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Controlling Methods Applied to a Roman Dome to be Restored

Méthodes de contrôle pour une coupole romaine en cours de réparation

Kontrollmethoden für eine römische Domkuppel

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1. BACKGROUND

The Temple of Romulus, named in honor of Romulus, the son of the Emperor Maxentius, was built in 311 AD on the site of the Temple of the Penates, which had been torn down to make way for the emperor's great basilica on the Via Sacra in the Roman Forum [1]. Much of the original building is extant, including a cylindrical entrance hall, approximately 15 meters in diameter, topped by a semicircular dome, the main hall, and two smaller halls, which, however, are in ruins. In the 6th century, the temple was transformed into the atrium of the church of Sts. Cosmas and Damian. In 1631, a Baroque vaulted ceiling was added, which is sustained by the outer drum walls and inner pillars at the church floor level. During this campaign, the temple was seriously damaged when a communicating door was opened to connect the rear of the church to the temple dome area.

2. PRESENT STATE OF THE DOME

The static condition of the dome is poor. This is the result of several factors: the collapse of the smaller halls, which laterally sustain the pressure of the dome; deterioration wrought by time; the 19th century excavations in the Forum; and the various modifications made to the building.

An examination of the cracking patterns has revealed the static and mechanical changes undergone by the dome over the centuries. The building contains serious lesions, which start at the top of the dome and continue downwards, almost vertically, to the ground. Moreover, the drum walls are rotated outward, visibly diverging from vertical. A major lesion, which from the arch keystone propagates throughout the dome up to the lantern, is the result of the construction of the communicating door. Also, the vaulted ceiling may also have contributed to the poor condition of the whole.

3. RESTORATION AND STRUCTURAL REPAIR OF THE BUILDING

Restoration of the Temple of Romulus is being undertaken by the Soprintendenza Archeologica in Rome, in conjunction with the Soprintendenza ai Beni Ambientali e

Architettonici. The project will entail restoration of the domed hall and demolition of the Baroque vaulting. The church communicating door will be left. An automatic monitoring system will be installed. In view of the precarious state of the whole, special care will be taken in the removal of the vaulting. To limit the effects of the modification, a temporary external encircling of the dome will be added at drum level. The encircling could be made permanent, should the results of the automatic monitoring warrant.

4. NUMERICAL FINITE ELEMENT METHOD USED IN RESTORATION

The mechanical history of the building will be determined as part of the forthcoming restoration project. A finite element model has been developed to accurately duplicate the geometry of the structure. Using a numerical analysis carried out on the virtual model of the integral structure, the static state of the building in its original geometry has been investigated. This has made it possible to determine the mechanical consequences of the evolutions from modifications (the church communicating door, the vaulted ceiling), structural cracking, and the collapse of various elements. Hence, using structural identification methods, we have been able to arrive at an exhaustive representation of the monument's present cracking state. This has entailed:

1. Carrying out tests for determining the stress state using flat jacks and assessing the deformability and resistance of the walls

2. Developing a permanent monitoring system to check the progress of crack propagation and structural movements.

The finite element numerical model together with mechanical measurements has enabled diagnosing the building's physical condition. The numerical model has given indications regarding the effects of removing the vaulted ceiling and the encircling system on the damaged structure. In simulating the some encircling system, beneficial effects have also emerged with regard to the existing state of cracking.

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