

Strategy for the Restoration of the Reinforced Concrete Water Tower

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The Reinforced concrete water tower at the Public Abattoir in Marsa Malta, was constructed in the 1930s and is considered to be an industrial heritage monument. It consists of a large reinforced concrete structure, c.14.5 m high with a tank having an internal diameter of c.9.5m. The tank consists of a shell structure with a cylindrical drum resting on a truncated conical structure with a dome at the base and with ring beams at the top and between each element. The tank rests on a ring beam supported on 12 slender reinforced concrete columns with a reinforced concrete foundation ring at the base. The structure has been repaired in the 1970s and the repair intervention included the strengthening of the 12 columns using a reinforced concrete jacket. The tank used to be filled in with brackish and sea water. The age of the structure including the use of sea water in the tank, its location close to the sea in the industrial area of the Grand Harbour and other aspects have contributed to its degradation. This is primarily due to the corrosion of its reinforcement, extensive on the south facing side of the tank. Carbonation of concrete and chloride ion penetration through the concrete structure resulted in the corrosion of reinforcement, cracking, spalling and delamination with loss of concrete section and loss of reinforcement. The combined effects of corrosion-related processes, wet and dry cycles and stresses in the structure in operation, all contributed to degradation. The strategy for its restoration is based on records and documentation, identification, classification and mapping of defects, assessment of materials including non-destructive and destructive testing, assessment of the structure, structural modelling and analysis. The restoration interventions are intended to reinstate the structure and respect the characteristics, geometry, structural performance of the Water Tower and its functions over time. To achieve these objectives various specific interventions are required in different parts of the structure including surface treatment; patch repair relying on repair mortars and polymer based materials; injection including epoxy injection; electrochemical repair including re-alkalisation and chloride extraction and external strengthening. External strengthening is proposed through the application of Ultra High Durability Concrete (UHDC), a high strength, high durability self-healing concrete based on nano-additives: An ultra high durability self compacting fibre reinforced concrete jacketing for the 12 reinforced concrete columns; textile reinforced concrete for the curved elements of the water tower. In addition a monitoring strategy is designed to assess the structure and restoration interventions, throughout the lifetime of the structure and includes a sensor network system based on three phases: structural health monitoring, durability monitoring, environmental monitoring. The Water Tower restoration project presents a first comprehensive intervention for the conservation of a historic reinforced concrete structure in Malta. In this regard it serves as a strategic innovative research platform for performance assessment and long-term monitoring of interventions.