Catalan methods for construction in Sardinia:
The use of «abeurador» in stone masonry

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Sardinia got on to the Spanish political and cultural influence during the 14th century, from then a real migration of people began towards the captured towns or the free-towns. Such people was employed in different activities, there was specially traders and craftsmen and masons with them.

The considerable cultural contribution was tightly connected with the technical applications, so that some rules of the masonry and some particular construction methods was implied in the change of taste and style. During the following centuries native people appropriated mason-craft or builder-craft gradually but in complete and fully aware way.

The goal of this research is to prove as studying constructions' methods is possible to identify the source of building workmen, in order to define groups of structures that are thought or built by the same rules. To identify groups of structures in a geographical context wider then source context, it means to connect researches also with the neighbouring constructive examples. It will have the purpose to define a classification method for the constructive, behaviour and damage model.

About archives and historical documents: studying Sardinian bookkeeping documents of the 15th–17th century written in Catalan language, it’s noticed a particular affinity of the technical-constructive terminology with the same terminology coming from Baleares Islands and again in use. In fact it is noticed the affinities that joins Palma of Mallorca with Sardinia about the most utilised material of stone masonry: stone of «mares» / «massacà» (same kind of

Figure 1
Operation of «abeurador»
sedimentary stone). It has caused the same technique in cutting of stones and in the correspondent pieces’ dimensions of blocks.

About buildings and structures: to analyse the use of the «abeurador» as a method for construction and assembling of arches, of strain blocks and of stereotomyc elements, that is diffused in Sardinia and in Palma.

GOAL OF THE RESEARCH

The present research is just a piece of a larger study about historical methods of construction in Sardinia during the Spanish influence. The goal is to create a database in order to connect data resulted from studying archives’ sources with data belonged history of construction’s methods. The data base has the purpose to recognize each methods as special and particular one: 1st belonged to a certain historical period (then useful to identify the age of the building or of one of its parts); 2nd belonged to a particular cultural circle (in order to identify the workmen or their place of origin); 3rd belonged to a specific static and structural meaning (then useful to restoration works).

AN EXAMPLE OF CATALAN METHOD OF CONSTRUCTION: THE «ABEURADOR»

The object of this research is the «abeurador», a methods of constructions that belong to Catalan countries and tightly to the cultural milieu of Baleares Islands, that are near Sardinia in historical and geographic meaning.

The «abeurador» or «beurador» is a little carved canal in the stone block exactly on the plain of laying joint. It must be filled of special mortar («beurada») and assembled with a symmetric one. When the mortar is wiped the «abeurador» makes use of joint nerve between the blocks. From the outside the result is a structure that seems built without joint of mortar; in fact it is specially made use for arches, pillars or columns with mouldings, special blocks or particular pieces of the masonry, just when the mortar joint must be invisible. The carved canal has different proceeding, it depends not by the block’s shape but by the block’s function when it is assembled in to the wall. In moulded blocks for the arches the carved canal has shape of arrow or fish thorn.

It is instead not used for generic walls, in order that the masonry’s rules with stonework’s sheathing are founded on different criteria and are not object of this part of research.

This method for construction is used specially on buildings as gothic-catalan architecture, for example in Sardinia on portal with stone arch. Such arch called «adovellado» is built with long trapezoidal stone-blocks arranged like a fan apparently without mortar, but with the carved canal on the interior side. The mason filled the carved pouring the «abeurada» by the mouth of the jug.

By means of studying and comparing archives and historical documents (and also by other parameters) it’s possible to retain that this method has came in Sardinia from the Baleares’ construction culture.

In a Catalan dictionary of construction method (Diccionari de l’Art y dels Oficis de la Construccio, Mallorca 1988) the word «abeurador» means: furrow made from stone-cutter or mason on the construction blocks, in order that the «abeurada» (kind of mortar) could be poured inside and also in order that it is used, fool of mortar, like a joint nerve in to the stone-blocks.

The method is effective for stone-blocks of arches («abeurador» as an arrow) or pillar or column (simple

Figure 2
«Abeuradors» in Cathedral of Palma of Mallorca
«abeurador» or just with one or two transversal carved canal). For example the furrows found on stone-blocks of the Majorca's cathedral, during restoration works, are simple «abeurador» carved on moulded stone pieces, got on to the structure as blocs without mortar. In Sardinia also is possible to find simple «abaurador» used in pillar's block, like the carved one in the stone-block of the circular pillar holding the umbrella-vault in the Tramariglio's tower of Alghero; nevertheless, as we can see at present, there are specially arrows for arches.

The arrow served a purpose to raise the distribution surface of the inner reinforcement. But it's necessary to reflect upon the direction and the way of the

Figure 3
Remain of arch with «abeurador» in the bell tower of Alghero's Cathedral
arrow’s wings or of the transversal carved canal. They are always in agreement with the mortar’s possibility to flow down throw all the carved-canal, in the opposite the mortar couldn’t fill the furrow up. In the mean-time the structural meaning of the stone-block is that the arrow’s wings must be carved in the opposite direction of the compression strain. Then, for example, the resistance of the arch’s system also depends to the joint of its pieces through this inner armour of mortar; in fact the arrow’s direction is on the opposite of the strain. The joint react as a friction strain opposite to the sliding of the blocks.

So it’s possible building arches that seem joint without mortar, but have inside a solid and collaborating armour to contrast the vertical force. It is the same building with stereotomic pieces and using the carved canal as an aid.

ARCHIVES AND HISTORICAL DOCUMENTS

In Sardinia there are many archives’ documents datable from 14th since 17th century confirming that building workmen belong in linguistically to the Baleares islands. The linguistic affinity is generally about materials used in masonry and about the dimension of the stone-blocks. For example lets study some catalan words in comparison with documents coming from Alghero, the small town that keep ancient catalan language since today. «Cantó» in catalan language means corner, corner-stone, in Alghero it means stone-block with perfect corner, with fixed dimensions; the word was used since 14th century in a parchment about reconstruction of the town-walls. In Minorca «cantó» means block of «marès»-stone (local sandstone) cut as parallelepiped with fixed dimension, similar to the blocks from Alghero. And again: «pessa» in catalan construction’s culture is a big stone-block proceeded from the cave, like approximately in Alghero. The same we can discover about «mitja», «quadro» and others. Plus the sandstone from Majorca and the one from Alghero («massacá»-stone) have the same nature and structural characteristics and both are easy to take out and to carve.

In the language of Majorca the word «abaurador» or «abeuradora» is often used, yet but in Sardinia they are completely forgotten. Then it’s evident the importance to studying documents comparing them with material traces on buildings, in order to identify the common cultural circle and first of all the origin’s place of the workmen.

Portar la calsina en lo moll o beurador

Lets try to translate one piece from this historical sources: «Portar la calsina en lo moll o beurador», a sentence from the Tarifa de Tralladores de cada Oficici, 1653–1658, kept in Historical Archives of Alghero.

The first hypothesis for literally translating the sentence is: taking the lime to the quay or to the place of drinking-trough. It could be possible to think of taking the lime to the quay in order to sell it or taking to the drinking-trough, where there was large quantity of water, in order to slake the lime in to the basins. But the sentence could have an other meaning in the translation, yet: putting the lime in to the mortar, as mollifying the quicklime, or in to the «beurada» (special kind of mortar), or taking the lime to the «beurador» (the worker who makes the «beurada») or putting the lime in to the «abeurador» (the carved canal).

There are two reasons for being inclined to believe that the last interpretation is the right one. In fact Sardinia is a country rich in limestone, and the lime generally had a local production, quarries and lime-kiln was largely located in many areas of island, usually in the country place near the towns or villages. Then instead of meaning to board in the quay the lime and to sell it somewhere, it could be better translate the sentence as mollifying the quicklime («moll»). The second reason, about the translation of the word «abeurador» as a place of drinking-trough, concern that the basins to slake the lime was generally located near the building yard or near the lime-kilns, then (following the tale of the document) is not understandable the necessity to take the lime of the kilns and bring it to the basin located near the drinking-trough, after from there to the building place.

The ground of this doubt during the translation is sure having forgotten a construction method; this is just one exempa of the possibility to find mistakes studying an historical document without keeping contact with the material argument of the text.
**Occasions of Discovering**

It is generally difficult discovering the presence of "abeuradors" in buildings, for the reason that they are inside the wall's structure. In Sardinia we usually find some of these arrows or furrows only in external face of the wall, when it is built whit salvage material or loose blocks belonged to a preceding structure. Then they have a casual disposition in the facade's composition. Unusually instead they could be found in their original position on a building in ruin condition.

**Temporary Catalogue of Discovering**

This is a temporary catalogue of "abeuradors" discovering; naturally the continuation of this research and the bringing up to date of data-base will sure give more and more information about them and discovering.

Alghero: found 11 arrows in structure built with blocks belonged to a preceding structure (boundary walls, closed holes, structure rebuilt after the second world war), 1 arrow in original position (impost of arch in to the bell tower of cathedral), some carved canal in original position (circular pillar). One of this arrows is notable for the number of wings.

Sassari: found 1 arrows and 1 carved canal in walls built with material taken of a preceding masonry (structure of 17th century of S. Maria of Bethlem, Cathedral).

Monteleone Roccadoria: 1 arrow in not original position (boundary wall).

Bolotana: 3 arrows in the same building in casual position on the walls (structure of 16th century of S. Bachisio).

Ploaghe: 1 arrow in not original position.

Cagliari: 15 arrows and 2 furrows with transversal canal in structure built with blocks belonged to a preceding structure (boundary walls, closed holes, structure rebuilt after the second world war, cathedral), 2 arrow in original position and in the same structure (2 blocks of a double arch "adovellado" in a ruin wall). There are a lot of different kind of carved canal or arrows.

**Figure 4**

Occasion of discovering in Alghero

**Figure 5**

Double arch "adovellado" (recto) and "regrás fals" (verso) with "abeuradors" carved on two blocks, in Cagliari
Figure 6
Occasion of discovering in Cagliari and in Sassari

**DIMENSION OF RECOVERED BLOCKS AND RELATION WITH THE CARVED CANAL**

Studying «abeuradors» in recovered blocks it’s possible notice some constants. The furrows, carved arrows or carved canals, usually hold all the side’s surface of the block, either length or width. There are two kinds of arrows, with simple wings and with multiple wings. For example a block recovered in Alghero has even five wings in the same arrow. In the group of simple arrows there are two different kinds again; the most common is the «abeurador» with open wings touching the block’s corner on 45° (this kind could begin multiple). The second is a simpler «abeurador» with a very long carved canal and little wings that never are over the middle third. The blocks have usually different dimension, but a fix width of 25–35 cm, then it is easy understanding the dimensional relation of the «abeuradors».

This is a very important notice in order to not confuse this furrows with job-work’s marks by the «picapedrers» that sometimes are like arrows but with less dimensions in relation to the block. An other important point of you is about studies concerning width and deep of the carved canal. Usually it shows a section about 1 or 2 cm, and maybe it depends on structural assignment of the block and on how much mortar it needed.

**FEATURES OF THE MORTAR NERVE**

In to the carved canal must run the «abeurada», kind of mortar made with lime, water, not much sand and with a good mixing, in order to be flowing. In Sardinia there are not found rests of this mortar inside the carved canals yet, but it depends on occasion of discovering.

Then it is just possible to believe that sardinian mortar for «abeurador» was a kind of mortar similar to the one found in Catalunya inside the same carved canals. About the laying of the blocks: in case of arches construction the flowing of the mortar happened probably just when the faces of the two blocks was placed side by side, then from the top of the framework. On the opposite the flowing mortar could fall down.

**APPLICATION AND FIRST RESULTS FROM THE COMPARATIVE STUDY OF THE DATA BASE**

About bell tower of the Alghero’s cathedral: the arrow found in a impost of arch in to the bell tower is in an intermediate level between two floors. It means

Figure 7
Reconstruction’s hypothesis of an «adovellado» arch with spires, belonged the first building phase of the church of San Bachisio in Bolotana. Below two exempla of Catalan arches with spires in Pozzomaggiore and in Alghero
that in the first project the floors must be unlike actually and that the bell tower had more than one building phase. A second hypothesis is that the impost of arch is the only evidence of a project changed during works. Sure, without the knowledge of the arrow’s meaning it would be difficult to handstand the presence of the arch.

About the church of San Bachisio in Bolotana: it’s known that the church had two building phases, but the document notify just about the second one (16th century). Then it’s unknown the construction date of the first building. Studying the architectonic structure same blocks from the first phase are recognisable on the walls having the carved canal as an arrow, plus there are two spires carved in long blocks on non correct position. Adding this parts it could be possible rebuild an «adovellado» arch with carved spires on the sides, like same arches in sardinian churches dated 15th century. Then it’s almost possible give a chronology to a part belonged the first building phase.

The same meanings are possible in other cases, for example in Cagliari or in Sassari, using the knowledge of this method of construction, as an instrument useful to date or to understand some part of a building, but never leaving the complex study of a whole building.

From a technical point of view it’s easy understanding the importance of «abeurador» during restoration works specially on restoration of arches that seems built without joint of mortar. That’s in order to avoid a mistake scarifying the blocks and making a large joint of mortar or reinforcing a structure that has inside a mortar bracket, yet.