The unbuilt Musmeci parabolic cross vault reinvented as a dry-masonry structure

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ABSTRACT

In 1954 the Italian engineer Sergio Musmeci (1926-1981) conceived a reinforced concrete parabolic cross vault, with a triangular plan, featured by the assembly of three triangular webs. Designed for a small market in southern Italy through a prime structural optimization experiment, the unique vault remained unbuilt [1].

In the framework of rigid no-tension constitutive model with no sliding [2-5], this study explores a new perspective on the elegant geometry of the Musmeci vault, revisiting the original reinforced concrete structure in a masonry vault. Therefore, three main steps are involved in the proposed design process. First, the discretization of the original geometry as a dry assemblage of blocks is carried out through the research on the proper stereotomy of blocks, related to the static admissibility of the vault. Second, a set of parametric analysis is conducted to assess the influence of the main geometric parameters on the global response. In particular, the minimum admissible thickness of the vault and its behaviour under horizontal loads are investigated. Furthermore, according to the Heyman sliced model [2,4,6], the vault capacity on spreading supports is evaluated in terms of ultimate displacements and maximum and minimum thrusts. Finally, to deeply understand the structural behaviour of the designed vault, the novel approach of the physical scaled model [7-8] is developed.

In conclusion, bringing new life to the original Musmeci geometry, a parametric survey is performed with the aim of evaluating the actual possibility of rebuilding the cross vault in dry-masonry and its structural capacity under different expected load scenarios.

REFERENCES

[1] S. Musmeci and G. Vaccaro, “Copertura a volte paraboliche per un mercato rurale”, *L’Ingegnere*, Vol. **5**, pp. 487–490, (1954).

[2] J. Heyman, “The stone skeleton”, *Int. J. Solids Struct.*, Vol. **2**, pp. 249–279, (1966).

[3] S. Huerta, “Mechanics of masonry vaults: The equilibrium approach”. In: P.B. Lourenco & P. Roca (eds) *Proceedings 3rd International Semester on Historic Constructions*, University of Minho, pp. 47–69, (2001).

[4] M. Como, *Statics of historic masonry constructions*, 2nd Edition, Vol. 1, Springer, 2016.

[5] J.A. Ochsendorf, “The masonry arch on spreading supports”, *Struct Eng Inst Struct Eng Lond*, Vol. **84**, pp. 29–36, (2006).

[6] C. Intrigila, N.A. Nodargi, P. Bisegna, “Square cross vaults on spreading supports”. In: Aguilar, Torrealva D, Moreira S, Pando M, Ramos LF (eds) *Structural Analysis of Historical Constructions*, Vol. **18**, Springer, RILEM Bookseries, pp 1045–1053, (2019).

[7] G. Milani, M. Rossi, C. Calderini, S. Lagomarsino, “Tilting plane tests on a small-scale masonry cross vault: Experimental results and numerical simulations through a heterogeneous approach”, *Eng. Struct*., Vol. **123**, pp. 300–312, (2016).

[8] C.C. Berentin, T. Van Mele and P. Block, “Robotically controlled scale-model testing of masonry vault collapse”, *Meccanica*, Vol. **53**, pp. 1917–1929, (2018).