



3MURI

Project

Encirclements module



STADATA

STRUCTURAL SOFTWARE

Encirclements module

The encirclement calculation module of 3Muri software represents an advanced tool for the design and verification of local interventions on masonry buildings. Based on current technical standards, the module allows the design and verification of steel encirclements and the verification of reinforced concrete encirclements, optimizing interventions and ensuring compliance with structural guidelines.

Main Benefits

- **Compliance with Regulations:** The module fully integrates the requirements of the Italian Technical Standards for Construction 2018 (NTC18) and Circular No. 7 of 2019, ensuring that projects meet safety and reliability requirements.
- **Ease of use:** With an intuitive working environment, the module allows easy data entry of materials, encirclement geometry and calculation parameters, with optimized management of openings and masonry characteristics.
- **Flexibility:** The software allows the design of both steel and concrete encirclements, with the possibility of defining free, rigid or semi-rigid constraints, ensuring maximum adaptability to different types of interventions.
- **Automatic Predimensioning:** The module includes a steel encirclement predimensioning function that automatically selects the optimal profile for posts and crossbars, facilitating verification of the strength and ductility of structures.

Main Features

1. Calculation Procedure

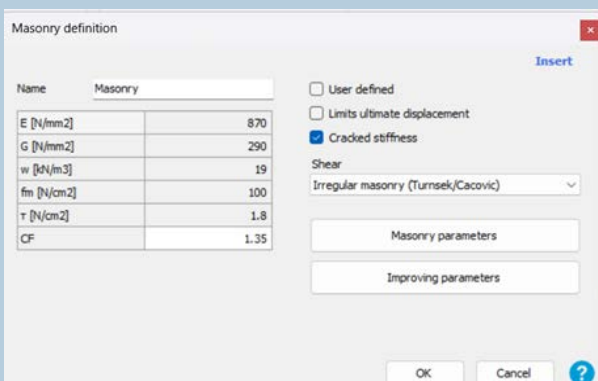
The calculation procedure within the module is designed to provide a detailed comparison between the current and project status of a masonry wall. This process includes:

- **Current status:** This is the initial condition of the wall before intervention, in which all existing structural parameters are considered, including strength, stiffness, and deformation capacity of the masonry panels.
- **Project status:** This defines the condition of the wall after the introduction of a new opening or the installation of encirclement. The module calculates how the intervention will affect the mechanical properties of the wall.
- **Comparison of states:** The software evaluates changes in strength, stiffness and strain work. These changes are critical in determining whether the intervention can be classified as a local intervention.
- **Specific formulations:** The calculation of the strength and stiffness of the wall system is done through specific formulas for masonry panels, reinforced concrete reinforcing frames, and steel frames, which consider several factors, such as elastic moduli, restraint conditions, and bending and shear strengths.

2. Materials Management

Accurate definition of materials is crucial for accurate results. The module offers several options for managing the materials used in construction:

- **Masonry:** The user can define the mechanical properties of the masonry, choosing from various masonry types and knowledge levels (LC). Depending on the knowledge level and the respective confidence factor, the software automatically calculates the mechanical parameters of the masonry and for LC = 3 and allows manual input of parameters from material tests.
- **Steel and Reinforced Concrete:** For steel or reinforced concrete encirclements, the module allows the selection and definition of the materials: Structural steel, rebar steel and concrete. It is possible to select the materials from the libraries present on the module or define their characteristics manually.
- **Improvement interventions:** The software allows to set parameters for improving masonry characteristics, such as through interventions already performed or planned.



Masonry definition

Name: Masonry

User defined
 Limits ultimate displacement
 Cracked stiffness

Shear: Irregular masonry (Turnsek/Cacovic)

E [N/mm ²]	870
G [N/mm ²]	290
w [M/m ³]	19
f _m [N/cm ²]	100
τ [N/cm ²]	1.8
CF	1.35

Masonry parameters

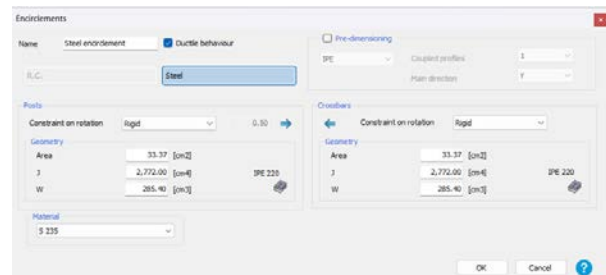
Improving parameters

OK Cancel ?

3. Encirclement definition

The module allows the definition of encirclements, with a high degree of customization to suit the specific needs of the project:

- **Steel encirclements:** It is possible to choose between different constraints: rigid, free or semi-rigid for the base of the posts and rigid or free for the crossbars. The module automatically calculates the formation of plastic hinges and the stiffness of the encirclement, considering the interaction between shear and displacement until the ultimate condition of the frame is reached.
- **Reinforced concrete encirclements:** For reinforced concrete encirclements, apart from the cross-section it is possible to define the longitudinal reinforcement. Again, constraints and ductile behavior can be defined, with the possibility of simulating brittle collapse at the first shear failure.
- **Automatic predimensioning for steel encirclements:** A key function of the module is steel encirclement predimensioning, which allows the optimal profile for posts and crossbars to be automatically selected based on the chosen profile family. This function is particularly useful for ensuring that the design meets strength criteria without having to perform complex manual calculations.



Encirclements

Name: Steel encirclement

Ductile behaviour
 Pre-dimensioning

Profile: Steel

Posts: Constraint on rotation: Rigid, 0.50

Area	33.37 [cm ²]
J	2,772.00 [cm ⁴]
W	285.40 [cm ³]

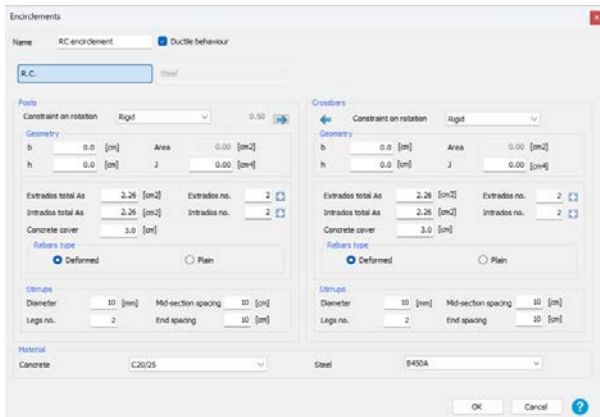
Material: S 235

Crossbars: Constraint on rotation: Rigid

Area	33.37 [cm ²]
J	2,772.00 [cm ⁴]
W	285.40 [cm ³]

Material: S 235

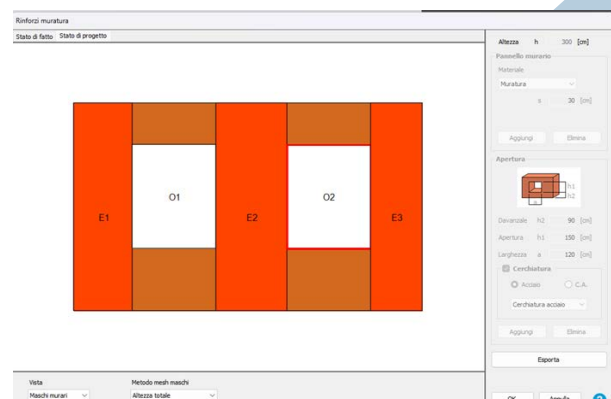
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4. Wall Analysis

The module's advanced graphical interface allows the user to visualize and modify the characteristics of the wall, with emphasis on the management of openings and load distribution:

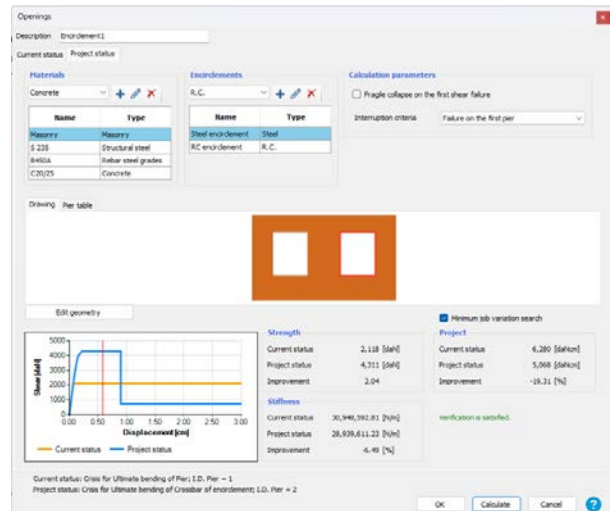
- Geometry definition:** The user can define the geometry of the wall through an intuitive graphical representation, with the ability to add, delete or modify panels and openings. Openings with encirclement are displayed with a red outline, making it easier to identify reinforced areas.
- Wall characteristics:** The module allows management of wall panels and acting loads through a summary table.
- Calculation Mesh:** Effective panel heights can be defined to optimize the calculation of limit displacement capacity.
- Calculation method:** It is possible to select the calculation method for the mesh of masonry piers, choosing from total height, average height, Dolce method or a user-customized definition.



5. Calculation Results

The module provides detailed results that enable complete design verification, with outputs that include:

- **Strength verification:** The module ensures that the strength of the project status is greater than that of the current status, according to the $V_{sdp}/V_{sdf} > 1$ criterion.
- **Stiffness variation containment:** Given the fact that there are no mandatory regulatory limits on the Italian standard NTC2018, the module verifies that the stiffness of the current status and project status are comparable.
- **Minimization of work variation:** The module helps to design the encirclements so that the difference in energy dissipated by the breaking process (work) between the current status and the project status is minimal. With work control, it is possible to simultaneously monitor stiffness, resistance and displacement so that they remain balanced. This approach proves to be very effective as in many cases it allows to obtain an effective improvement with limited resistant sections, thus limiting costs.
- **Export and visualization:** Outputs can be displayed graphically and exported in a report in RTF format.



Conclusions

The encirclement calculation module of 3Muri software is confirmed as an indispensable ally for designers, combining accuracy, flexibility and regulatory compliance in a single solution. Investing in this tool means guaranteeing optimal results in any structural retrofit or improvement project.