

ANCHORING IN RAMMED-EARTH WALLS.

IS IT:

☐ *Product*

☒ *Technology*

☐ *Equipment*

APPLICABLE FOR:

☐ *Restoration*

☒ *Rehabilitation*

☐ *New Construction*

APPLICABLE ON:

☐ *1. Foundations and underground structures*

☐ *2. Vertical structures*

☒ *3. Horizontal structures and vertical connections*

☐ *4. Roof and terraces*

☐ *5. Façade and building envelope*

☐ *6. Finishes and completion elements*

☐ *7. Integrated services*

☐ *8. General strategies for building recovery*

Related companies: No companies; university research; structural study.

DESCRIPTION

When it is necessary to effectively join walls with other walls (made of rammed earth, stone masonry or ceramic masonry) or when it is necessary to join floors or slabs with rammed earth walls, in order to improve the overall stability of the building and its seismic response capacity.

WHY TO USE

To join the structural elements of buildings with load-bearing walls: the walls to each other and the floor slabs to the perimeter walls so that they can act as structural diaphragms.

HOW TO USE AND APPLY

By driving rebar (B500) into larger diameter pre-drilled holes and backfilling with cement grout (as used for backfilling sheaths in post-tensioned bonded strand slabs).

1. Proceed to a campaign of adhesion tests with rebars of a diameter to be defined according to the performance required in each case (normally 12.16 mm) and a minimum penetration of 15 cm.
2. Since the failure of the anchors is not usually due to adhesion but to tangential stresses of the material (wall), it is necessary to carry out tests with a tripod in order to verify the apparent diameter of the cone of rupture on the surface.
3. Depending on the quantity of specimens to be extracted, the characteristic value to be considered in subsequent structural design applications can be adopted by statistical calculation.
4. To join masonry (stone) walls, normally facade walls, with interior load-bearing walls, we proceed to extract with a toothed probe a superficial stone cylinder that allows to lodge later the washer and the anchor nut. Once the anchor has been screwed in, the hole is filled with repair mortar so that the surface of the wall is not affected, especially if it is a facade wall.
 - a. Drilling (with a slight slope of 10 or 15 degrees) with a drill bit of a diameter greater than that of the anchor (normally a diameter of 20mm will suffice) to a depth in the wall of no less than 60cm, obviously passing through the entire edge of the stone wall.

- b. Filling by decanting, of the hole with cement grout (Cablegrout-Betec-Propamsa type, or similar) well mixed (according to proportions provided by the manufacturer).
 - c. Insert the rebar with the threaded head (B500), turning it gently so that it is embedded in the cement grout.
 - d. When the grout has set and hardened (time to be fixed by the manufacturer in the technical data sheet of the product) proceed with the placement of the washer and nut to fix the anchor. Tightening torque sufficient for the thread to enter in tension, without forcing.
 - e. Depending on the calculation, the location between anchors should be sized: normally at a distance of no more than 30 or 40 cm, to ensure effective sewing between the two walls to be joined.
5. To join floor slabs all around their perimeter with the rammed earth walls:
 - a. Normally, there are two possibilities in renovations: to take advantage of part of the wooden beam slabs, converting them into composite slabs by eliminating the existing deteriorated deck, and placing a compression layer connected to the wooden beams; or by making new slabs without taking advantage of the elements of the existing slab.
 - b. In the case of using the existing beams (usually wood), at the level of the compression layer, anchors are driven into the wall (both parallel to the beams and perpendicular to them) using the same system described above in the case of the wall connection, before concreting (and reinforcing) the compression layer. Thus the slab becomes a structural diaphragm that ties the walls together.
 - c. In the case of making new slabs, whether based on concrete slabs or a mix of concrete and concrete slabs, the same procedure is followed.
 - d. In the case of concrete slabs, the support on the walls of the wall is carried out by means of rack and pinion formation (alternating the wall of the wall, in a similar way as it is done in the case of concrete screens) and driving of anchors as described above.
6. The application of both construction solutions (effective connection of walls and formation of diaphragms) obviously substantially improves the overall stability of the building and, of course, its

capacity to respond to accidental seismic stresses, preventing the building from collapsing like a house of cards in such a case.

7. It should be taken into account that the regulations, in the case of building rehabilitation, postulate that the building's seismic response capacity should be improved as much as possible. This connector system responds to this requirement.

TECHNICAL CHARACTERISTICS

This is the well-known anchoring technique, in general, but applied to buildings with load-bearing walls, usually "centenary", in which a qualitative evaluation can qualify them as still in a good state of service and therefore susceptible to be rehabilitated.

RECOMMENDATIONS AND OTHER INFORMATION

From a calculation point of view, it is convenient to model the building as a whole, in the initial state and in the final state (already with connectors) to be able to compare the improvement in stability and seismic response.

At the discretion of the design engineer, the test campaign will be carried out on the basis of population groups of not less than 15 specimens to be extracted.

It is important to bear in mind that the walls cannot be waterproofed with any type of product: portland cement mortar, plastic paints, coatings, etc. Lime mortar with calibrated sand and lime stucco (with marble sand) will always be adequate in the case of noble walls.

The wall must always be able to "breathe" so that interstitial humidity is not altered or concentrated, which would affect the cohesion and consequently the compressive strength.

Before anchoring, any waterproofing coating other than lime mortar plaster must be removed.

EXAMPLES

An example of integral rehabilitation with change of use of the building "El Mallol" in Sant Hipòlit de Voltregà (Osona) Catalonia.

REFERENCES / SOURCES AND LITERATURE



Carles Crosas i Gemma Domingo, Arquitectos. SOG ARQUITECTURA ALRIDO SLP; Josep Baquer Arquitecto Técnico, Consultor de Estructuras

Josep Baquer: Paredes de tàpia: avaluació quantitativa. L'Informatiu 366, Octubre-Desembre 2020. (cf. Quaderns d'Estructures 56)

WEBSITE OF THE COMPANY

www.aceweb.cat

www.sog-design.com

Details of project

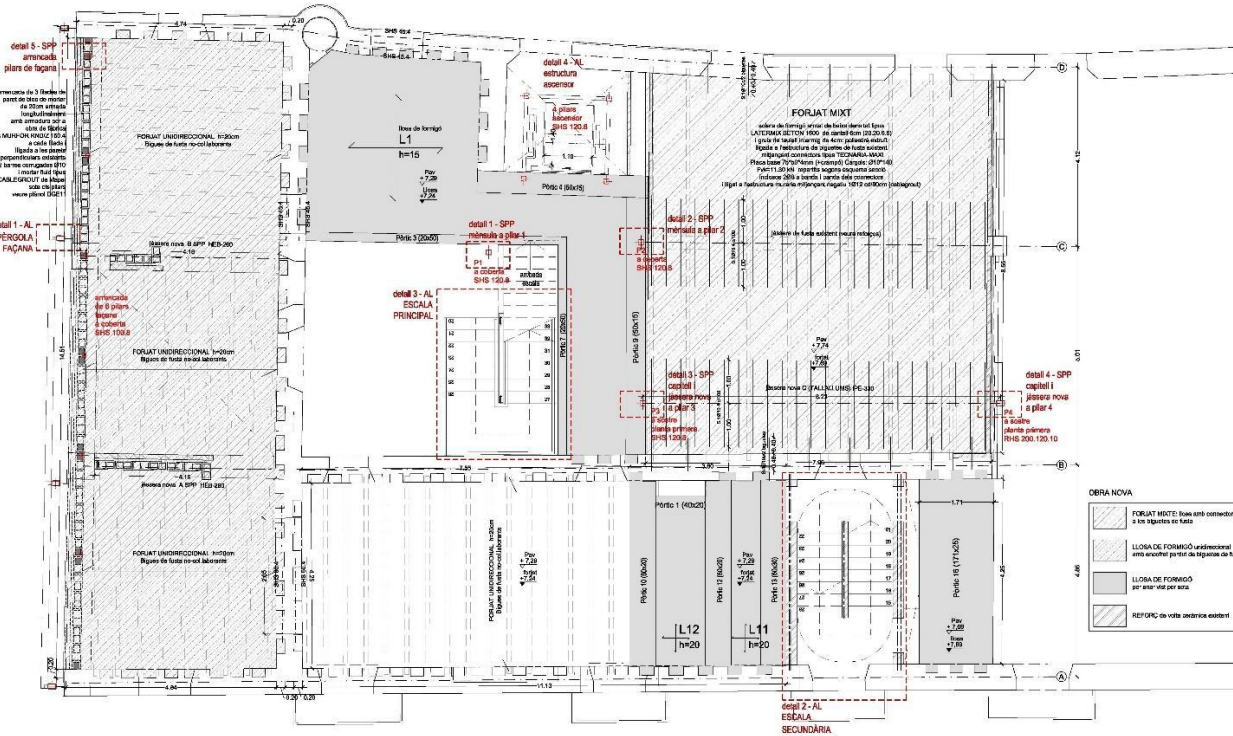


Fig.6: Floor plan, with slabs (new) supported by "zipper" walls and connectors.



Fig.7: Rehabilitated wall in which a test campaign was carried out.



Fig.8: Encounter of rammed earth walls connected with anchors.



Fig.9: Façade of rammed earth and masonry, connected to interior walls with anchors.