Lithic Hypar: New Frontiers in Structural Stone's Research

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Introduction: The main idea of this lithic reinterpretation of the hypar is to replace reinforced concrete with pre-stressed stone through post-stressed steel bars.

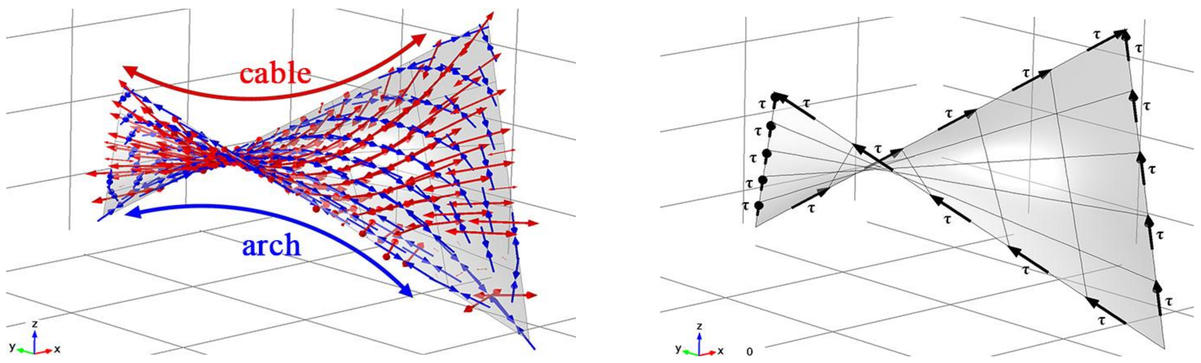

Figure 1. Mechanical behavior of a hyperbolic paraboloid subjected to uniform vertical load

Working Principles and Technical issues: The stone is perfectly able to carry out the tasks of the “arches”, while the pre-compression has to eliminate the tensile stresses of the “cables”. The surface’s edge elements are made of steel beams with channel section, which also have the function of transferring the post-stress to the stone, such as evenly distributed compression.

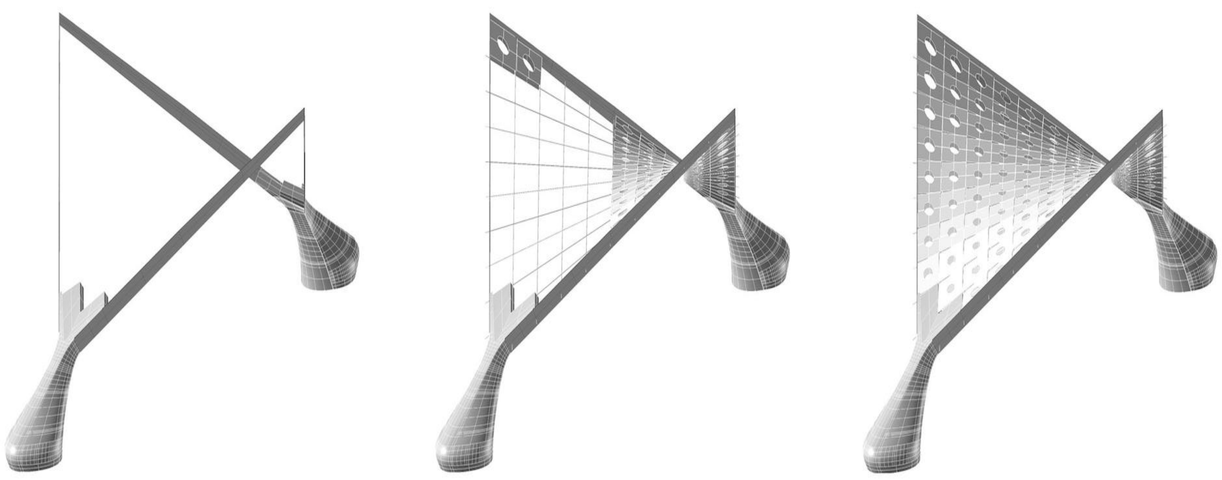

Figure 2. Main steps of construction: edge steel beams, pre-stress steel cables and stone ashlars

Linear Elastic Model Approach: Describing the structural analysis of lithic hyperbolic paraboloid It has been proposed a linear elastic approach: if the pre-stress introduced is sufficient to eliminate the tensile stresses on the surface, it is then reasonable to represent the structure as a continuous shell.

Parametric Definition: The post-stressed steel strands has been modeled setting a sweep parameter called λ that allows to determine the real post-stress value.

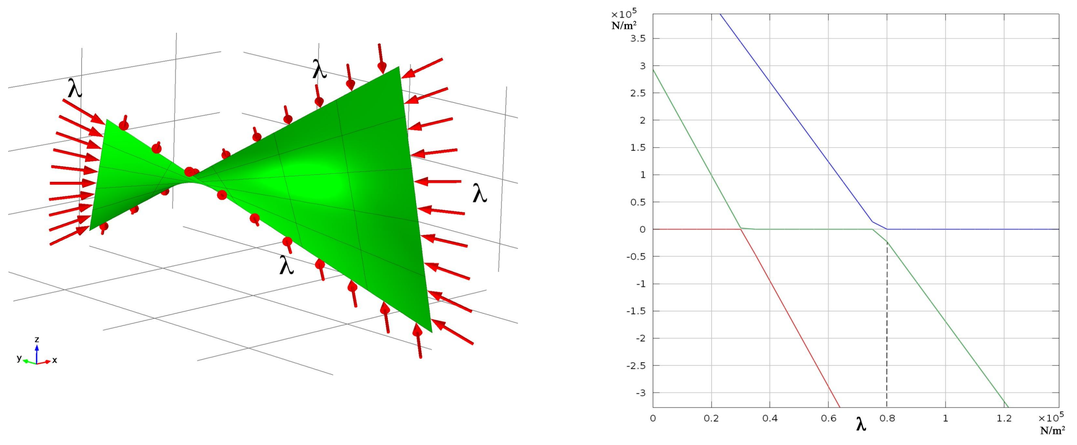

Figure 3. Parametric sweep λ: edge load condition, 2d plot of λ values in N/m^2

Results and Conclusions: The sweep parameter λ indicates the necessary post-stress value that is about 8 kN/mt ,i.e. 45 kN for each steel bar. The adopted modeling elaborated with the mechanical module allows to effectively reduce the number of mechanical test on physical models, influencing the work also in economic terms.

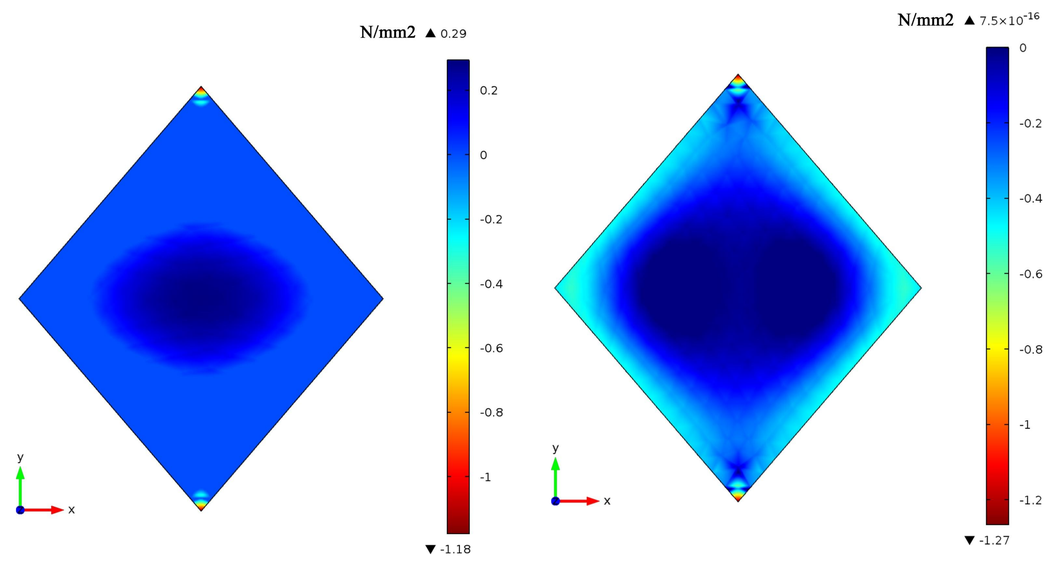

Figure 4. Second principal stress before and after the pre-stress load

References:

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