STRUCTURAL EVALUATION OF RAMMED EARTH WALLS.

IS IT:

- [ ] *Product*
- [x] *Technology*
- [ ] *Equipment*

APPLICABLE FOR:

- [ ] *Restoration*
- [x] *Rehabilitation*
- [ ] *New Construction*

APPLICABLE ON:

- [ ] *1. Foundations and underground structures*
- [x] *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 quantitatively evaluate the bearing capacity of walls or rammed earth walls (pressed clay). Compressive work capacity.

WHY TO USE

In order to establish the safety (ultimate limit) of the bearing walls.

HOW TO USE AND APPLY

By laboratory analysis of specimens taken from the wall.

Ideally, unaltered samples should be extracted from the wall. For this, it will be necessary to extract a sufficient portion of the face to cut the cylindrical sample in the laboratory, or to extract it directly from the wall by means of a rotating probe with a dry cut (so as not to alter the interstitial moisture).

The objective is to prepare the samples to proceed to the rapid triaxial test without drainage.

It is also possible to extract altered samples to proceed to the direct shear test: disadvantage: the internal structure of the sample is destroyed. This is important in soils with a silty-sandy matrix amalgamated with lime slurry. The results can give values much lower than the reality of the wall material.

TECHNICAL CHARACTERISTICS

Proceed to the extraction of pairs of specimens (undisturbed) to submit them to the rapid triaxial test without drainage.

The more tests, the better the compressive strength can be established.

For each triaxial test, the Morh circle is plotted to deduce the Coulomb line, the angle of internal friction and the cohesion.

By plotting the circle of Morh passing through the origin of coordinates, the expected breaking stress (intersection of circle with abscissa) is deduced.

It has to be this circle, since what would be the test chamber pressure would be of zero value, since the specimen in the wall would be confined in the plane of the wall, but not in the transverse direction. The most unfavorable situation would thus be adopted.

RECOMMENDATIONS AND OTHER INFORMATION

The more tests the better: a characteristic value will never be deduced (a very extensive sampling would be necessary) but it will be sufficiently reliable.

If the same parameters are defined on the basis of samples altered by the direct shear test (three specimens per test), the results will be much more unfavorable since the internal structure of the material as it is in the wall is "broken": they may decrease by up to 50%.

Tests can be carried out with a "pressuremeter" (currently under study) driven transversely into the wall, so that its expansion would act as confined in the x/y axes.

The results will have to be compared with those of the triaxial test and establish an analogy that allows, with the pressuremeter, to make many more tests in situ without the need to extract more samples and take them to the laboratory.

EXAMPLES

An example of a rehabilitated building with a change of use is provided, in Sant Hipòlit de Voltregà (Bages), whose rammed earth walls were tested and used as load-bearing walls, being able to establish a quantitative evaluation to justify it.

REFERENCES / SOURCES AND LITERATURE

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

Josep Baquer: Parets de tàpia: avaluació quantitativa. L'Informatiu 366, Octubre-Desembre 2020.

WEBSITE OF THE COMPANY

www.sog-design.com

www.aceweb.cat

IMAGES AND CAPTIONS

Fig.1: El Mallol building before the intervention, constructed with rammed earth and masonry. *©Josep Baquer*

Fig.2: El Mallol building after the intervention, fully restored and rehabilitated. *©Josep Baquer*

Details of project

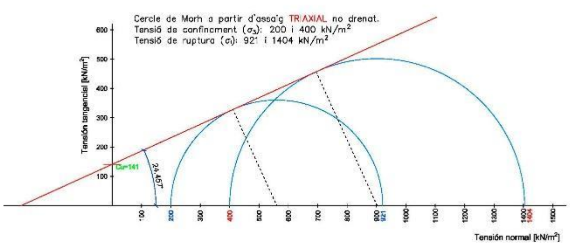


Fig.3: The triaxial test is performed on two specimens extracted from the ground (in this case from the wall of the wall). A vertical load is applied by means of a loading piston (which occurs through the lid of the chamber), which increases at a constant deformation rate, until the specimen breaks. *©Josep Baquer*

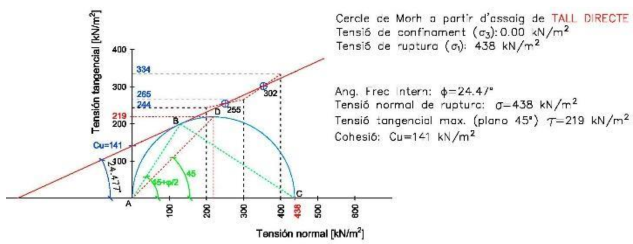
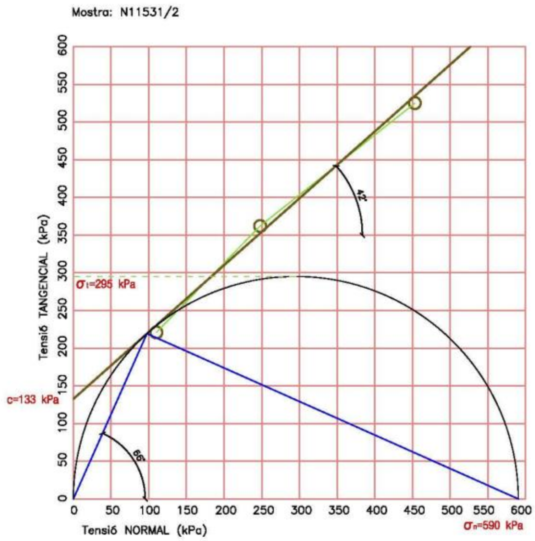
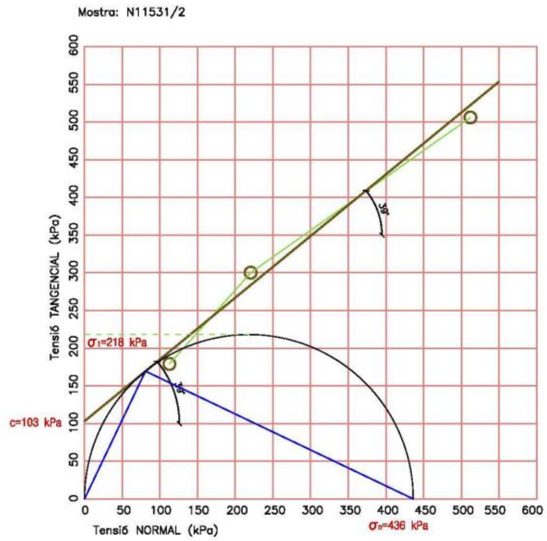


Fig.4: In the case of the direct shear test, it is necessary to break three specimens in order to define the Coulomb line. *©Josep Baquer*





N11531/2	Tensió NORMAL	Tensió TANGENCIAL
Proveta 1	110.12	220.93
Proveta 2	247.84	362.08
Proveta 3	453.14	525.24
Cohessió	c=135 kPa	
A. Frec Int.	φ=42°	
Tens. Normal. Ruptura		σ_n=590 kPa
Tens. Tangen. Ruptura		σ_t=295 kPa

N11531/5	Tensió NORMAL	Tensió TANGENCIAL
Proveta 1	112.62	179.08
Proveta 2	220.52	300.29
Proveta 3	512.28	506.12
Cohessió	c=103 kPa	
A. Frec Int.	φ=39°	
Tens. Normal. Ruptura		σ_n=436 kPa
Tens. Tangen. Ruptura		σ_t=218 kPa

Fig.5: Direct cutting test of a wall sample from "El Mallol" and Coulomb line tracing from Mohr's circle. Once the Coulomb line is defined, we can draw as many circles as we want, starting from pre-established chamber pressures. Each circle will define the expected rupture stress. We can also define a circle that is of special interest to us: the circle that has an initial chamber pressure of zero value. The trace of the corresponding circle, tangent as all of them in the Coulomb line, will define the value of rupture of the sample in these states.

Why are we interested in this value? Because it is what defines a sample in an unconfined situation. Normally, the soil under footings and foundation elements is confined, and the more it is confined, the better it will behave. That is why it is so important that the so-called "shallow" footings are as shallow as possible, because the more "confined" the soil is, the more resistance it will have in terms of breaking point.

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