



## PORTUGUESE TRADITIONAL SCHIST MASONRY WALLS

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### KEYWORDS

Schist, masonry, typologies.

### ABSTRACT

The schist constructions represent a very important cultural, architectonic and historical legacy in Portugal and in Europe, that urges to preserve. Included among the traditional Portuguese architectural heritage, there are many traditional buildings in masonry schist, distributed from North to South, varying the types of buildings, the constructive methodologies and even the schist, which may have quite different properties and characteristics, depending on the area where it is extracted. Over the years, this traditional architecture has implemented a truly sustainable construction through the use of natural materials existing in the region, as today it is pretended to implement in the contemporary construction. The constructive methodologies of these traditional structures have been developed in direct relation to the various factors that influence them, including economic, environmental and social ones, adapting to different environments and requirements over the time, originating a wide diversity of typologies that today exist in the Portuguese territory.

### INTRODUCTION

The survey of the traditional schist constructions in the different regions of the country allows understanding that there are significant variations in construction methods related to the local geology, namely the masonry construction is closely related to the schist material existing in the neighbourhood of the construction. According to Boeri (Boeri, 1995), the natural stones when used in the constructions have the same characteristics as they were on the nature. Furthermore, Ribeiro et al. (Ribeiro et al., 2008) state that this type of construction is closely linked to nature, which holds its roots and where it is raised, resulting in a symbiosis between nature and human work. In general, the schist traditional houses have slightly square or rectangular in-plan geometry, with two or three floors at most. As these buildings are traditionally built in mountain areas, it is usual that the first floor has a facade leaning to the ground and thus, the second floor is at ground level at that facade. Thus, it is clear that the different typologies of the schist constructions in Portugal, see Figure 1, are closely related to the material

available, the population itself, its culture, traditions and knowledge, as well as its economic power.



Figure 1 - Examples of building typologies: (a) Trás-os-Montes; (b) Beiras.

### FOUNDATION SYSTEM

The foundations of the schist rural constructions are normally made of schist, except in some constructions at Minho region where they are made of granite. These constructive elements are practically an extension of the walls to the foundation soil, with a current depth of 60 cm, but it may vary depending on the soil type, implantation of the building, and dimensions of the building. Schist constructions are often located on land with steep slopes, especially in the Beiras region.

### MASONRY WALLS

In the schist masonry walls construction, typically larger stones were used at the corners, where concentration of larger stresses tends to occur, so appropriate connection between the wall panels should be provided. Stones of smaller dimensions are used in the remaining wall, facilitating their handling in the walls construction process.

The walls stiffness and strength, as well as of their connections, depends on the quality and size of the stones used in their construction, but also their arrangement and constructive method. An adequate arrangement of the schist stones in the construction of the walls has an extreme importance, largely affecting their mechanical properties and structural performance. Relatively to the typology, in the Minho region, where it is possible to extract larger schist stones and where was usual the combination of schist stones with granite stones in the walls construction, they are usually simple. When it is not possible to extract larger schist stones, the walls can present two leaves, see Figure 2, as is the case of many buildings in Portugal. In these cases, the schist stones are neatly arranged and the binding mortar is usually made of earth. In this type of schist fabric,

wood or stone connectors can be found. They play a fundamental role for the monolithic behaviour of the masonry walls.



Figure 2 – Two leaves walls without connection.

An aspect varying considerably in the different types of schist masonry in Portugal is the presence or absence of mortar connecting the schist stones, see examples Figure 3. In existing walls, different types of mortar connecting the schist stones can be found, such as lime or simple earth mortar. But, it can be also found masonry schist walls without mortar, for which the meticulous settlement of the schist provide imbrications which ensures the adequate mechanical behaviour of these walls.



Figure 3 – Joint in schist masonry: (a) With earth mortar; (b) Without mortar.

The employment of plaster on the masonry walls of schist construction was somewhat unusual and they can be found mostly in religious or noble buildings. In Portugal, they are more easily found in the South and in the Minho regions.

The partition interior walls, when are structural as in larger buildings, are usually constructed also in schist. In some particular cases can be found a combination of schist with granite. However, the partitions walls are most commonly made of “tabique”, a partition wall with timber frame with cover made with lime.

Masonry corners play an important role in the building structural performance, since on one hand they ensure the connection between perpendicular walls. But, on the other hand, these elements in masonry structures tends to concentrate larger stresses, due to the horizontal loadings induced by wind and earthquakes, as well as the resulting thrust from the roof structure. The quality of the materials and its arrangements in the corners is even more important for buildings with multi-leaf walls, considering that for these cases the quality of the masonry is lower, as stated before, due to the smaller dimensions and poor mechanical properties of the stone units.

## FINAL CONSIDERATIONS

In Portugal mainland abound metamorphic rocks, being the schist one of the most common. Nearly three quarters of the national territory soil consists of the called “old massive”, occupying the regions of Minho, Trás-os-Montes, Beiras and part of Alentejo. In fact, the schist stone itself is a major factor that distinguishes the building typologies found in each region, due to variations in the type of schist available locally.

But, the differences in schist masonry structures found in Portugal are obviously also related to the population, i.e. its traditions and technical experience, but naturally also with its economic conditions. The analysis of all these factors is crucial to better understanding the typological variation founded in traditional constructions in Portugal.

Nowadays, the schist as a masonry construction material starts to gain the attention of architects, builders and owners, due to its recognized value in terms of local historical and patrimonial value, but also due to other intangible values associated with traditional construction methods.

Future work involves the study of the types of schist constructions in Algarve and Alentejo regions, as well as to characterize the schist as a construction material and the mechanical characteristics of schist structures.

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