

Structural Assessment of a Reinforced Concrete Water Tower

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The paper presents a structural appraisal of a reinforced concrete water tower at the Public Abattoir in Malta. The water tower was constructed in the first half of the 20th century and consists in a reinforced concrete thin shell structure supported on twelve columns. Detailed drawings and a refined 3D model were prepared based on detailed site measurements of the structure. The concrete was assessed through non-destructive tests and with reference to extracted concrete core samples from different parts of the structure and extracted steel reinforcement samples. Detailed deterioration mapping was conducted for the entire structure. This data was used to model the structure and analyse it through finite element models intended to determine the structural performance of the water tower.

A preliminary linear finite element analysis was performed first using Scia Engineer in order to determine the internal forces acting within specific members of the structure with reference to two cases. The first model consisted in a non-deteriorated water tower. Through historic research, water tower surveys and materials testing, a numerical model was created in order to achieve an understanding of the original design of the water tower and how it was actually built on site. The reinforcement present within the water tower and the required reinforcement as per specific load cases derived from the numerical model were compared in order to understand to the design and its performance when constructed. The second model consisted of the deteriorated scenario. The deterioration mapping and material properties obtained from the tests conducted on materials on site, were used to model the structure in its existing condition. The same load cases as for the first model were considered to identify failure points and mechanisms acting within the deteriorated water.

The structural performance was then verified through an additional finite element analysis using SAP 2000, conducted for the two cases: as originally constructed and the structure in the degraded state. In addition, a non-linear analysis of the structure was performed for the assessment of the ultimate and serviceability state for the non-degraded and degraded state. The finite element analysis provided important information for the understanding of performance of the structure as originally designed and constructed and the structure in the degraded state. The information on the structural performance obtained through FEM is required in the consideration and design of structural repair interventions for the reinstatement of the water tower.