptive re-use of the building as a restaurant. "Commentary L" of National Building Code of Canada was utilized for evaluation of the existing building, along with the results of concrete durability and strength tests. The analyses revealed several structural deficiencies requiring remediation for either scenario. Strengthening systems for different parts of the moment-frame concrete structure such as cross beams, columns, beam-column connections and elevated slab were proposed. For the adaptive re-use proposition more strengthening was needed to resist the higher design loads, so externally-bonded FRPs were recommended as the main strengthening system in addition to restoration of the concrete because of their several advantages such as durability, ease of use, lightweight, reversibility and minimum intervention. In the design of the strengthening systems, the existence of several uncertainties were considered - the quality of the concrete and the aggregates, the position, size, cover and splice lengths of longitudinal reinforcing bars, the amount of damage and deterioration in different areas and the durability of FRP materials.