UNIVERSIDADE BEIRA INTERIOR

Assessment model for vernacular limestone buildings using Microsoft Excel®: the case of Serra de Santo António

Ana Luísa Vieira Faria

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Orientadora: Professora Doutora Ana Lídia Moreira Machado Santos das Virtudes

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Resumo

Esta dissertação pretende fazer um levantamento e estudar o estado de conservação dos edifícios vernacular de pedra calcária na Serra de Santo António. Esta aldeia, localizada no PNSAC (Parque Natural das Serras de Aire e Candeeiros) na região centro de Portugal, é conhecida pelas suas construções em calcário, incluindo muros usados pelos pastores e agricultores como delimitação de terreno e como cerca, as designadas Casinas, edifícios de habitação e moinhos de vento.

Os objetivos principais desta dissertação são criar um modelo para a avaliação (do estado de conservação e proximidade à matriz arquitetónica original) de edifícios de pedra calcária utilizando o Microsoft Excel®. Este modelo será subsequentemente aplicado a uma amostra de edifícios da Serra de Santo António. A amostra escolhida é composta por vinte e quatro edifícios que foram avaliados com este modelo. Contudo, a folha de cálculo criada no software possibilita proceder a novas avaliações dos estudos de caso em momentos posteriores, bem como a sua aplicação a outras zonas de aldeia, ou a outras localidades em que existam edifícios semelhantes.

Após a aplicação do modelo de avaliação dos edifícios vernaculares em pedra da Serra de Santo António, é possível concluir que nenhum dos edifícios analisados está no nível 1 de proximidade à matriz arquitetónica, ou seja, no qual a identidade da sua arquitetura está totalmente perdida. Verificou-se ainda que apenas 8% dos edifícios estão no nível 2 (de acordo com o qual alguns elementos arquitetónicos e construtivos originais podem ter sido removidos ou adicionados) e que a grande maioria dos casos, cerca de 92% se encontram no nível 3, ou seja o mais elevado sendo as suas características atuais praticamente idênticas às da construção original. Por outro lado, conclui-se que nenhum dos edifícios analisados está no nível 1 quanto ao estado de conservação, ou seja, em muito mau estado, cerca de 4% estão no nível 2 (em mau estado), 8% estão no nível 3 (condição média de conservação), mais de 16%) estão no nível 4 (em bom estado) e a grande maioria cerca de 70%, encontra-se no nível 5, ou seja, em muito bom estado de conservação. Em síntese, a maioria dos edifícios encontra-se em muito bom estado de conservação e manteve a identidade arquitetónica vernacular.

Palavras-chave:

Modelo de avaliação de edifícios vernaculares em pedra; Microsoft Excel®; Matriz arquitetónica; Estado de conservação; Serra de Santo António.

Abstract

This dissertation intends to survey and study the state of conservation of the vernacular limestone buildings in Serra de Santo António. This village, located in the PNSAC (Parque Natural das Serras de Aire e Candeeiros) in central Portugal, is known for its limestone constructions, including walls used by shepherds and farmers as boundaries of land and as a fence, the so-called Casinas, buildings housing and windmills.

The main goals of this dissertation are to create a model for the evaluation (of the state of conservation and proximity to the original architectural matrix) of limestone buildings using Microsoft Excel®. This model will subsequently be applied to a sample of buildings in Serra de Santo António. The sample chosen is composed of twenty-four buildings that were evaluated with this model. However, the spreadsheet created in the software makes it possible to carry out new evaluations of the case studies later, as well as its application to other village areas, or to other locations where similar buildings exist**.**

After the application of the evaluation model of vernacular stone buildings in Serra de Santo António, it is possible to conclude that none of the buildings analyzed is at level 1 of proximity to the architectural matrix, that is, in which the identity of its architecture is totally lost. It was also found that only 8% of buildings are at level 2 (according to which some original architectural and construction elements may have been removed or added) and that the vast majority of cases, about 92% are at level 3, that is, the highest being its current characteristics practically identical to those of the original construction. On the other hand, it is concluded that none of the buildings analyzed is at level 1 regarding the state of conservation, that is, in very poor condition, about 4% are at level 2 (in poor condition), 8% are at level 3 (average conservation condition), more than 16%) are at level 4 (in good condition) and the vast majority about 70% are at level 5, that is, in very good condition. In summary, most of the buildings are in very good condition and have maintained their vernacular architectural identity.

Keywords

Evaluation model of vernacular stone buildings; Microsoft Excel®; Architectural matrix; Conservation state; Serra de Santo António.

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Acronym List

UBI	Universidade da Beira Interior
PNSAC	Parque Natural da Serra de Aire e Candeeiros
INE	Instituto Nacional de Estatística
ID	Identification
UK	United Kingdom
USA	United States of America
DRE	Diário da República Electrónico

Chapter 1 - Introduction

1.1 Problematic

The study of the vernacular limestone masonry buildings was chosen for this research because Portugal is still very apt towards new construction, while conservation and rehabilitation actions of the existent buildings are not so popular. However, the literature reveals that conservation and rehabilitation are the best bets for the future of territories, in order to keep their traditional features.

In this regard, it becomes increasingly important in an over constructed Portugal, to maintain the existing buildings instead of building new housing. The national statistics show that in 2011 there were about 700 thousand empty houses in the country. Also, in an increasingly global world, is important to preserve the identity of the places, and preservation of the vernacular architecture is a way of doing so.

In 2001 there were about 3.000.000 buildings in Portugal, and 11,15% of those were in adobe, rammed soil or stone masonry, yet there are few tools and/or software able to help with evaluating their state of conservation.

The lack of specific tools could be explained by how challenging it is to create a software to evaluate the state of preservation of these types of buildings, since most of them were built a long time ago, mostly using practical knowledge leaving very few records, projects, or documentation behind. Thus, these facts are making very difficult to be certain about details such as their dates of construction, who built them and what are the main features of their original architectural matrix looked like.

Even though preservation is encouraged by law, such as the case of the Law nº 107/2001, of September 8th which basically states that "In these areas, tourism should be sustainable on the long run, to ensure the continuation of ecological processes…. And ensuring the usage of the resources allows future generations to enjoy them", the same document incorporates "Promote the value, the restoration and/or reconversion of the cultural, built … and immaterial heritage in existence…". However, the natural park of Serra de Aire e Candeeiros does not keep records of the existing vernacular limestone buildings in Serra de Santo António, or their state of conservation, even though steps in this direction were taken with the neighboring village of Alvados.

In this sense, this dissertation will be focused on the mapping and collection of data from 24 vernacular limestone buildings, as case studies, that could be the beginning of a larger study to further value these buildings and their preservation, in a way that does not compromise their identity. They are all part of the small village of Serra de Santo António, localized in the area of the natural park of Serra de Aire e Candeeiros, in the Central region of Portugal, belonging to the Municipality of Alcanena. Since modern building methods and materials are very popular, and the builders specialized in vernacular techniques are disappearing, it is pressing to find a path to keep these traditional buildings and by doing so keep the identity of the places also.

Although vernacular limestone houses are the focus of this dissertation there are other limestone constructions of interest in the village. Since limestone was abundant in the region it was used not only for building housing but also fence walls, threshing floors, barns, windmills and even small water tanks amongst others. Limestone construction is very important to local identity and some well-intended conservation of these structures as already taken place. Therefore, creating an architectural matrix, and evaluating their proximity to it, can help future conservation interventions keep their vernacular identity while breathing new life into them.

1.2 Main goals

The goal of this dissertation is to evaluate the traditional limestone buildings of Serra de Santo António, considering buildings as case studies. To do that, a model with specific descriptive options will be created in Microsoft Excel®.

This model will allow the description of the exterior elements of each house, in order to find their characteristics, and create an architectural matrix.

The same exterior elements will also be scored according to their state of conservation, allowing for an evaluation of the state of buildings conservation of each one of the 24 case studies. This sample is considered big enough to allow to achieve relevant results, to get an idea of how the state of buildings conservation is, and to find out if the original architectural features were lost, or if the vernacular identity of the building is still there. This will be done by a score system based on the previously defined architectural matrix, and on a visual inspection (in the case of the state of buildings conservation scores), allowing the evaluation of the state of buildings conservation and how close their appearance remains faithful to the original architectural matrix.

1.3 Methodological approach

The methodological approach is comprised of the following four main steps:

1st - The first step was bibliographic research in order to achieve the state of the art. This was done by researching information (publications and pictures) referred to vernacular limestone buildings in general.

2nd - The second step was the creation of the vernacular limestone buildings assessment model using Microsoft Excel®. It was based on creating diagnosis sheets and score tables, to create an architectural matrix of vernacular limestone buildings.

3rd - The third step was the application of the assessment model to the 24 vernacular limestone buildings of Serra de Santo António, using the diagnosis sheets, in order to evaluate the state of each building conservation, and comparing their current architecture to the previously created architectural matrix. It was based on in situ inspection of the 24 existent constructions, mapping parts of this village.

4th - The fourth and final step was analyzing the results of the software application to the 24 buildings, regarding a set of information (result tables, average values…etc.), in order to record the knowledge referring to this case.

1.4 Structure of the dissertation

This dissertation has the following three main parts:

Chapter 2 considers vernacular stone masonry buildings, not only in the village at study, but also Portugal (subchapter 2.2), and the world (subchapter 2.1). Showing that these types of constructions are very prevalent, and that more attention should be dedicated to them. Subchapter 2.3 mentions the historical background of the village, and some outlier buildings that were not part of the sample but are still part of the local identity.

Chapter 3 focuses exclusively on the case study buildings and shows their mapping (subchapter 3.1) and characterizes its general features (subchapter 3.1), collecting data through visual in situ inspection, to later create the architectural matrix.

Chapter 4 is split in two main subparts, the first one (subchapter 4.1) concentrates on how vernacular limestone buildings assessment model in Microsoft Excel®, was created, from

the creation of the diagnosis sheets (subchapter 4.1.1), to defining the architectural matrix (subchapter 4.1.2), and creating the score tables (subchapter 4.1.3).

The second part (subchapter 4.2) focuses on the application of the model to 24 buildings in Serra de Santo António, and on the results obtained, from calculating proximity to the architectural matrix (subchapter 4.2.1) and calculating the state of buildings conservation score (subchapter 4.2.2), to analyzing the results (subchapter 4.2.3).

Chapter 2 – Vernacular stone masonry buildings

Stone Masonry is one the most commonly found materials in the older constructions, Roman, Arab, Visigoths and more. They used stone when building, and it is no surprise they did, since stone masonry has some advantages: the used materials were easily found in nature; the stone buildings were sturdier and outlasted wooden ones; the usually thick walls provided higher thermal inertia. So, naturally, various stone buildings can be found all over the world, and even though they have some similarities, it is possible to find differences or particular aspects as well.

2. 1 Worldwide main features

Since the dawn of human civilization, local communities have learned to quarry, process, and transport stone. Stone's use became widespread in several historical periods; therefore, ancient dry-stone structures remain dispersed all over the world, "Prehistoric dwellings [...] extend from the Shetland Islands to the eastern Mediterranean. Drystone terraces and canals built to aid agriculture around the world are equally ancient and widespread." (Dry Stone Conservancy., 2020).

Stone was not only used to build houses, but also symbolic and religious buildings, like the dolmens of the prehistoric peoples. In Europe this can be seen specially in medieval times when "[...] stone was the basic material for the construction of houses and castles. [...] but is also used for the construction of buildings of higher value, such as churches." HARRIES, K. A., & SHARMA, B., (2019: 405) .

Stone became a successful building technique for many reasons including the need of minimal tools to erect structures, the material's durability, and the fact that if damaged, these structures were easily repaired, despite their fire, water, and insect resistance, and do not deplete natural resources. Stone structures also, arguably, complement and enhance the landscape, while using locally sourced material, "Vernacular architecture [...] determine the character and uniqueness of each site, and technical and stylistic convergences between different territories may occur in instances of availability of similar materials." HARRIEs, K. A., & SHARMA, B., (2019: 412).

With such dispersion, it is not surprising that in some of these locations, the buildings found are made of limestone, "In architecture, carbonate rocks [...] have been widely used as building materials both as dressed/cut stones, thin slabs for roofing [...] limestones

have been widely used in the constructions of north central Italy [...]". DIPASQUALE, L., ROVERO, L., & FRATINI, F. (2020: 307)

The UK is also home to "[...] many old limestone buildings in cities such as Oxford, Bath and London" (SMITH, B. J., 2010: 1) and so is Malta where "[...] Limestone [...] was the building material of choice for millennia, starting from the first structures built in the Maltese Islands by their prehistoric inhabitants." (SMITH, B. J., 2010: 23).

Limestone construction can also be found in Bloomington (USA) where "More than 100 buildings on the campus of Indiana University are of limestone" and "as are nearly all government buildings and countless homes and commercial structures" (PATTON, J. B., & CARR, D. D., 1982).

But stone masonry is not a technology, exclusively, of the past, it can help us step into the future, today, stone materials can gain an advantageous position compared to other building materials, demonstrating their competitive qualities, in which reduced environmental impact is a key strength, "The use of stone responded to a test of its feasibility with respect to very high requirements in terms of energy, environmental impact, and cost [...]" (DIPASQUALE, L., ROVERO, L., & FRATINI, F. 2020: 326). Many studies comparing natural stone with other building materials have demonstrated that total energy inputs consumed throughout a stone construction life cycle and the carbon footprints of the entire process are lower than those of other building materials, such as concrete, bricks, and concrete block.

Construction affects the environment and resources. The emerging world energy and environment challenges demand a substantial revolution of building design philosophies, strategies, technologies, and construction methods. Vernacular architectures, [...] are valuable in promoting climate-specific passive building technologies to modern buildings." ZHAI, Z. J., & PREVITALI, J. M. (2010: 357)

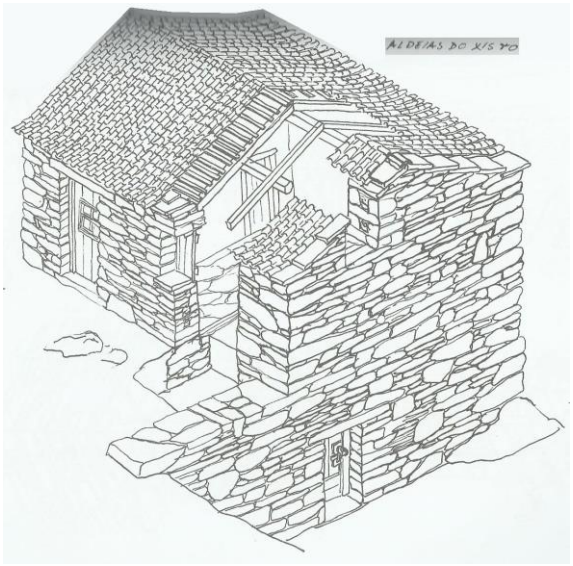
There are other types of stone masonry, mostly mixed with other materials used as reinforcements, but they are of little interest to this dissertation.

2. 2 Some particular aspects in Portugal

In 2011 the national statistics (INE, I. P., 2012) revealed that existed in Portugal about 700.000 empty houses, representing 12,55% of all houses. It is increasingly important in an over constructed Portugal, to maintain the existing buildings instead of building new housing. To avoid new unnecessary construction while keeping the construction sector afloat and satisfying the modern living standards, rehabilitation/conservation of the existing buildings became a path for the future (GOMES, J. F. M. M., 2011: 3). Also, in an increasingly standardized world, is important to preserve the identity of the places, and preservation of the vernacular architecture is a way of doing so.

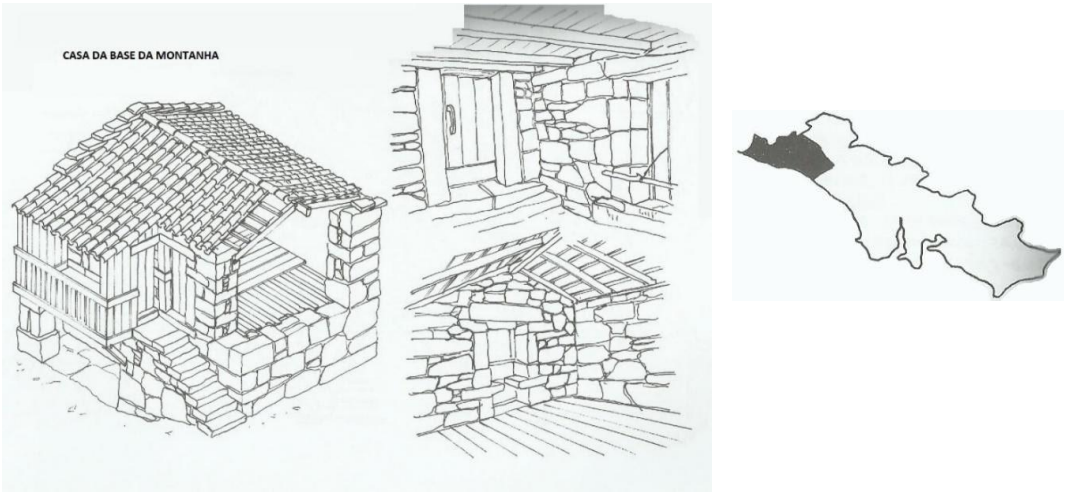
According to the same reference, in 2001 there were about 3.160.043 buildings in Portugal, and 11,15% of those are adobe, rammed soil or stone masonry (INE, I. P., 2002). Masonry can be found all over Portugal, Aldeias do Xisto are one of the best well-known examples, their constructive typology is shown in picture 1.

In this section will be presented some examples of these buildings coming from the literature (Mascarenhas, J., 2015).



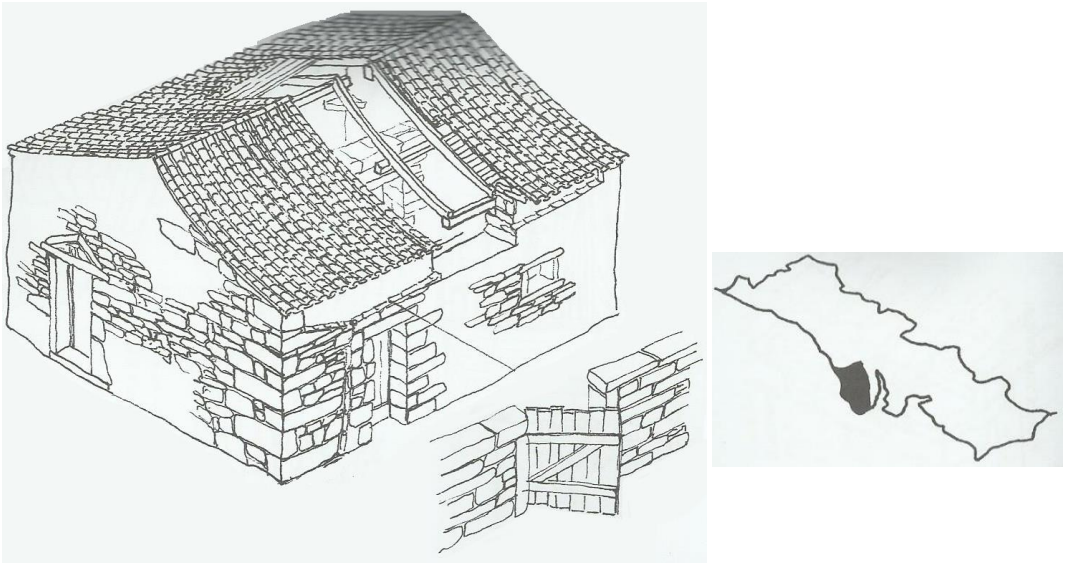
Picture 1 – Building at Aldeias de Xisto in Portugal(in Mascarenhas, J., 2015: 119)

Aldeias de Xisto is not the only example of stone buildings in Portugal. They can also be found from the north of the country (Picture 2), located in Alto Minho the northernmost region of the country.



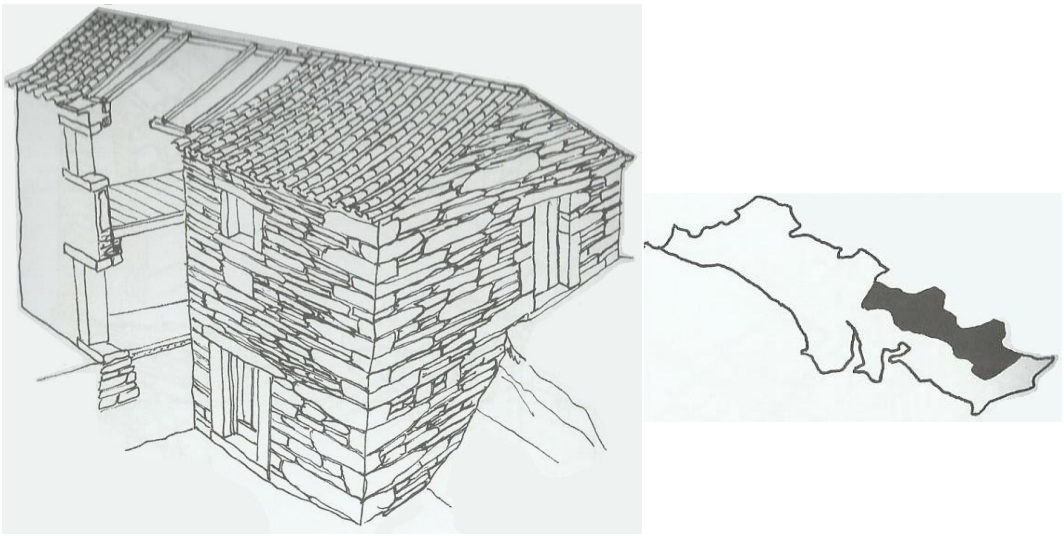
Picture 2 - Mountain base house in Alto Minho, Portugal (in Mascarenhas, J.,2015: 85)

As well as in Estremadura region, in the central part of Portugal (picture 3) there are these kinds of buildings.



Picture 3 - House in Estremadura, Portugal (in Mascarenhas, J., 2015: 137)

And all the way to Alentejo Interior, to the interior and south of Portugal, is possible to find the presence of these buildings (picture 4).



Picture 4 - House in Alentejo Interior , Portugal – (Mascarenhas, J., 2015: 176)

These previously referred characteristics match some of the ones found in the case study village of Serra de Santo António. Like the two slopes roof, the stairs (Picture 2) are also similar to ones later found (Picture 14), the case of one house (Picture 3) is the one that is geographically closer to the study area. And so, it is the one with more similarities from the stone fence wall, the doorsills, windowsills, and the corners of the walls. Another construction (Picture 4) also has doorsills, windowsills, and corners of the walls similar to the ones found in the village of Serra de Santo António.

Many more examples of stone houses can be found all over Portugal. In fact, the amount of stone structures still existing are a testament to stones durability, limestone being no exception. The literature, considers them "…strong and durable", making these structures good candidates to rehabilitation (SIEGESMUND, S., & SNETHLAGE, R., 2011)

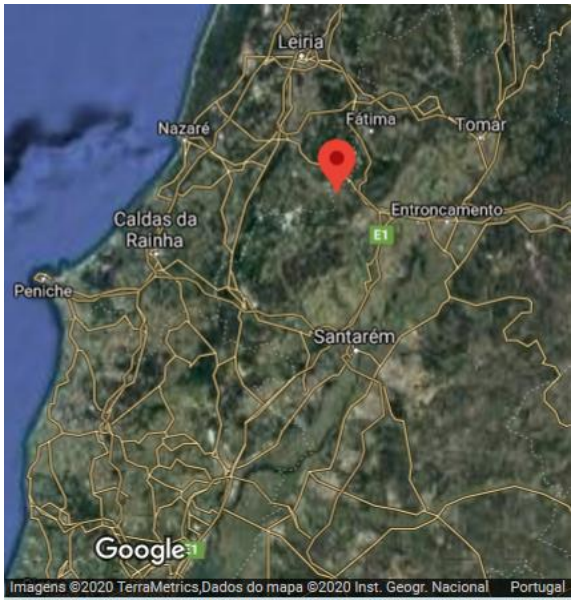
Although these types of constructions can still be found all over, they are slowly disappearing since some became ruins and new buildings do not use this construction technique, so the time to star rehabilitating them is now. The literature shows that protecting these types of constructions is vital, "The vulnerability of vernacular traditions in the face of forceful processes of modernization and globalization makes it desirable to document, study and preserve historical and traditional buildings before they may be lost or become irreversibly changed." (ASQUITH, L., & VELLINGA, M.,2006: 83)

2.3 Case study main features: Serra de Santo António

2.3.1 Location and historical background

Serra de Santo António is a small village belonging to a parish with the same name that stretches over 14km, located in the central part of Portugal (Pictures 5 and 6), in the Municipality of Alcanena. This region is characterized by an abundance of limestone, which lead the people to use it in the wall fences, and in their houses. As both a way to use the easily available material and to clear the soil for agriculture and cattle raising.

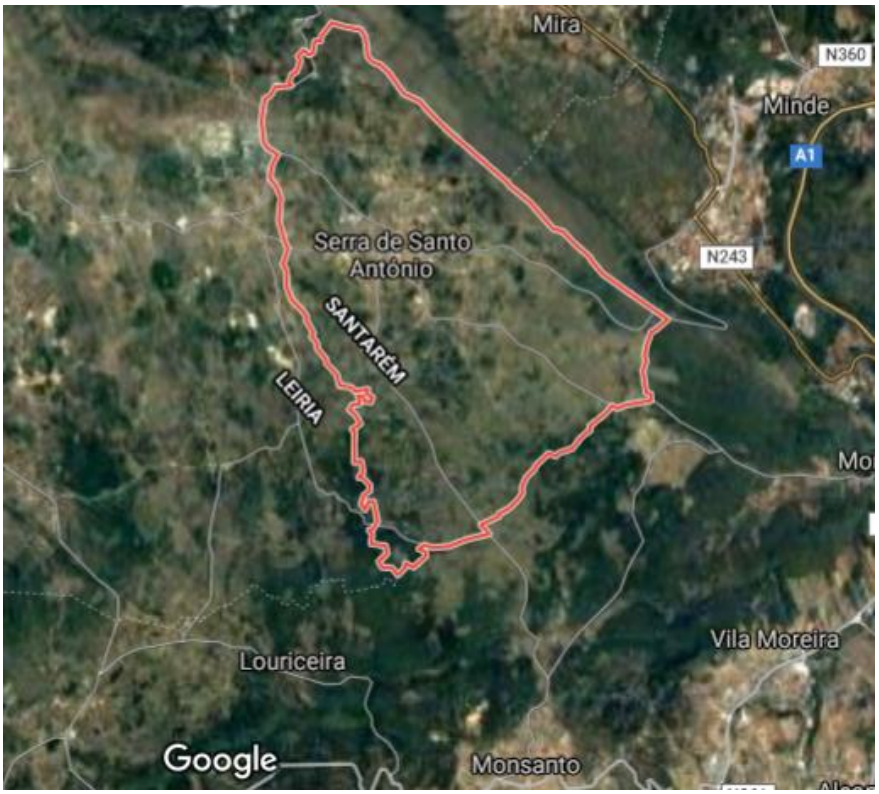
Picture 5 - Location of Serra de Santo António in a National view (Google 2020).



Picture 6 - Location of Serra de Santo António in a closer view (Google 2020).

Standing on elevated ground known as Planalto de Santo António, according to Câmara municipal de Alcanena, the oldest reference to the village dates to 1560, but the name was not yet the modern one. Previously known as Penedos Altos it was firstly referred to as Santo António dos Casaes da Serra, and later gained the current name in the 18th century, where it was mentioned that the village was made up of 73 houses, were 295 people lived.

In the beginning of the 20th century the village had 600 inhabitants, and 150 houses. In April 1918, the civil parish of Serra de Santo António (Picture 7) was created by detachment from the parish of Minde. According to the last national statistics, the 2011 census the village had at the time 725 inhabitants.



Picture 7 - Location of Serra de Santo António in a closer view (Google 2020).

2.3.2 The outlier buildings

This dissertation focused on a sample of 24 vernacular limestone houses, but there are much more limestone structures in the village of Serra de Santo António. And while only houses will be studied, these other constructions are worth being mentioned.

Even though there are underground water deposits. The closest surface water course is Olhos de Água of Alviela river near to Louriceira about 12 km distance from Serra de Santo António, which naturally led to the construction of wells (Pictures 8 and 9). They

were very useful when these vernacular buildings were constructed, since there was no water distribution at the time.

Pictures 8 - 9 – Pictures of limestone wells in Serra de Santo António.

Since agriculture was one of the main occupations of local community, and the altitude of about 360m provides windy days, it should come as no surprise that windmills exist on the village (Pictures 10 and 11). To use the windmills grain was needed, in order, to dry, thresh and sieve the grain threshing floors were used and some can still be found (Picture 12).

Pictures 10 - 11 – Limestone windmills in Serra de Santo António.

Picture 12 – Limestone threshing floor (Google).

Another main occupation was cattle raising, which gave way to casinas buildings that were used to shelter shepherds from harsh weather (picture 13).

Picture 13 – Casina made of limestone in Serra de Santo António.

While not very common, it is possible to find some buildings with limestone stairs (picture 14).

Picture 14 – Limestone stairs on the outside of building in Serra de Santo António

Besides houses there are also isolated barns/granaries (picture 15), it is possible to differentiate from houses due to the lack of windows.

Picture 15 – Isolated barn/granary in Serra de Santo António.

While most constructions have limestone walls with a structural function, there is at least one very curious limestone house, known as house Maria do Bento. It was disassembled, the interior walls were built using modern methods and them the exterior walls were reassembled, so the exterior limestone walls are not structural in this case (pictures 16, 17 and 18).

Picture 16 – House Maria do Bento before the restorations in Serra de Santo António

Picture 17 - House Maria do Bento during the restorations in Serra de Santo António

Picture 18 – House Maria do Bento after the restorations in Serra de Santo António

Finally, the most widespread of limestone structures are fence walls (picture 19), which can be found even in plots of land without any other structures. They were important in shaping the landscape and have become a trademark of the Nature Park of das Serras de Aire e Candeeiros (PNSAC).

Picture 2 – Limestone fence wall – Serra de Santo António

Stone structures are advantageous, long lasting, ecological friendly and can be found all over the World, including Portugal, and Serra de Santo António.

Although, limestone started being used in construction in this area, out of convenience, the abundance, and variety of limestone structures all around the village, decades after modern construction became available and reachable, emphasize how essential this resource was to everyday life, and how crucial it is to its identity.

Chapter 3 – Vernacular stone masonry buildings in Serra de Santo António

Serra de Santo António is a small village of Alcanena, characterized by limestone pavement (Lapiás) and caves. Since limestone is abundant, houses, fence-walls, windmills and barns, made of it are easy to find all over the village, this means that mapping all the limestone buildings in it, would be a colossal task. Instead, this dissertation focused on a sample of 24 houses.

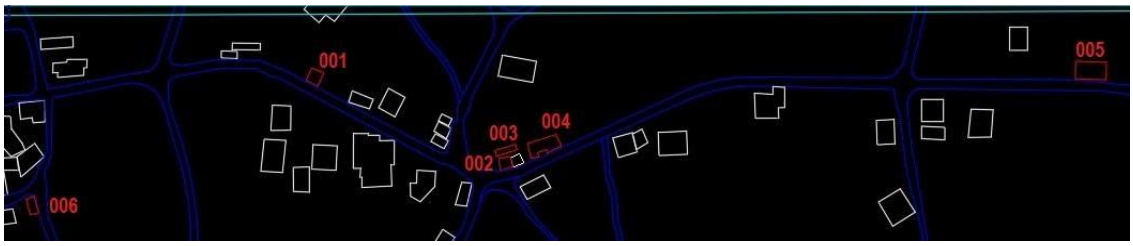
3. 1 Mapping the buildings

Most of the 24 referred buildings are located at Rua António Galveias Dias (map 1, picture 22), Rua Joaquim Maria Batista (map 2, picture 23) and in the Rua Luís Vaz de Camões proximity (map 3, picture 24). So, to make the detailed mapping of the houses, they were split in to three maps, located at the areas marked in the following pictures (pictures 20 and 21).

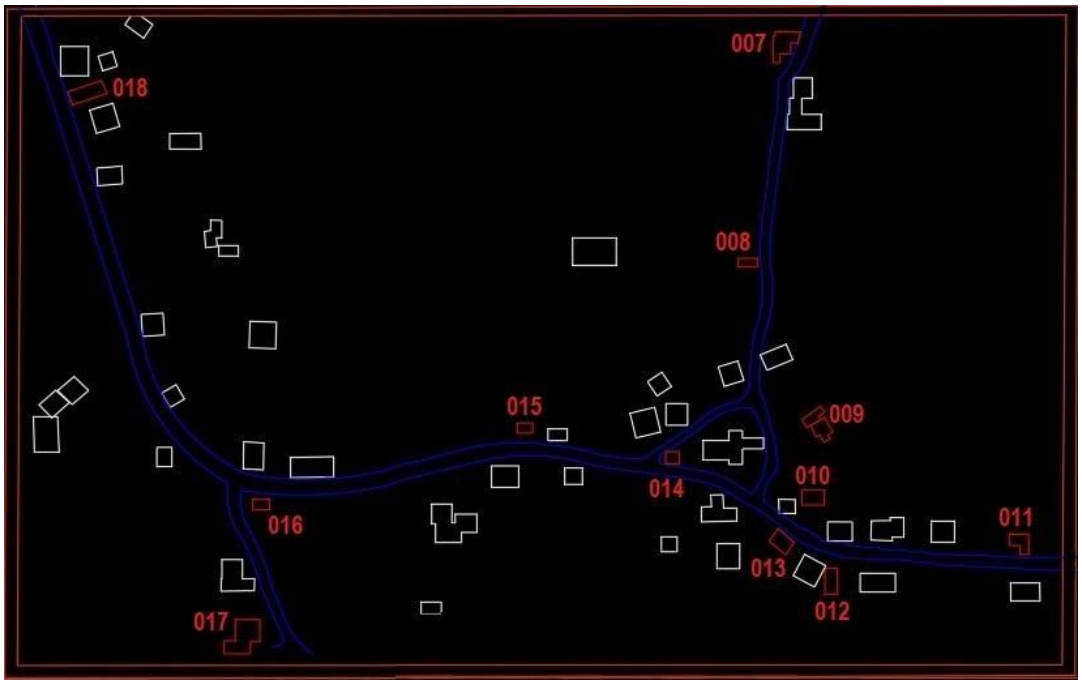
Picture 20 - Location of the case study buildings (based on Google maps)

Picture 21 - Detailed location of the case study buildings (Based on google maps)

After dividing the sample in three sets, each part got a detailed map with the sample buildings numbered and shown in red.



Picture 22 - Map1 - Case study buildings numbers 001 to 006.



Picture 23 - Map 2 - Case study buildings numbers 007 to 018.

Picture 24 - Map 3 - Case study buildings numbers 019 to 024.

Lastly, each building was analyzed by itself as displayed in the next point 3.2.

3.2 Features of the case study buildings

The features of each building in the sample are displayed in three tables. The two main ones list the general characteristics and the general features as well as the building ID, and the third exhibits the possible Deductions due to architectural changes.

The first table is comprised of two main aspects the general features and building ID. The building ID section includes the code number, street, and village. The general features include the type of use, number of floors, compared building height, annex, adjacent free space, and added area. If the building has added area the next three options should be filled describing if the added area is to the side, or an added floor, and finally if it blends in, these options are then used to calculate the Deductions due to architectural changes (third table). For a building without added area the deduction is zero. For a building which Added area blends in, the total deductions on the architectural matrix score will be from -0,02 (to the side or added floor) to -0,04(to the side and added floor). And for a building which Added area does not blend in, the total deductions on the architectural matrix score will be from -0,32 (to the side or added floor) to -0,34(to the side and added floor).

The second table is organized in two main aspects the general characteristics and their description and it is comprised of five categories, exterior walls**,** roof, access, spans and equipment. The exterior walls are described by the Masonry (type), Masonry (coating) and Masonry (Finishing). The roof is characterized by the Roof (shape), Roof (cover), Chimney and Drainage of rainwater. Access relates to if the building has stairs or not. The Spans are characterized by the Window frames (material), Windowpanes, Windowsills, Door(s) (material) and Door(s) sill(s). Equipment is described by the Fence, Threshing-floor, Porch (support), Porch (guard-rail), Water tank/well and other details.

The possible *Descriptors* for the categories were chosen based on a visual inspection and are the following:

- for **type of use**: housing; commerce; windmill or other.
- for **number of floor**s: 1;2;3; or more than 3.
- for **masonry (Type)**: Limestone Masonry; Other stone Masonry; Brick Masonry; Other or Not identifiable.
- for **masonry (coating):** Cement mortar: Lime mortar; Without Coating; Other; Not identifiable or Nonexistent.
- for **Masonry (Finishing**): Paint; Lime paint; Decorative limestone; Ceramic Tile; Other: Not identifiable or Nonexistent.
- for **Roof (Shape):** Not identifiable; One slope (Shed); Two slopes (Gable); Three slopes; Four slopes (Hip); More than four slopes or Nonexistent.

● for **Roof (Cover):** Nonexistent; Mission roof tile; Marseille tile; Portuguese Tile; Flat cover or Other.
● for **Chimney:** Not identifiable; Nonexistent; Metal; Cement mortar and decorative Limestone; Masonry with cement mortar**;** Brick or Other
● for **Drainage of rainwater:** Nonexistent; Aluminum**;** PVC**;** Iron**;** Zinc or Other.
● for **Stairs:** Nonexistent; Stone masonry**;** Stone masonry with mortar**;** Brick masonry or Other.
● for **Window frames:** Nonexistent; Wood; Brown Aluminum; Aluminum or Iron.
● for **Windowpanes:** Nonexistent**;** Transparent glass**;** Colored glass or Other;
● for **Windowsills:** Not identifiable; Brushed limestone; Crafted limestone; Concrete; Wood; Other or Nonexistent.
● for **Doors (Material):** Nonexistent; Wood; Brown Aluminum; Aluminum or Iron.
● for **Door(s) Sill(s):** Not identifiable; Brushed limestone; Nonexistent; Wood; Concrete; Crafted limestone or Other.
● for **Fence:** Nonexistent; Not identifiable; Limestone wall; Limestone wall with mortar; Brick wall; Brick with decorative limestone or Other.
● for **Threshing-floor:** Nonexistent; Not identifiable; Limestone with/without mortar; Brick masonry/cement mortal; Cement mortar or Other.
● for **Water tank/well:** Nonexistent; Not identifiable; Limestone with/without mortar; Concrete with decorative limestone; Cement mortar or Other.
● for **Porch (Support):** Nonexistent; Not identifiable; Limestone pillars; Brick; Wood; Concrete or Other.
● for **Porch (Guard-rail):** Nonexistent; Aluminum; Iron; Ornate Iron; Wood; Limestone Wall or Other;
● for **Other details:** Nonexistent; Not identifiable; Limestone masonry or Brick masonry.
● for **Annex:** Garage; Barn/Granary; Other or Unidentifiable.
● for **Compared building height:** Same height as adjoining buildings; Smaller than adjoining buildings; Height in between adjoining buildings; Higher than adjoining buildings; Different gable height or Isolated building.

Building 1

Building 1 is located at Rua António Galveias Dias (picture 25), it is an isolated one-story building, with no annexes, the limestone of the walls is showing (pictures 26, 27 and 28), it has no added area and adjacent free space. Some of its general features are a three slopes roof, a metal fence, wood doors and windows, the rest are listed in tables 1, 2 and 3.

Picture 25 - Detail of map 1

Picture 26-27 – Pictures of building 1 – Serra de Santo António

Picture 28 - Picture of building 1 in 2009 (Google)

Building ID	
Code number	001
Street	Rua António Galveias Dias
Village	Serra de Santo António
General Features	
Type of use	Housing
Number of floors	1
Compared building height	Isolated building
Annex	No
Added area:	No
To the side?	
Added floor?	
Blends in?	
Adjacent free space	Yes

Deductions due to architectural changes	
Added area	0
To the side?	
Added floor?	
Blends in?	
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Three slopes
Roof (Cover)	Marseille tile
Chimney	Metal/Brick
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Wood
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) Material)	Wood
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Other
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Cement mortar
Other details	Nonexistent

Tables 1, 2 and 3 - Characteristics of building 1

Building 2

Building 2 is located at Rua António Galveias Dias (picture 29). It is an isolated one-story building, with a barn/granary annex, the limestone of the walls is covered by mortar (pictures 30 and 31), it has no added area and no adjacent free space. Some of its general features are a two slopes roof, Marseille roof tile, doorsills and windowsills made with brushed limestone, the rest are listed in tables 4, 5 and 6.

Picture 29 - Detail of map 1

Picture 30 - Picture of building 2 – Serra de Santo António

Picture 31 - Picture of building 2 in 2009 (Google)

Building ID		
Code number	002	
Street	Rua António Galveias Dias	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	Yes	Barn/ Granary
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	No	

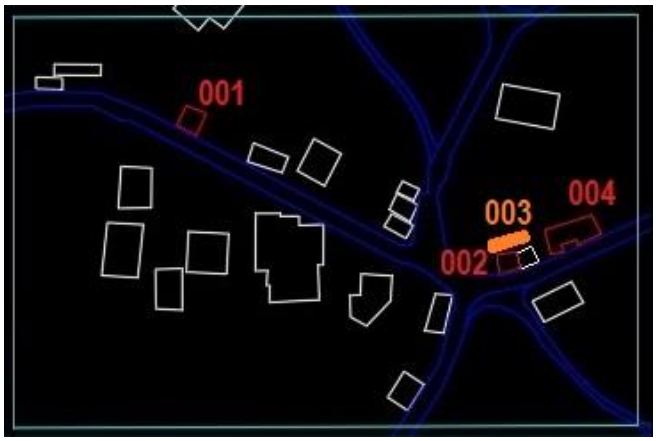
Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Cement mortar/ Lime mortar
Masonry (Finishing)	Lime paint
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Marseille tile
Chimney	Nonexistent
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Nonexistent
Windowpanes	Nonexistent
Windowsills	Brushed limestone
Door(s) (Material)	Nonexistent
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Nonexistent
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 4;5 and 6 - Characteristics of building 2

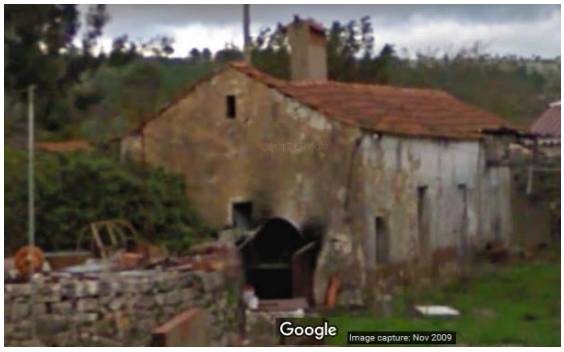
Building 3

Building 3, is located at Rua António Galveias Dias (picture 32). It is an isolated one-story building, with no annexes, the limestone of the walls is covered (pictures 33 and 34), it has no added area and adjacent free space. Some of its general features include a brickwall fence, and a limestone water tank or well, the rest are listed in tables 7; 8 and 9.



Picture 32 - Detail of map 1

Picture 3 - Picture of building 3 – Serra de Santo António



Picture 4 - Picture of building 3 in 2009 (Google)

Building ID		
Code number	003	
Street	Rua António Galveias Dias	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	No	
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

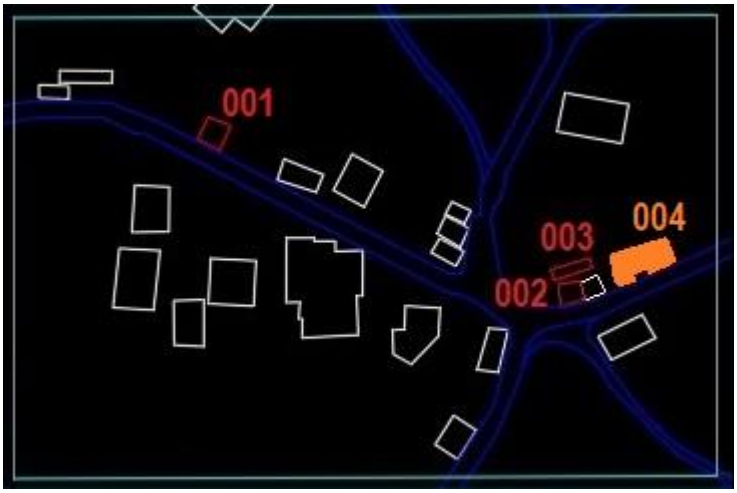
Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Lime mortar
Masonry (Finishing)	Lime paint
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Marseille tile
Chimney	Masonry with cement mortar
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Wood
Windowpanes	Nonexistent
Windowsills	Other
Door(s) (Material)	Wood
Door(s) Sill(s)	Other
Equipment	
Fence	Brick wall
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Limestone with mortar
Other details	Nonexistent

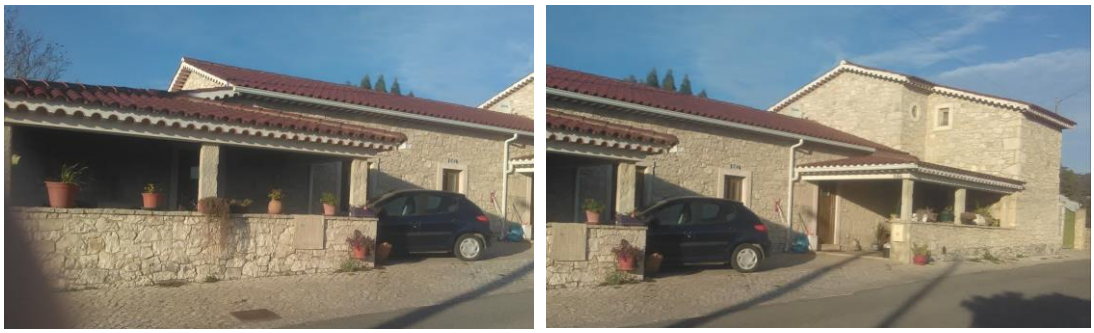
Tables 7;8 and 9 - Characteristics of building 3

Building 4

Building 4, is located at Rua António Galveias Dias (picture 35). It is an isolated two-story building, with no annexes, the limestone of the walls is showing (pictures 36, 37 and 38), it has no added area and adjacent free space. Some of its general features are portuguese roof tile, doorsills and windowsills made with brushed limestone, and wood doors, others are listed in tables 10; 11 and 12.



Picture 5 - Detail of map 1



Picture 6;37 - Pictures of building 4– Serra de Santo António

Picture 38 - Pictures of building 4 in 2009 (Google)

Building ID		
Code number	004	
Street	Rua António Galveias Dias	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	2	
Compared building height	Isolated building	
Annex	No	
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

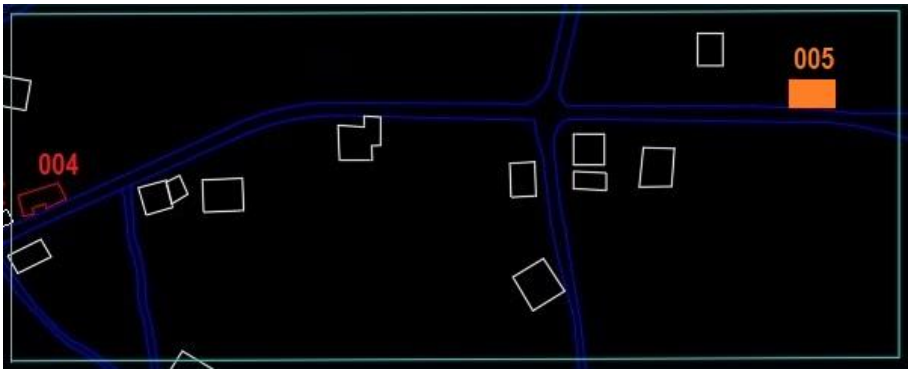
Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	More than four slopes
Roof (Cover)	Portuguese Tile
Chimney	Nonexistent
Drainage of rainwater	Aluminum
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Wood
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Wood
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall with mortar
Threshing-floor	Nonexistent
Porch (Support)	Limestone pillars
Porch (Guard-rail)	Limestone wall with mortar
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 10;11 and 12 - Characteristics of building 4

Building 5

Building 5, is located at Rua António Galveias Dias (picture 39), it is an isolated one-story building with no annex, the limestone of the walls is showing (pictures 40 and 41), it has no added area and adjacent free space. Some of its general features include a brick chimney, doors and windows made of wood and limestone fence wall, the remaining ones are listed in tables 13; 14 and 15.



Picture 39 - Detail of map 1

Picture 40 - Pictures of building 5 (google)

Picture 41 - Pictures of building 5 in 2009 (Google)

Building ID		
Code number	005	
Street	Rua António Galveias Dias	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	No	
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

Deductions due to architectural changes	
Added area	-0,2
To the side?	-0,02
Added floor?	0
Blends in?	0,2
Total:	-0,02

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Marseille tile
Chimney	Brick
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Wood
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Wood
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 13;14 and 15 - Characteristics of building 5

Building 6

Building 6, is located at Rua Padre Joaquim Dias (picture 42), it is an isolated one-story building with no annex, the limestone of the walls is showing (pictures 43, 44 and 45), it has adjacent free space and no added area. Some of its general features include a two slopes roof, mission roof tile and a chicken coop, the rest are listed in tables 16; 17 and 18.

Picture 42 - Detail of map 1

Pictures 43;44;45 - Pictures of building 6 – Serra de Santo António

Building ID	
Code number	006
Street	Rua Padre Joaquim
Village	Serra de Santo António
General Features	
Type of use	Housing
Number of floors	1
Compared building height	Isolated building
Annex	No
Added area:	No
	To the side?
	Added floor?
	Blends in?
Adjacent free space	Yes

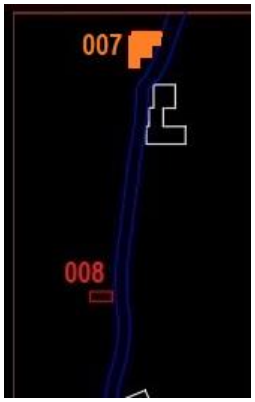
Deductions due to architectural changes	
Added area	0
To the side?	
Added floor?	
Blends in?	
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Mission roof tile
Chimney	Masonry with cement mortar
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Iron
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Nonexistent
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall/ Brick wall
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Limestone with mortar
Other details	Chicken coop

Tables 16;17 and 18 - Characteristics of building 6

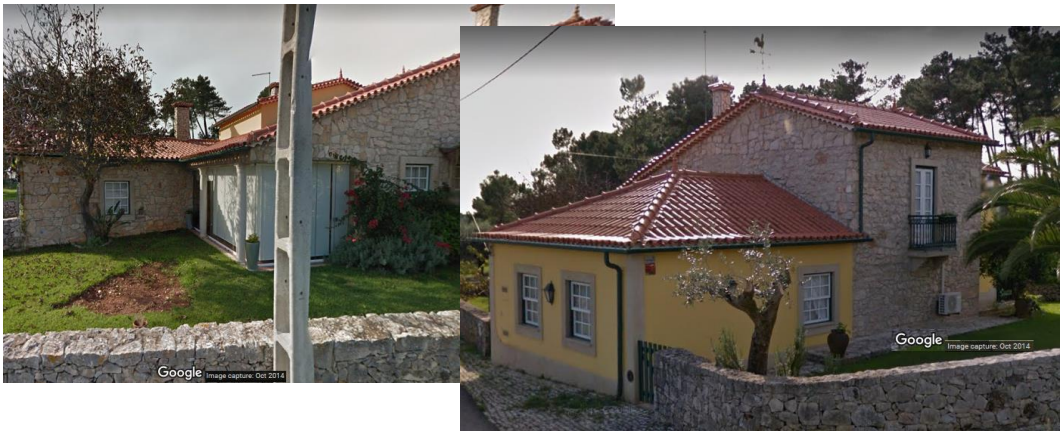
Building 7

Building 7, is located at Rua Várzea (picture 46), it is an isolated two-story building with no annex, the limestone of the walls is showing (pictures 47,48 and 49), it has added area and adjacent free space. Some of its general features include added area to the side (that led to deductions due to architectural changes), and limestone fence wall, the remaining ones are listed in tables 19; 20 and 21.



Picture 46 - Detail of map 2

Picture 47 - Picture of building 7 – Serra de Santo António



Picture 48;49 - Pictures of building 7 in 2014 (Google)

Building ID		
Code number	007	
Street	Rua Várzea	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	2	
Compared building height	Isolated building	
Annex	Yes	Garage
Added area:	Yes	
	To the side?	Yes
	Added floor?	No
	Blends in?	No
Adjacent free space	Yes	

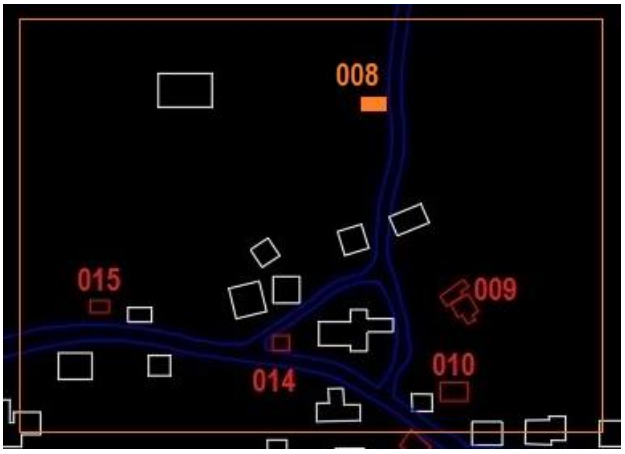
Deductions due to architectural changes	
Added area	-0,2
To the side?	-0,02
Added floor?	0
Blends in?	-0,1
Total:	-0,32

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone and Brick Masonry
Masonry (coating)	Cement mortar/Without Coating
Masonry (Finishing)	Paint/Decorative limestone/ Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)/Three slopes
Roof (Cover)	Portuguese Tile
Chimney	Brick
Drainage of rainwater	Aluminum
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Wood
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Wood
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall
Threshing-floor	Nonexistent
Porch (Support)	Cement pilars
Porch (Guard-rail)	Other (Glass)
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 19;20 and 21 - Characteristics of building 7

Building 8

Building 8, is located at Rua Várzea (picture 50), it is an isolated one-story building, with one annex, the limestone of the walls is partially showing (pictures 51 and 52), it has no added area and adjacent free space. Some of its general features are a two slopes roof, a limestone wall fence, and a water tank or well, the rest are listed in tables 22; 23 and 24.



Picture 50 - Detail of map 2

Picture 51 - Picture of building 8 in 2014 (Google)

Building ID		
Code number	008	
Street	Rua Várzea	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	Yes	Unidentifiable
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

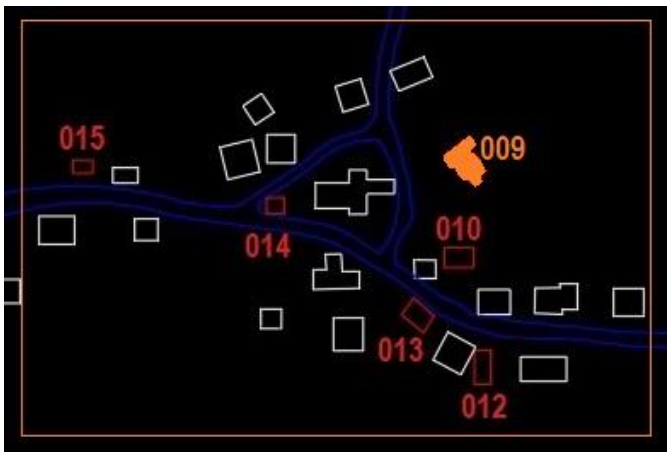
General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Without Coating/Lime mortar
Masonry (Finishing)	Paint/Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Marseille tile
Chimney	Masonry with cement mortar
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Iron
Windowpanes	Nonexistent
Windowsills	Brushed limestone
Door(s) (Material)	Iron
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Limestone with mortar
Other details	Nonexistent

Deductions due to architectural changes	
Added area	-0,2
To the side?	-0,02
Added floor?	-0,02
Blends in?	0,2
Total:	-0,04

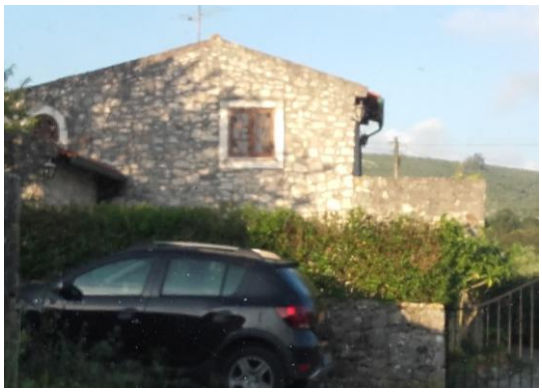
Tables 22;23 and 24 - Characteristics of building 8

Building 9

Building 9, is located at Rua Várzea (picture 53), it is an isolated two-story building with annexes, the limestone of the walls is showing (pictures 54 and 55), it has added area and adjacent free space. Some of its general features include added area to the side and an extra floor (that led to deductions due to architectural changes), and limestone fence wall, the remaining ones are listed in tables 25; 26 and 27.



Picture 52 - Detail of map 2



Picture 53 - Picture of building 9 – Serra de Santo António

Picture 54- Picture of building 7 in 2014 (Google)

Building ID		
Code number	009	
Street	Rua Várzea	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	2	
Compared building height	Isolated building	
Annex	Yes	garage
Added area:	Yes	
	To the side?	Yes
	Added floor?	Yes
	Blends in?	Yes
Adjacent free space	Yes	

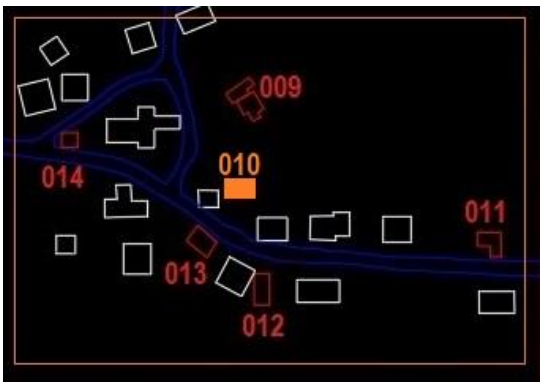
Deductions due to architectural changes	
Added area	-0,2
To the side?	-0,02
Added floor?	-0,02
Blends in?	0,2
Total:	-0,04

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Portuguese Tile
Chimney	Masonry with cement mortar
Drainage of rainwater	Aluminum
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Wood
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Wood
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Concrete with decorative limestone
Other details	Nonexistent

Tables 25;26 and 27 - Characteristics of building 9

Building 10

Building 10, is located at Rua Joaquim Maria Batista (picture 56), it is a one-story building with annexes, the limestone of the walls is partially showing (pictures 57, 58 and 59), it has added area and no adjacent free space. Some of its general features include a two slope roof, and Marseille roof tile, the rest are listed in tables 28; 29 and 30.



Picture 55 - Detail of map 2

Picture 56-58 – Picture of building 10 – Serra de Santo António

Picture 59 - Picture of building in 2009 (Google)

Building ID		
Code number	010	
Street	Rua Joaquim Maria Batista	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	2	
Compared building height	Height in between adjoining buildings	
Annex	Yes	Unidentifiable
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	No	

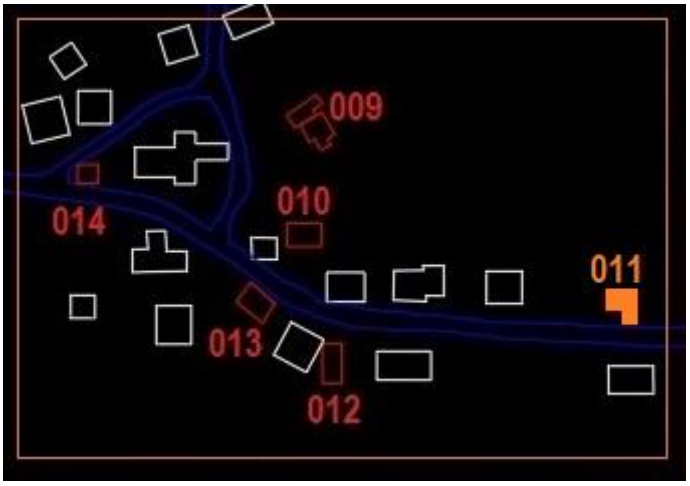
Deductions due to architectural changes	
Added area	-0,2
To the side?	0
Added floor?	-0,02
Blends in?	0,2
Total:	-0,02

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent/Lime mortar
Masonry (Finishing)	Nonexistent/Lime paint
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Marseille tile
Chimney	Masonry with cement mortar
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Wood
Windowpanes	Nonexistent
Windowsills	Brushed limestone
Door(s) (Material)	Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Nonexistent
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 28;29 and 30 - Characteristics of building 10

Building 11

Building 11 is located at Rua Joaquim Maria Batista (picture 60), it is an isolated one-story building with annexes, the limestone of the walls is showing (pictures 61 and 62), it has no added area and adjacent free space. Some of its general features are a three slopes roof, Marseille roof tile, and aluminum doors, the rest are listed in tables 31; 32 and 33.



Picture 60 - Detail of map 2

Picture 61 - Picture of building 11 – Serra de Santo António

Picture 62 - Picture of building 11 in 2014 (google)

Building ID		
Code number	011	
Street	Rua Joaquim Maria Batista	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	Yes	Barn/granary
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

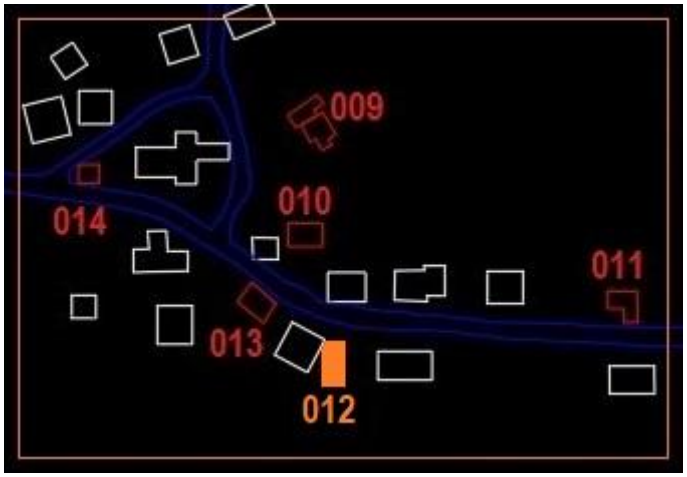
General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Three slopes
Roof (Cover)	Marseille tile
Chimney	Nonexistent
Drainage of rainwater	Aluminum
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Brick wall
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

Tables 31;32 and 33 - Characteristics of building 11

Building 12

Building 12, is located at Rua Joaquim Maria Batista (picture 63), it is an isolated one-story building with annexes, the limestone of the walls is partially showing (picture 64), it has no added area and adjacent free space. Some of its general features include a two slopes roof, and windowsills made with brushed limestone, and wood doors, the rest are listed in tables 34; 35 and 36.



Picture 63 - Detail of map 2

Picture 64 - Picture of building 12 – Serra de Santo António

Building ID		
Code number	012	
Street	Rua Joaquim Maria Batista	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	Yes	Unidentifiable
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

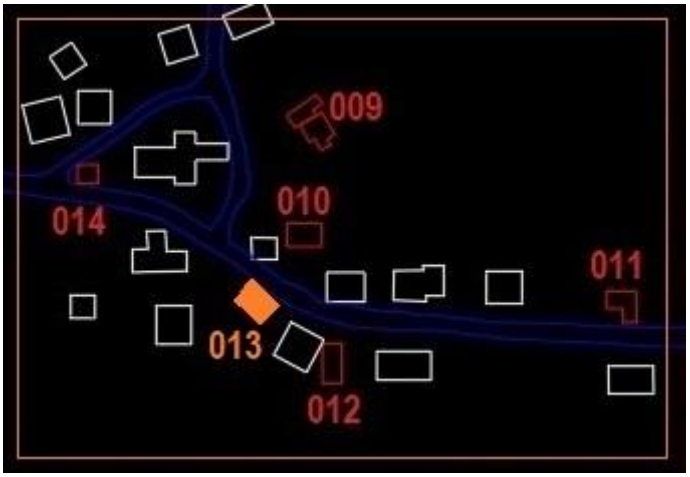
Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent/Lime mortar
Masonry (Finishing)	Nonexistent/Lime paint
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Mission roof tile
Chimney	Nonexistent
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Nonexistent
Windowpanes	Nonexistent
Windowsills	Brushed limestone
Door(s) (Material)	Nonexistent
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Nonexistent
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 34;35 and 36 - Characteristics of building 12

Building 13

Building 13 is located at Rua Joaquim Maria Batista (picture 65), it is an isolated one-story building with no annexes, the limestone of the walls is showing (pictures 66 and 67), it has adjacent free space and no added area. Some of its general features are a two slopes roof, doorsills and windowsills made with brushed limestone, others are listed in tables 37; 38 and 39.



Picture 65 - Detail of map 2

Picture 66 – Picture of building 13 – Serra de Santo António

Picture 77 – Picture of building 13 in 2014 (Google)

Building ID		
Code number	013	
Street	Rua Joaquim Maria Batista	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	No	
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

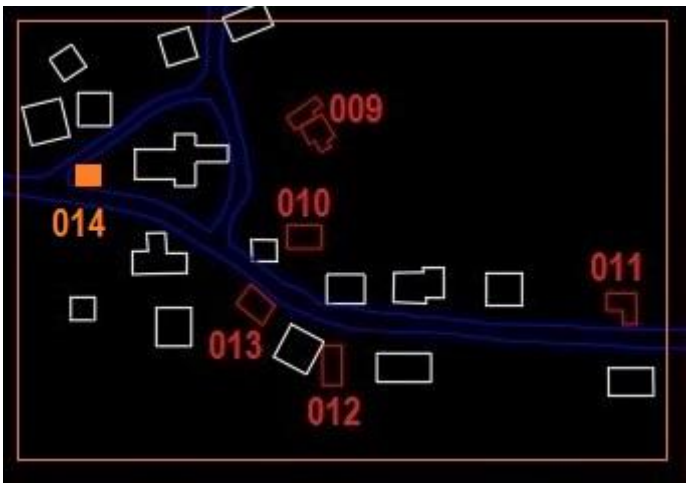
Deductions due to architectural changes		
Added area		0
To the side?		-0,02
Added floor?		-0,02
Blends in?		-0,1
Total:		0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Marseille tile
Chimney	Metal
Drainage of rainwater	Aluminum
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Nonexistent
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 37;38 and 39 - Characteristics of building 13

Building 14

Building 14, is located at Rua Joaquim Maria Batista (picture 68), it is a one-story building, with no annexes, the limestone of the walls is showing (pictures 69 and 70), it has added area and no adjacent free space. Some of its general features include a two slopes roof, portuguese roof tile, and aluminum doors, the rest are listed in tables 40; 41 and 42.



Picture 68 - Detail of map 2

Picture 69 – Picture of building 14 – Serra de Santo António

Picture 70 – Picture of building 14 in 2014 (Google)

Building ID		
Code number	014	
Street	Rua Joaquim Maria Batista	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Smaller than adjoining buildings	
Annex	Yes	Other
Added area:	Yes	
	To the side?	No
	Added floor?	Yes
	Blends in?	Yes
Adjacent free space	No	

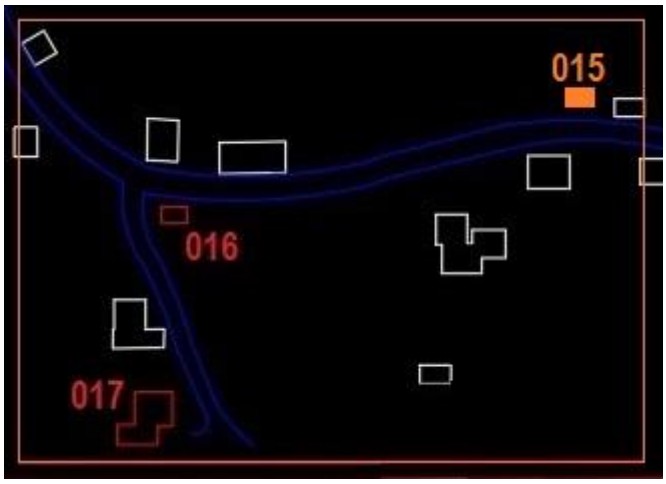
Deductions due to architectural changes	
Added area	-0,2
To the side?	0
Added floor?	-0,02
Blends in?	0,2
Total:	-0,02

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone and Brick Masonry
Masonry (coating)	Nonexistent/Cement mortar
Masonry (Finishing)	Nonexistent/Decorative Limestone
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Portuguese Tile
Chimney	Nonexistent
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Nonexistent
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 40;41 and 42 - Characteristics of building 14

Building 15

Building 15 is located at Rua Joaquim Maria Batista (picture 71), it is an isolated two-story building, with one annex, the limestone of the walls is showing (pictures 72 and 73), it has adjacent free space and no added area. Some of its general features include a two slopes roof, and marseille roof tile, the rest are listed in tables 43; 44 and 45.



Picture 71 - Detail of map 2

Picture 72 - Picture of building 15 – Serra de Santo António

Picture 73 – Picture of building 15 in 2009 (google)

Building ID		
Code number	015	
Street	Rua Joaquim Maria Batista	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	2	
Compared building height	Isolated building	
Annex	Yes	Garage
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

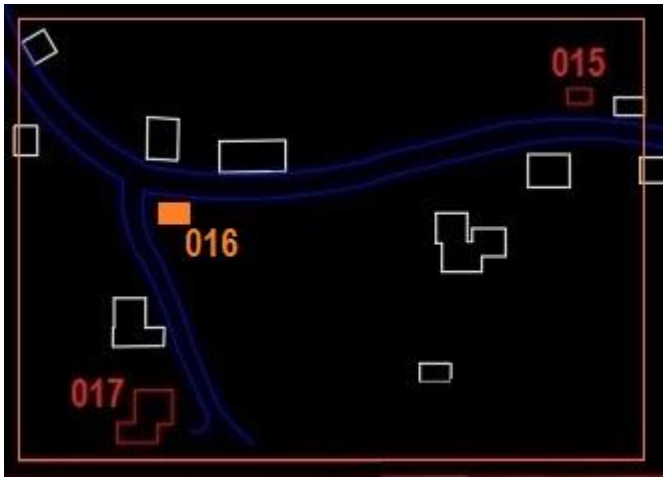
General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Cement mortar/Without Coating
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Marseille tile
Chimney	Nonexistent
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Iron
Windowpanes	Transparent glass
Windowsills	Nonexistent
Door(s) (Material)	Aluminum
Door(s) Sill(s)	Crafted limestone
Equipment	
Fence	Brick with decorative stone
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

Tables 43;44 and 45 - Characteristics of building 15

Building 16

Building 16, is located at Rua Joaquim Maria Batista (picture 74), it is an isolated one-story building with one annex, the limestone of the walls is showing (Picture 75 and 76), it has adjacent free space and no added area. Some of its general features include a two slopes roof, and marseille roof tile, the rest are listed in tables 46; 47 and 48.



Picture 74 - Detail of map 2

Pictures 75 and 76 - Pictures of building 16– Serra de Santo António

Building ID		
Code number	016	
Street	Rua Joaquim Maria Batista	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	Yes	Unidentifiable
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

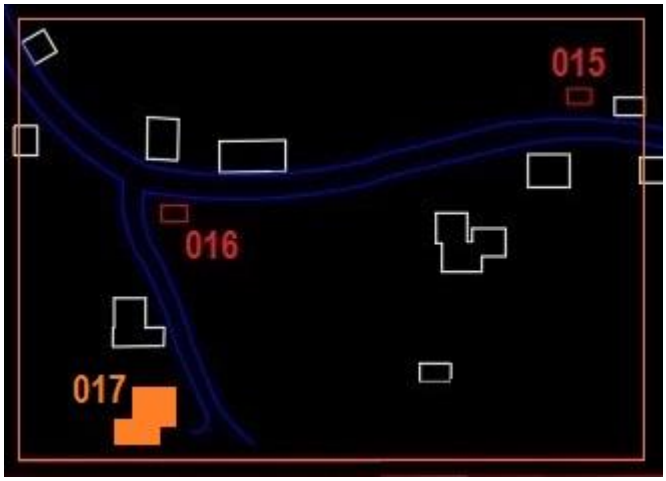
Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Lime mortar
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Marseille tile
Chimney	Nonexistent
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Nonexistent
Windowpanes	Nonexistent
Windowsills	Brushed limestone
Door(s) (Material)	Nonexistent
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall with mortar
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 46;47 and 48 - Characteristics of building 16

Building 17

Building 17, is located at Rua Covinhas (picture 77), it is an isolated two-story building, with annexes, the limestone of the walls is showing (pictures 78 and 79), it has added area and adjacent free space. include added area to the side (that led to deductions due to architectural changes), and limestone fence wall, the remaining ones are listed in tables 49; 50 and 51.



Picture 77 - Detail of map 2

Picture 78;79 - Picture of building 17– Serra de Santo António

Building ID		
Code number	017	
Street	Rua Covinhas	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	2	
Compared building height	Isolated building	
Annex	Yes	
Added area:	Yes	
	To the side?	Yes
	Added floor?	Yes
	Blends in?	No
Adjacent free space	Yes	

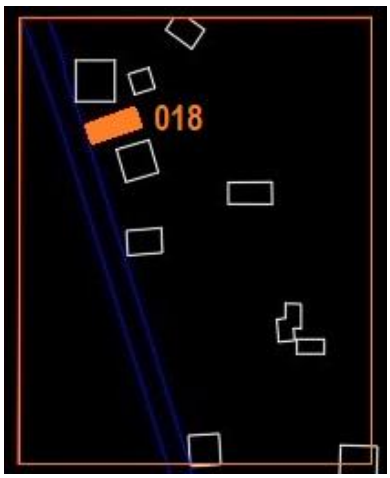
Deductions due to architectural changes		
Added area		-0,2
To the side?		-0,02
Added floor?		-0,02
Blends in?		-0,1
Total:		-0,34

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone and Brick Masonry
Masonry (coating)	Cement mortar/ Without Coating
Masonry (Finishing)	Paint/ Nonexistent
Roof	
Roof (Shape)	Other
Roof (Cover)	Portuguese Tile
Chimney	Nonexistent
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Aluminum
Windowpanes	Transparent glass
Windowsills	Nonexistent / Crafted limestone
Door(s) (Material)	Wood
Door(s) Sill(s)	Nonexistent / Crafted limestone
Equipment	
Fence	Limestone wall
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 49;50 and 51 - Characteristics of building 17

Building 18

Building 18, is located Rua Joaquim Maria Batista (picture 80), it is an isolated one-story building with no annex, the limestone of the walls is showing (pictures 81 and 82), it has no added area and adjacent free space. Some of its general features include a four slopes roof, marseille roof tile, and a metal chimney, the rest are listed in tables 52; 53 and 54.



Picture 80 - Detail of map 2

Picture 81– Picture of building 18 in 2009 (google)

Picture 82 – Picture of building 18 in 2014 (google)

Building ID		
Code number	018	
Street	Rua Joaquim Maria Batista	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	No	
Added area:	Yes	
	To the side?	Yes
	Added floor?	No
	Blends in?	No
Adjacent free space	Yes	

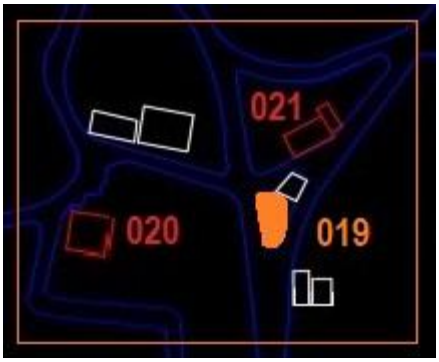
Deductions due to architectural changes		
Added area		-0,2
To the side?		-0,02
Added floor?		0
Blends in?		-0,1
Total:		-0,32

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Four slopes (Pyramid hip)
Roof (Cover)	Marseille tile
Chimney	Metal
Drainage of rainwater	Aluminum
Access	
Stairs	Limestone Masonry
Spans	
Window frames (Material)	Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Nonexistent
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 52;53 and 54 - Characteristics of building 18

Building 19

Building 19, is located Rua Luís Vaz de Camões (picture 83), it is an isolated one-story building with no annex, the limestone of the walls is showing (pictures 84; 85 and 86), it has added area and adjacent free space. Some of its general features include a four slopes roof, and marseille roof tile, the rest are listed in tables 55; 56 and 57.



Picture 83 - Detail of map 3

Pictures 84;85;86 - Pictures of building 19 – Serra de Santo António

Building ID		
Code number	019	
Street	Rua Luís Vaz de Camões	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	No	
Added area:	Yes	
	To the side?	Yes
	Added floor?	No
	Blends in?	Yes
Adjacent free space	Yes	

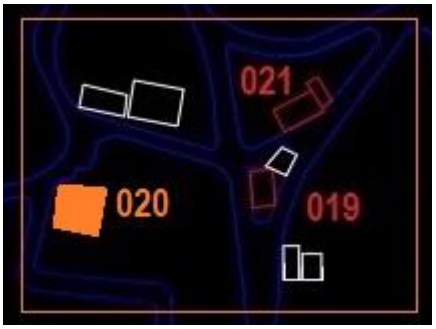
Deductions due to architectural changes	
Added area	-0,2
To the side?	-0,02
Added floor?	0
Blends in?	-0,1
Total:	-0,32

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Four slopes (Pyramid hip)
Roof (Cover)	Marseille tile
Chimney	Metal
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Brick with decorative stone/ Limestone wal with mortar
Threshing-floor	Nonexistent
Porch (Support)	Concrete
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

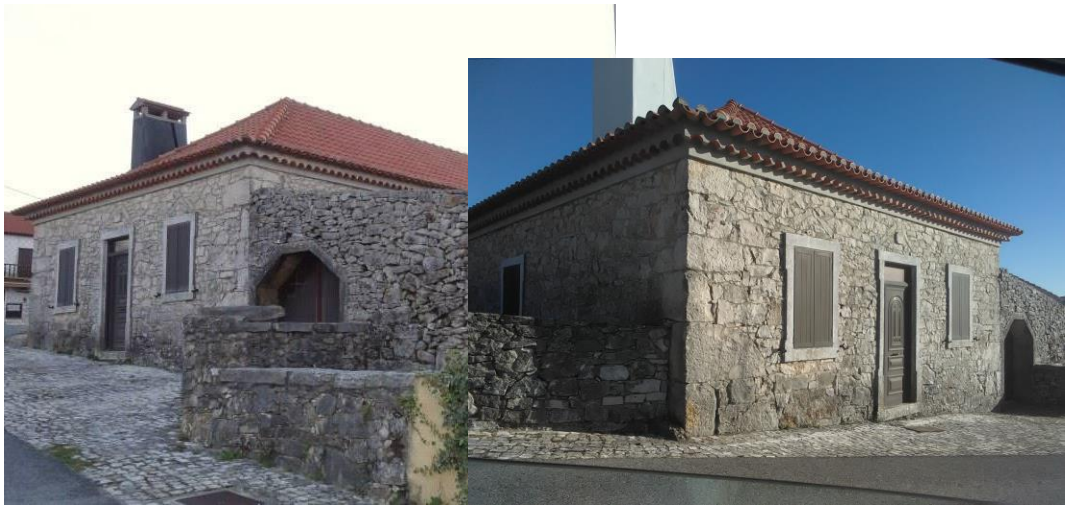
Tables 55;56 and 57 - Characteristics of building 19

Building 20

Building 20, is located Rua Ezequiel Arriaga F. Galo (picture 87), it is an isolated one-story building with annexes, the limestone of the walls is showing (pictures 88 and 89), it has adjacent free space and no added area. Some of its general features include a four slopes roof, portuguese roof tile, and brown aluminum doors and windows, the remaining features are listed in tables 58; 59 and 60.



Picture 87 - Detail of map 3



Pictures 88; 89 - Pictures of building 20– Serra de Santo António

Building ID		
Code number	020	
Street	Rua Ezequiel Arriaga F. Galo	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	Yes	
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

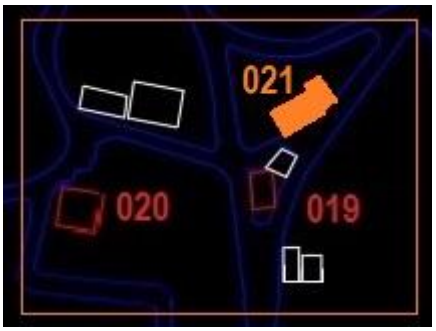
General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Four slopes (Pyramid hip)
Roof (Cover)	Portuguese Tile
Chimney	Masonry with cement mortar
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Brown Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Brown Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

Tables 58;59 and 60 - Characteristics of building 20

Building 21

Building 21, is located Travessa João Velez Salvador Pinheiro (picture 90), it is an isolated one-story building, with annexes, the limestone of the walls is showing (pictures 91 and 92), it has no added area and adjacent free space. Some of its general features include a two slopes roof, marseille roof tile, and brown aluminum doors and windows, the rest of the features are listed in tables 61; 62 and 63.



Picture 90 - Detail of map 3

Pictures 91 and 92 – Pictures of building 21 – Serra de Santo António

Building ID		
Code number	021	
Street	Travessa João Velez Salvador Pinheiro	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	Yes	
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Marseille tile
Chimney	Nonexistent
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Brown Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Brown Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Cement mortar
Other details	Nonexistent

Deductions due to architectural changes		
Added area		0
To the side?		-0,02
Added floor?		-0,02
Blends in?		-0,1
Total:		0

Tables 61;62 and 63 - Characteristics of building 21

Building 22

Building 22, is located Rua Luís Vaz de Camões (picture 93), it is an isolated one-story building, with annexes, the limestone of the walls is showing (pictures 94 and 95), it has no added area and adjacent free space. Some of its general features include a four slopes roof, portuguese roof tile, and aluminum doors and windows, the rest of the features are listed in tables 64; 65 and 66.

Picture 99 - Detail of map 3

Picture 94 – Picture of building 22 – Serra de Santo António

Picture 95 – Picture of building 22 in 2009 (Google)

Building ID		
Code number	022	
Street	Rua Luís Vaz de Camões	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	Yes	Other
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Four slopes (Pyramid hip)
Roof (Cover)	Portuguese Tile
Chimney	Brick
Drainage of rainwater	Iron/Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Brick with decorative stone
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Nonexistent
Other details	Nonexistent

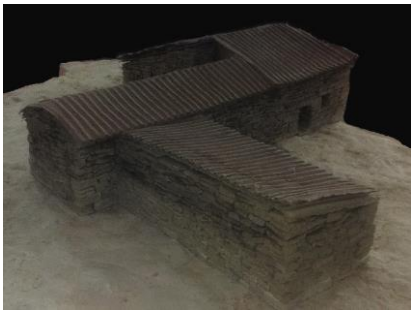
Tables 64;65 and 66 - Characteristics of building 22

Building 23

Building 23, is located at Rua do Seminário (picture 96), it is an isolated one-story building, with annexes, the limestone of the walls is showing (picture 97 and 98), it has no added area and adjacent free space. This building was previously a Jesuit school (many years ago) and there is even a model of it (picture 99). Some of its general features include a two slopes roof, mission roof tile, and aluminum doors and windows, the rest of the features are listed in tables 67; 68 and 69.

Picture 96 - Detail of map 3

Pictures 97 and 98; - Pictures of building 23– Serra de Santo António



Picture 99 - Picture of a model of building 23– Serra de Santo António

Building ID		
Code number	023	
Street	Rua do Seminário	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	1	
Compared building height	Isolated building	
Annex	Yes	Garage
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Mission roof tile
Chimney	Masonry with cement mortar and decorative Limestone
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone
Door(s) (Material)	Aluminum
Door(s) Sill(s)	Brushed limestone
Equipment	
Fence	Limestone wall with cement mortar
Threshing-floor	Nonexistent
Porch (Support)	Nonexistent
Porch (Guard-rail)	Nonexistent
Water tank/ Well	Limestone with cement mortar
Other details	Nonexistent

Tables 67;68 and 69 - Characteristics of building 23

Building 24

Building 24, is located Rua do Seminário (picture 100), it is an isolated two-story building, with annexes, the limestone of the walls is showing (Pictures 101;102;103;104), it has no added area and adjacent free space. Some of its general features include a two slopes roof, mission roof tile, and brown aluminum windows, the rest of the features are listed in tables 70; 71 and 69.

Picture 100 - Detail of map 3

Pictures 101 - 104 - Pictures of building 24– Serra de Santo António

Building ID		
Code number	024	
Street	Rua do Seminário	
Village	Serra de Santo António	
General Features		
Type of use	Housing	
Number of floors	2	
Compared building height	Isolated building	
Annex	No	
Added area:	No	
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space	Yes	

Deductions due to architectural changes	
Added area	0
To the side?	-0,02
Added floor?	-0,02
Blends in?	-0,1
Total:	0

General characteristics	Description
Exterior walls	
Masonry (Type)	Limestone Masonry
Masonry (coating)	Nonexistent
Masonry (Finishing)	Nonexistent
Roof	
Roof (Shape)	Two slopes (Gable)
Roof (Cover)	Mission roof tile
Chimney	Masonry with cement mortar and decorative Limestone
Drainage of rainwater	Nonexistent
Access	
Stairs	Nonexistent
Spans	
Window frames (Material)	Brown Aluminum
Windowpanes	Transparent glass
Windowsills	Brushed limestone/Nonexistent
Door(s) (Material)	Wood
Door(s) Sill(s)	Brushed limestone/Nonexistent
Equipment	
Fence	Limestone with mortar/ Other
Threshing-floor	Nonexistent
Porch (Support)	Limestone pillars
Porch (Guard-rail)	Limestone wall with mortar
Water tank/ Well	Nonexistent
Other details	Nonexistent

Tables 70;71 and 72 - Characteristics of building 24

After the visual analysis of the 24 buildings in the sample, all were houses (even though some had barns and/or granaries annexed),16 (66,7%) had 1 floor, and 8 (33,3%) had 2 floors, 22 (91,7%) were isolated buildings, 15 (62,5%) had annex and 9 (37,5%) did not, 18 (75%) had no added area and 6 (25%) did, 22 (91,7%) had adjacent free space while 2 (8,3%) did not.

21 (87,5%) were made purely of limestone masonry, and 3 (12,5%) were made of limestone masonry in combination with other masonry type.

14 (58,3%) had no coating over the masonry, 7 (29,2%) had a mixture of areas with coating and areas without it, and 3 (12,5%) had their masonry fully coated.

16 (66,7%) had no finishing layer, 6 (25%) had a mixture of areas with finishing layer and areas without it, and 2 (8,3%) had a finishing layer all over.

16 (66,7%) had a roof with two slopes, 2 (8,3%) had a roof with three slopes, 4 (16,7%) had four sloped roofs, and 2 (8,3%) had more than four slopes or other shapes.

12 (50%) had Marseille tile as roof cover, 8 (33,3%) had Portuguese Tile, and the other 4 (16,7%) had Mission roof tile cover.

9 (37,5%) buildings did not have a chimney, 6 (25%) had chimneys made of Masonry with cement mortar, 3 (12,5%) had metal chimneys, 3 (12,5%) had brick chimneys, 2 (8,3%) had chimneys with Cement mortar and decorative Limestone and 1 (4,2%) building had both metal and brick chimneys.

17 (70,8%) buildings had no Drainage of rainwater system, 6 (25%) had aluminum gutters and 1 (4,2%) had iron drains.

Only 1 (4,2%) building had stairs.

11 (45,8%) buildings had window frames made of aluminum, 3 (12,5%) of those were Brown Aluminum, 7 (29,2%) were made of wood, 3 (12,5%) of iron, and 3 (12,5%) were made from other materials or nonexistent.

11 (45,8%) buildings had aluminum doors, 2 (8,3%) of which were brown aluminum, 8 (33,3%) had wooden doors, 1 (4,2%) had iron door, and 4 (16,7%) buildings had nonexistent doors.

11 (45,8%) buildings had limestone walls as fence, 4 (16,7%) of which with mortar, 1 (4,2%) had a combination of brick wall with decorative limestone and limestone with mortar, 6 (25%) buildings had no fence, 4 (16,7%) had brick wall, 2 (8,3%) of those having

decorative limestone, and 1 (4,2%) building had a combination of brick wall and limestone wall, one building had other kind of fencing. (4,2%)

None of the analyzed buildings had a threshing- floor.

20 (83,3%) buildings had no porch, from the other 4 (16,7%), 2 (8,3%) were supported by limestone pillars, and 2 (8,3%) were supported by concrete pillars.

From the 4 (16,7%) buildings that had porches 1 (4,2%) had no guard rail, 2 (8,3%) had limestone walls as Guard-rails and 1 (4,2%) had glass.

16 (66,7%) buildings had no Water tank/well, 5 (20,8%) had Water tanks/wells made of Limestone with or without mortar, 1 (4,2%) had a water tank or well made of Concrete with decorative limestone, 2 (8,3%) had a water tank/well made of Brick masonry covered in cement mortar.

1 (4,2%) building had a limestone Chicken Coop.

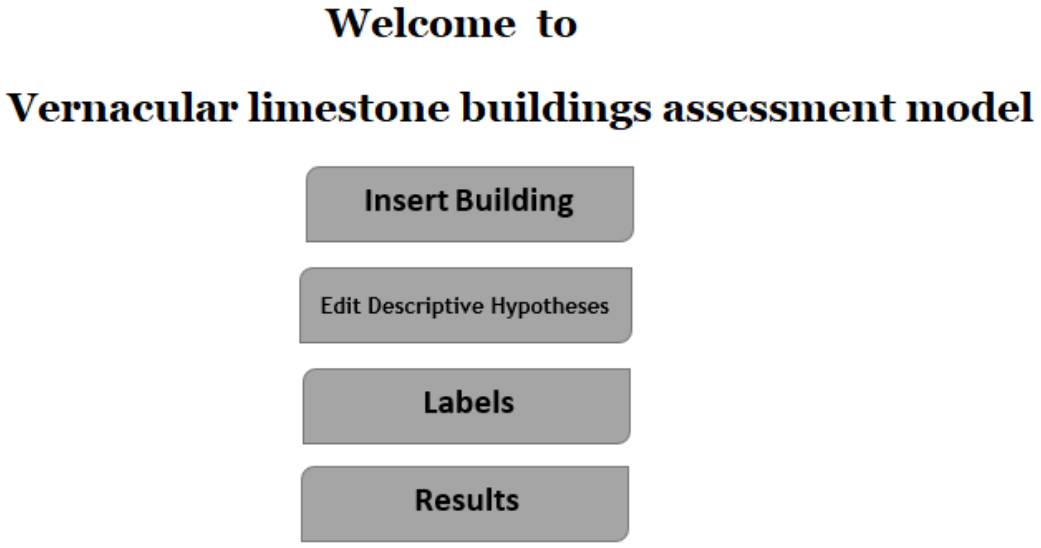
In summation, most of the analyzed buildings were isolated, one floor houses, purely made of limestone masonry without any coating or finish, with at least one annex, and adjacent free space (likely a backyard, front yard, or garden). The majority of studied houses also had a two-slope roof (gable), with Marseille tile as roof cover, a chimney, no drainage of rainwater system, a limestone fence wall (or a wall with decorative limestone), and no porch or threshing-floor. This data will be used to help define the architectural matrix.

Chapter 4 – Assessment model for vernacular limestone buildings using Microsoft Excel®: application in Serra de Santo António

After realizing that the better-known programs applicable to stone buildings were relative to their earthquake resistance and not their characterization, or the evaluation of their state of conservation, it became clear that a need to create such software existed. Microsoft Excel® was the chosen tool to do it due to its capacity to hold information, make calculations, verifications, and allowing menu-like lists which help the user fill the tables, (with the information collected in the visual inspection of the buildings). Microsoft Excel® is also a very common tool on other areas of Civil Engineering, so most engineers are already familiar with it, making it "user friendly".

4.1 Creating the assessment Model

The first part of the Model is the menu (picture 105), the menu has 4 buttons.



Picture 10 – menu of the model

The first button, *Insert Building*, allows the user to add new buildings to the program.

The second button, *Edit De*scriptive Hypotheses, allows the user to add or remove descriptive hypotheses. The third button, *Label*s, allows the user to read the guidelines and helps with scoring the elements. The fourth button, *Results*, allows the user to go directly to the results sheet.

The process of creating the Limestone building assessment model was divided in three parts *Creating diagnosis sheets, Defining the architectural matrix*, and *Creating the score tables.*

Each building has its own diagnosis sheet, so there are 24 diagnosis sheets in total, while the score tables appear only once and should be used as directives to allow a uniform evaluation, regardless of who is making the evaluation.

4.1.1 Creating diagnosis sheets

The process of creating the diagnosis sheets was not without its ups and downs, one of the early versions can be found annexed at the end of this dissertation. The final version is made up of several parts, the first being the building identification section (table 73), in a small table it is shown the ***code number***, the ***street*** and the ***village*** to which the building belongs. These are free to fill and offer no automated options, since they do not affect the final scores of the either the identity diagnosis score or the state of conservation score.

The ***code numbe***r is defined by the user, to make identification of the buildings at study easier. In the case of this dissertation the code numbers were given in the same order of the visual inspection, building 001 was the first to be inspected and building 024 was the last.

The ***village*** category is redundant, in the case study, since all the buildings are part of Serra de Santo António, but it was included nonetheless, to prepare for the eventuality of an extension to the area of study, or for the possibility of these diagnosis sheet being used to study other areas in posterity.

Building ID	
Code number	
Street	
Village	

Table 73 - First part of the diagnosis sheet - building identification section

The second section includes the ***general features*** of the building, some of these are purely descriptive and will not affect the calculations made later. Whoever buildings that have **Added area** may suffer **Deductions due to architectural changes**, these deductions are calculated in a separate section of the sheet, and are from -0,02 to -0,04 in the case they **Blend in**, and range from -0,02 to -0,34 in the case they don't.

The ***general features*** (table 74) listed include de *Type of use*, *Number of floors*, *Compared building height*, if it has an *Annex or Adjacent free space*, and if it has *Added area*, in case the building in analysis has indeed *added area* to the original vernacular, how this area was added should be described, for that purpose the options: ***To the side?*** and ***Added floor?*** were created, and also the ***Blends in?*** option is available in the eventuality the *added area* was covered in limestone.

General Features		
Type of use		
Number of floors		
Compared building height		
Annex		
Added area:		
	To the side?	
	Added floor?	
	Blends in?	
Adjacent free space		

Table 74 - Second part of the diagnosis sheet - General features

In the ***General Features*** table, all the options have a menu-list to help fill the diagnosis sheet, some of these are simple "Yes" or "No", but those which are not offer the following options (tables 75 and 76):

Type of use	Nr of floors
Housing	1
Commerce	2
Windmill	3
Other	More than 3

Tables 75 - menus to help fill the *General features* in the diagnosis sheet

Annex	Compared building height
Garage	Same height as adjoining buildings
Barn/Granary	Smaller than adjoining buildings
Other	Height in-between adjoining buildings
Unidentifiable	Higher than adjoining buildings
	Different gable height
	Isolated building

Tables 76 – More menus to help fill the *General features* in the diagnosis sheet

In the case of ***Added area***, the table below will be filled (table 77). For a building with an Added area that does not blend in, the total deductions on the architectural matrix score will be from -0,32 to -0,34 (out of a maximum of 3).

Deductions due to architectural changes	
Added area	
To the side?	
Added floor?	
Blends in?	
Total:	0

Table 77 - Third part of the diagnosis sheet - Deductions due to architectural changes

The third section is a table with the following headline:

General characteristics	Description	Conservation score	Identity score

In this table the ***General characteristics*** of the building are divided into categories and the relevant elements are listed, after that, they get a descriptor, based on which they will get an ***Identity score*** (0 to 3)**.**

Finally, the listed elements will get a ***Conservation score*** (0 to 5), based on a visual inspection of the buildings in the case study, and their state of conservation.

The first elements listed are the ***Exterior walls,*** the *Type*, *Coating*, and *Finishing* of the walls, get descriptors (table 78)*:*

Exterior walls
Masonry (Type)
Masonry (coating)
Masonry (Finishing)

Table 78 - Fourth part of the diagnosis sheet - Exterior walls

The second set of elements listed are the ***Roof*** and ***Access*** (table 79), the *Shape, Cover, Chimney, Drainage of rainwater* and *Stairs* get a descriptor.

Roof
Roof (Shape)
Roof (Cover)
Chimney
Drainage of rainwater
Access
Stairs

Table 79 - Fifth part of the diagnosis sheet - Roof and Access

The third elements listed are the ***Spans*** (table 80), the *Material* of the *doors* and *window frames,* the *Material* of the *door sills* and *windowsills* and *Windowpanes,* get a descriptor.

Spans
Window frames (Material)
Windowpanes
Windowsills
Doors (Material)
Door(s) Sill(s)

Table 80 - Sixth part of the diagnosis sheet – Spans

The final elements listed are the **Equipment** (table 81), the *Fence*, *Threshing-floor*, *Porch (Support)*, *Porch (Guard-rail), Water tank/ Well* and *Other* details, get a descriptor.

Equipment
Fence
Threshing-floor
Porch (Support)
Porch (Guard-rail)
Water tank/ Well
Other details

Table 82 - Final part of the diagnosis sheet – Equipment

4.1.2 Defining the architectural matrix

After defining the building elements that were listed in the diagnosis sheet, the descriptors were defined, in accordance with the buildings in study. These descriptors are the same options that appear in the ***Microsoft Excel® assessment model*** menu to help fill the diagnosis sheets.

All these options were defined after a visual inspection of the buildings and reflect the type of materials more commonly found, in the studied buildings.

The first elements listed are the *Type*, *Coating*, and *Finishing* of the walls, their descriptors are listed below (table 82):

Masonry (Type)	Masonry (coating)	Masonry (Finishing)
Limestone Masonry	Cement mortar	Paint
Other stone Masonry	Lime mortar	Decorative limestone
Brick Masonry	Without Coating	Ceramic Tile
Other	Other	Other
Not identifiable	Not identifiable	Not identifiable
Nonexistent	Nonexistent	Nonexistent
		Lime paint

Table 83 - Descriptors for Exterior Walls

The second set of elements listed are the ***Roof*** and ***Access,*** the *Shape* of the roof, it's *Cover* type, *Chimney* material, the drain material for the *Drainage of rainwater* and material of the *Stairs*, their descriptors are listed in the table below (table 83):

Roof	Roof (Shape)	Roof (Cover)	Chimney	Drainage of rainwater	Access	Stairs
	Not identifiable	Nonexistent	Not identifiable	Nonexistent		Nonexistent
	One slope (Shed)	Mission roof tile	Nonexistent	Aluminum		Stone masonry
	Two slopes (Gable)	Marseille tile	Metal	PVC		Stone masonry with mortar
	Three slopes	Portuguese tile	Masonry with lime mortar	Iron		Brick masonry
	Four slopes (Pyramid hip)	Flat cover	Masonry with cement mortar	Zinc		Other
	More than four slopes	Other	Brick	Other		
	Nonexistent		Other			

Table 84 - Descriptors for Roof and Access

The third elements listed are the ***Spans,*** the *Material* of the *Doors* and *Window frames,* the *Material* of the *Door sills* and *Windowsills* and *Windowpanes*, their descriptors are listed in the table below (table 84):

Window frames	Windowpanes	Windowsills	Doors (Material)	Door(s) Sill(s)
Nonexistent	Nonexistent	Not identifiable	Nonexistent	Not identifiable
Wood	Transparent glass	Brushed stone	Wood	Brushed limestone
Brown Aluminum	Colored glass	Crafted limestone	Brown Aluminum	Nonexistent
Aluminum	Other	Concrete	Aluminum	Wood
Iron		Wood	Iron	Concrete
		Other		Crafted stone
		Nonexistent		Other

Table 85 - Descriptors for the spans

The fourth elements listed are the **Equipment,** the type of *Fence*, the *Threshing-floor*, material, the *Porch (Support)* material, the *Porch (Guard-rail)* type, the material of the *Water tank/ Well* and *Other details*, their descriptors are listed in the table below (table 85):

Equip-ment	Fence	Threshing-floor	Water tank/well	Porch (Support)	Porch (Guard-rail)	Other details
	Nonexistent	Nonexistent	Nonexistent	Nonexistent	Nonexistent	Nonexistent
	Not identifiable	Not identifiable	Not identifiable	Not identifiable	Aluminum	Not identifiable
	Limestone wall	Limestone	Limestone with mortar	Brushed stone	Iron	Limestone masonry
	Limestone wall with mortar	Limestone with mortar	Concrete with decorative limestone	Crafted stone	Ornate Iron	Brick masonry
	Brick wall	Cement mortar	Cement mortar	Brick	Wood	
	Brick with decorative stone	Other	Other	Wood	Limestone Wall	
	Other				Other	

Table 86 - Descriptors for Equipment

4.1.3 Creating the score tables

The score tables were created to help avoid discrepancies in the evaluation of the buildings, these were used to allow a fair evaluation of each element listed on the diagnosis sheets, regardless of the general appearance of the building, and hopefully reducing the subjectiveness existent in any visual inspection.

These make the ***Conservation score*** (varying from 1 to 5) correspond to a description, making it easier to choose which number to attribute to a certain element, accordingly to the degradation of that element (table 86).

The state of conservation score tables were based on AVAL-Nisa: Estudo do Património Histórico Habitacional através da criação de um Modelo no Microsoft Excel™ (Malpique, P. R. S., 2019: page of excel file). and Aldeias palafíticas fluviais em Portugal: urbanismo e arquitetura Avieiras(Almeida, F. A. D. C., 2016: 440 to 478)

General characteristics	State of conservation score				
	5	4	3	2	1
Exterior walls					
Masonry (Type)	Good conser-vation state;	Poorly made previous repairs; Dirt and shallow parasitic vegetation;	Localized breakdown of elements; Small loss of material;	Extensive average or large aperture cracking; Extensive breakdown of elements; Change in geometry; Visible swells;	Risk of collapse; Extensive breakdown of elements; Significantly changed geometry; Bulging visible to the naked eye;
Masonry (coating)	Good conser-vation state;	Slight element wear; Maintenance needed;	Extensive cracking of small width; Signs of efflorescence or traces of biological attack; Limited wet or humid areas; Heterogeneity of coating types over large areas;	Localized crack of average width; Missing, loose, blistered, or degraded coating in limited areas; Generalized efflorescence or extensive biological attack; Large wet or humid areas;	Missing, loose, blistered, or degraded coating in large areas, requiring replacement or total repair;
Masonry (Finishing)	Good conser-vation state;	Slight element wear; Maintenance needed;	Small areas with great deterioration in finish; Dirt or stains; Small wet or humid areas; Small areas without finish;	Large areas with great finish deterioration; Generalized efflorescence or extensive biological attack; Large wet or humid areas; Average areas without finish;	Large areas without finish;
Roof					
Roof (Shape)	Good conser-vation state;	Small maladjusted previous repairs; Indications of the action of biological agents or xylophages;	Deformation in limited areas; Structure with some deterioration of elements;	Deformation over large areas; Structure with large deterioration of elements;	Partial or total destruction of the element; Ruin;
Roof (Cover)	Good conser-vation state;	Soil and shallow parasitic vegetation; Light wear of the elements; Small maladjusted previous repairs;	Dirt and parasitic vegetation; Medium to severe wear; Misalignment of the elements that compromises the leak tightness; Major maladjustment repairs; Major maladjustment repairs;	Leakage in small areas;	Leakage in large areas; Ruin;
Chimney	Good conser-vation state;	Peeling or degradation of the finish; Poorly made previous repairs;	Localized leakage; Localized loss of coating;	Leakage in large areas; Partial destruction of the element without danger of falling elements; Coating loss over large areas;	Partial or total destruction of the element with danger of falling elements; Ruin;

Table 86 - State of conservation score table part 1

General characteristics	State of conservation score				
	5	4	3	2	1
Roof					
Drainage of rainwater	Good conser-vation state;	Peeling Paint; Poorly made previous repairs;	Equipment needs maintenance to keep it functional;	Loss of functionality; Elements missing;	Total destruction of the element;
Spans					
Window frames (Material)	Good conser-vation state;	Slight deterioration of the elements, does not impede functionality;	Window frames in need of repair for regular use; Punctual entry of water; Medium to accentuated wear;	Inoperative window frames; Deteriorated elements; Absence of secure closing devices; Dismountable from the outside; Loss of leak tightness;	Non-existent window frames;
Windowpanes	Good conser-vation state;	Slight element wear;	Accentuated wear of the element;	Broken glass without danger of falling;	Absence of glass; Broken glass with danger of falling;
Windowsills	Good conser-vation state;	Previous repairs not well taken care of; Slight maintenance needed;	Small crack opening; Loss of material in surrounding areas;	Large or Average cracking; Change in geometry; Loss of material on supports;	Element rupture; Loss of material;
Doors (Material)	Good conser-vation state;	Dirt; Oxidations; Light wear;	Deteriorated elements (broken, corroded, warped, biological attack) and in need of specific repairs; Punctual entry of water; Medium to accentuated wear;	Deteriorated elements (broken, corroded, warped, biological attack) in need generalized intervention; Absence of secure closing devices; Removable from the outside; Compromised tightness;	Absence of the element or ruin; Compromised functionality; Badly degraded door frames;
Door(s) Sill(s)	Good conser-vation state;	Previous repairs not well taken care of; Slight maintenance needed;	Small crack opening; Loss of material in surrounding areas;	Large or Average cracking vertical; Change in geometry; Loss of material on supports;	Element rupture; Loss of material;
Equipment					
Fence	Good conse-vation state;	Poorly made previous repairs; Small opening cracking; Dirt and shallow parasitic vegetation; Small areas with lack of paint and/or rust;	Average, extensive small opening or localized from average to large opening; Localized breakdown of elements; Loose material in limited areas; Medium sized areas with lack of paint and/or rust; Deformation in limited areas;	Small opening cracking in the entire wall thickness; Extensive to large aperture cracking; Extensive breakdown of elements; Loose material in many areas; Change in geometry; Visible swells; Extensive areas with lack of paint and rust;	Large opening cracking in the entire wall thickness; Risk of collapse; Extensive breakdown of elements; Loose material in most areas; Significantly changed geometry; Bulging visible to the naked eye; Extensive areas with rust and corroded elements;

Table 87 - State of conservation score table part 2

General characteristics	State of conservation score				
	5	4	3	2	1
Threshing-floor	Good conservation state;	Shallow vegetation; Poorly made previous repairs;	Small opening cracking; Presence of tall vegetation;	Large opening cracking; Structural deformation;	Partial ruin of the element;
Water tank/ Well	Good conservation state;	Shallow vegetation; Poorly made previous repairs;	Small opening cracking; Presence of tall vegetation; Compromised the leak tightness;	Large opening cracking; Structural deformation; Leakage in small areas;	Leakage in large areas; Ruin;
Porch (Support)	Good conservation state;	Shallow vegetation; Poorly made previous repairs;	Small opening cracking; Presence of tall vegetation;	Large opening cracking; Structural deformation;	Partial ruin of the element;
Porch (Guard-rail)	Good conservation state;	Shallow vegetation; Poorly made previous repairs; Degradation in the finishes of the protection element; Lack of maintenance;	Small opening cracking; Presence of tall vegetation;	Large opening cracking; Circulation protection elements with advanced degradation;	Lack of circulation protection;
Other details					
Access					
Stairs	Good conservation state;	Lack of maintenance; Steps with some wear; Poorly made previous repairs;	Slight change in geometry; Broken steps with missing parts or loose elements;	Bulging, yielding or other deformations; Lack or degradation of structural elements;	The stair/ramp required to access the building is missing;

Table 88 - State of conservation score table part 3

How to assign state of conservation scores:

Masonry (Type):

5 - Good conservation state.

4 - Poorly made previous repairs; Dirt and shallow parasitic vegetation.

3 - Localized breakdown of elements; Small loss of material.

2 - Extensive average or large aperture cracking; Extensive breakdown of elements; Change in geometry; Visible swells;

1 - Risk of collapse; Extensive breakdown of elements; Significantly changed geometry; Bulging visible to the naked eye;

Masonry (coating):

5 - Good conservation state.

4 - Slight element wear; Maintenance needed;

3 - Extensive cracking of small width; Signs of efflorescence or traces of biological attack; Limited wet or humid areas; Heterogeneity of coating types over large areas;

2 - Localized crack of average width; Missing, loose, blistered, or degraded coating in limited areas; Generalized efflorescence or extensive biological attack; Large wet or humid areas;

1 - Missing, loose, blistered, or degraded coating in large areas, requiring replacement or total repair;

0 - When it is not possible to inspect the element; or it does not exist;

Masonry (Finishing)

5 - Good conservation state.

4 - Slight element wear; Maintenance needed;

3 - Small areas with great deterioration in finish; Dirt or stains; Small wet or humid areas; Small areas without finish;

2 - Large areas with great finish deterioration; Generalized efflorescence or extensive biological attack; Large wet or humid areas; Average areas without finish;

1- Large areas without finish;

0 - When it is not possible to inspect the element; or it does not exist;

Roof (Shape)

5 - Good conservation state.

4 - Small maladjusted previous repairs; Indications of the action of biological agents or xylophages;

3 - Deformation in limited areas; Structure with some deterioration of elements;

2 - Deformation over large areas; Structure with large deterioration of elements;

1- Partial or total destruction of the element; Ruin;

Roof (Cover)

5 - Good conservation state.

4 - Soil and shallow parasitic vegetation; Light wear of the elements; Small maladjusted previous repairs;

3 - Dirt and parasitic vegetation; Medium to severe wear; Misalignment of the elements that compromises the leak tightness; Major maladjustment repairs; Major maladjustment repairs;

2 - Leakage in small areas;

1- Leakage in large areas; Ruin;

Chimney

5 - Good conservation state.

4 - Peeling or degradation of the finish; Poorly made previous repairs;

3 - Localized leakage; Localized loss of coating;

2 - Leakage in large areas; Partial destruction of the element without danger of falling elements; Coating loss over large areas;

1- Partial or total destruction of the element with danger of falling elements; Ruin;

0 - When it is not possible to inspect the element; or it does not exist;

Drainage of rainwater

5 - Good conservation state.

4 - Peeling Paint; Poorly made previous repairs;

3 - Equipment needs maintenance to keep it functional;

2 - Loss of functionality; Elements missing;

1- Total destruction of the element;

0 - When it is not possible to inspect the element; or it does not exist;

Window frames (Material)

5 - Good conservation state.

4 - Slight deterioration of the elements, does not impede functionality;

3 - Window frames in need of repair for regular use; Punctual entry of water; Medium to accentuated wear;

2 - inoperative window frames; Deteriorated elements; Absence of secure closing devices; Dismountable from the outside; Loss of leak tightness;

1 - Non-existent window frames;

Windowpanes

5 - Good conservation state.

4 - Slight element wear;

3 - Accentuated wear of the element;

2 - Broken glass without danger of falling;

1 - Absence of glass; Broken glass with danger of falling;

Windowsills

5 - Good conservation state.

4 - Previous repairs not well taken care of; Slight maintenance needed;

3 - Small crack opening; Loss of material in surrounding areas;

2 - Large or Average cracking; Change in geometry; Loss of material on supports;

1 - Element rupture; Loss of material;

0 - When it is not possible to inspect the element; or it does not exist;

Doors (Material)

5 - Good conservation state.

4 - Dirt; Oxidations; Light wear;

3 - Deteriorated elements (broken, corroded, warped, biological attack) and in need of specific repairs; Punctual entry of water; Medium to accentuated wear;

2 - Deteriorated elements (broken, corroded, warped, biological attack) in need generalized intervention; Absence of secure closing devices; Removable from the outside; Compromised tightness;

1 - Absence of the element or ruin; Compromised functionality; Badly degraded door frames;

Door(s) Sill(s)

5 - Good conservation state.

4 - Previous repairs not well taken care of; Slight maintenance needed;

3 - Previous repairs not well taken care of; Slight maintenance needed;

2 - Large or Average cracking vertical; Change in geometry; Loss of material on supports;

1- Element rupture; Loss of material;

0 - When it is not possible to inspect the element; or it does not exist;

Fence

5 - Good conservation state.

4 - Poorly made previous repairs; Small opening cracking; Dirt and shallow parasitic vegetation; Small areas with lack of paint and/or rust (metallic fences);

3 - Average, extensive small opening or localized from average to large opening; Localized breakdown of elements; Loose material in limited areas; Medium sized areas with lack of paint and/or rust (metallic fences); Deformation in limited areas;

2 - Small opening cracking in the entire wall thickness; Extensive to large aperture cracking; Extensive breakdown of elements; Loose material in many areas; Change in geometry; Visible swells; Extensive areas with lack of paint and rust (metallic fences);

1- Large opening cracking in the entire wall thickness; Risk of collapse; Extensive breakdown of elements; Loose material in most areas; Significantly changed geometry; Bulging visible to the naked eye; Extensive areas with rust and corroded elements (metallic fences);

0 - When it is not possible to inspect the element; or it does not exist;

Threshing-floor

5 - Good conservation state.

4 - Shallow vegetation; Poorly made previous repairs;

3 - Small opening cracking; Presence of tall vegetation;

2 - Large opening cracking; Structural deformation;

1- Partial ruin of the element;

0 - When it is not possible to inspect the element; or it does not exist;

Water tank/ Well

5 - Good conservation state.

4 - Shallow vegetation; Poorly made previous repairs;

3 - Small opening cracking; Presence of tall vegetation; Compromised the leak tightness;

2 - Large opening cracking; Structural deformation; Leakage in small areas;

1- Leakage in large areas; Ruin;

0 - When it is not possible to inspect the element; or it does not exist;

Porch (Support)

5 - Good conservation state.

4 - Shallow vegetation; Poorly made previous repairs;

3 - Small opening cracking; Presence of tall vegetation.

2 - Large opening cracking; Structural deformation.

1- Partial ruin of the element;

0 - When it is not possible to inspect the element; or it does not exist;

Porch (Guard-rail)

5 - Good conservation state.

4 - Shallow vegetation; Poorly made previous repairs; Degradation in the finishes of the protection element; Lack of maintenance;

3 - Large opening cracking; Circulation protection elements with advanced degradation;

2 - Leakage in large areas; Partial destruction of the element without danger of falling elements; Coating loss over large areas;

1- Lack of circulation protection;

0 - When it is not possible to inspect the element; or it does not exist;

Stairs

5 - Good conservation state.

4 - Lack of maintenance; Steps with some wear; Poorly made previous repairs;

3 - Slight change in geometry; Broken steps with missing parts or loose elements;

2 - Bulging, yielding or other deformations; Lack or degradation of structural elements;

1- The stair/ramp required to access the building is missing;

0 - When it is not possible to inspect the element; or it does not exist;

The following table shows the ***Identity Diagnosis*** score (varying from 1 to 3), corresponding to a description, making it easier to choose which number to attribute to a certain element, accordingly to the proximity of that element to the architectural matrix.

The option ***Not identifiable*** is also shown, this is applicable to ***both*** the ***Identity Diagnosis*** score and the ***state of conservation*** **score,** is equivalent to zero in the numerical scale. This option was added in order not to hinder constructions built without such elements.

General characteristics	Both	Identity Diagnosis		
	Not identifiable	3	2	1
Exterior walls	0			
Masonry (Type)		100 to 85 % Limestone masonry	From 84% to 40 % limestone masonry	Mostly other materials
Masonry (coating)	When it is not possible to inspect the element; or it does not exist;	No Finish over Limestone;	Lime mortar;	Other
Masonry (Finishing)	When it is not possible to inspect the element; or it does not exist;	No Coat over Limestone; Decorative Limestone;	Lime paint;	Other
Roof				
Roof (Shape)		Two slopes (Gable)	Four slopes (Pyramid hip)	Other
Roof (Cover)		Mission roof tile	Portuguese Tile; Marseille tile;	Other
Chimney	When it is not possible to inspect the element; or it does not exist;	Masonry with lime mortar;	Masonry with cement mortar; Masonry with cement mortar and decorative limestone;	Other
Drainage of rainwater	When it is not possible to inspect the element; or it does not exist;	Nonexistent;	Iron	Other
Spans				
Window frames		Wood	Brown aluminum	Other
Windowpanes		Transparent Glass	Colored Glass	Other
Windowsills	When it is not possible to inspect the element; or it does not exist;	Brushed limestone/ Nonexistent/ Crafted limestone	Other brushed stone	Other
Doors (Material)		Wood	Brown aluminum	Other
Door(s) Sill(s)	When it is not possible to inspect the element; or it does not exist;	Brushed limestone/ Nonexistent	Other brushed stone	Other
Equipment				
Fence	When it is not possible to inspect the element; or it does not exist;	Limestone masonry with/without mortar	Brick masonry covered in decorative limestone	Other materials
Threshing-floor	When it is not possible to inspect the element; or it does not exist;	Limestone masonry with/without mortar	Brick masonry/cement mortal	Other materials
Water tank/ Well	When it is not possible to inspect the element; or it does not exist;	Limestone masonry with/without mortar	Brick masonry/cement mortal with decorative limestone	Other materials
Porch (Support)	When it is not possible to inspect the element; or it does not exist;	Limestone pillars with/without mortar	Other stone pillars	Other materials
Porch (Guard-rail)	When it is not possible to inspect the element; or it does not exist;	Limestone masonry wall	Brick masonry covered in decorative limestone	Other materials
Other details	When it is not possible to inspect the element; or it does not exist;	Limestone	Covered in decorative limestone	Other materials
Access				
Stairs	When it is not possible to inspect the element; or it does not exist;	100 to 85 % Limestone masonry	From 84% to 40 % limestone masonry	Mostly other materials

Table 89 – Identity diagnosis score table

The maximum score for exterior wall masonry type was attributed to buildings with a percentage of limestone masonry as low as 85 %, this allows a margin for buildings that have been already recovered or rehabilitated, since the comfort standards are higher now, that they were when most of them were built, and it is very common that the height of the vernacular buildings is slightly increased when they are target of a recovery or rehabilitation.

The intermedium score was attributed to buildings with a percentage of limestone masonry between 84% and 40%. The same way the comfort standards are higher now than they were many years ago, also the space each of us requires in a living space has increase "[...] em termos de área habitável, regista-se um aumento generalizado a todas as regiões da superfície média habitável das divisões." (INE, Estatísticas da Construção e Habitação.,2009), and some of these vernacular constructions have quite a small area by today's standards, with that in mind, buildings with up to 60% of their masonry made from different materials are still in the intermedium score.

The minimum score was attributed to buildings with a percentage of limestone masonry lower than 40%.

Proximity to architectural matrix scores can be attributed in the following way:

Masonry (Type):

3 - 100 to 85 % Limestone masonry.

2 - From 84% to 40 % limestone masonry.

1- Mostly other materials.

Masonry (coating):

3 - No Finish over Limestone;

2 - Lime mortar

1 - Other

0 - When it is not possible to inspect the element; or it does not exist;

Masonry (Finishing)

3 - No Coat over Limestone; Decorative Limestone;

2 - Lime paint;

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Roof (Shape)

3 - Two slopes (Gable)

2 - Four slopes (hip);

1- Other

Roof (Cover)

3 - Mission roof tile

2 - Portuguese Tile; Marseille tile;

1- Other

Chimney

3 - Masonry with lime mortar;

2 - Masonry with cement mortar; Masonry with cement mortar and decorative limestone;

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Drainage of rainwater

3 - Non existent;

2 – Iron

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Window frames (Material)

3 - Wood

2 - Brown aluminium;

1- Other

Windowpanes

3 - Transparent Glass

2 - Colored Glass

1- Other

Windowsills

3 - Brushed limestone / Non existent /Crafted limestone

2 - Other brushed stone

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Doors (Material)

3 - Wood

2 - Brown aluminium;

1- Other

Door(s) Sill(s)

3 - Brushed limestone / Nonexistent

2 - Other brushed stone

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Fence

3 - Limestone masonry with/without mortar

2 - Brick masonry covered in decorative limestone

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Threshing-floor

3 - Limestone masonry with/without mortar

2 - Brick masonry/cement mortal

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Water tank/ Well

3 - Limestone masonry with/without mortar

2 - Brick masonry/cement mortal with decorative limestone

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Porch (Support)

3 - Limestone pillars with/without mortar

2 - Other stone pillars.

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Porch (Guard-rail)

3 - Limestone masonry wall

2 - Brick masonry covered in decorative limestone

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

Stairs

3 - 100 to 85 % Limestone masonry

2 - From 84% to 40 % limestone masonry

1- Other

0 - When it is not possible to inspect the element; or it does not exist;

4.2 Applying the Microsoft Excel® assessment model to case study buildings

After all the information is collected and the first scores start emerging some calculations can be done. One of the first things done in this regard was giving the categories different weight.

4.2.1 Calculating proximity to the architectural matrix

One of the defining characteristics of this vernacular structures is their **Exterior walls**, so this category is worth 0,4 (or 40%) of the total, with the Masonry Type being 0,2 (or 20%) worth, Masonry Coating 0,1 (or 10%), and Masonry Finishing 0,1 (or 10%).

After that we have the **Roof** section which is worth 0,25 (or 25%), the shape (0,1 or 10%) and cover type (0,1 or 10%) are worth much more than the other two elements in this category, Chimney (0,02 or 2%) and Drainage of rainwater (0,03 or 3%).

Next comes the **Spans** with a value of 0,15 (or 15%), it is made up by 5 subcategories Window frames (Material), Windowpanes, Windowsills, Doors (Material) and Door(s) Sill(s), each worth 0,03 (or 3%).

After that the **Equipment** value is 0,19 (or 19%), it is worth remarking that the Fence 0,1 (or 10%) is worth more than half the weight of the category, the other elements in this category are the Threshing-floor 0,03 (or 3%) Porch (Support) 0,01 (or 1%), Porch (Guard-rail) 0,01 (or 1%), Water tank/ Well 0,03 (or 3%) and Other details 0,01 (or 1%).

Lastly the **Access** value is 0,01 (or 1%), it only has one subcategory Stairs 0,01 (or 1%).

The proximity to architectural matrix value (1-3) selected by the user, is divided by the maximum value possible (3), to obtain the Input value. Then a True or false verification is run, giving a number to Existence (1 if exists, 0 if it does not). After, the Input value is multiplied by the element weight to get Including element weight. Including element weight is then divided by the Category weight to get Category relative weight. The partial sum is then obtained by multiplying the sum of the input values for the category, by the category weight and then multiplying it all by 3.

After these verifications and the partial sum calculations, the final result is then calculated by adding all the partial sums. An example table for the proximity to architectural matrix score is shown in table 90.

category weight	category	element weight	Input value		Existence	including element weight	category relative weight	proximity to architectural matrix	
		Matrix						Matrix (1-3)	Results
0,40	**Exterior walls**								
	Masonry (Type)	0,2	0,00	–	0	0	0,000	0	
	Masonry (coating)	0,1	0,00	–	0	0	0,000	0	
	Masonry (Finishing)	0,1	0,00	–	0	0	0,000	0	
						0	0,000	**Partial sum**	
0,25	**Roof**								
	Roof (Shape)	0,1	0,00	–	0	0	0,000	0	
	Roof (Cover)	0,1	0,00	–	0	0	0,000	0	
	Chimney	0,02	0,00	–	0	0,000	0,000	0	
	Drainage of rain water	0,03	0,00	–	0	0	0,000	0	
						0,000	0,000	**Partial sum**	
0,15	**Spans**								
	Window frames (Material)	0,03	0,00	–	0	0	0,000	0	
	Window panes	0,03	0,00	–	0	0	0,000	0	
	Window sills	0,03	0,00	–	0	0	0,000	0	
	Doors (Material)	0,03	0,00	–	0	0	0,000	0	
	Door(s) Sill(s)	0,03	0,00	–	0	0	0,000	0	
				-		0	0,000	**Partial sum**	
0,19	**Equipment**								
	Fence	0,1	0,00	–	0	0,000	0,000	0	
	Threshing-floor	0,03	0,00	–	0	0	0,000	0	
	Porch (Suport)	0,01	0,00	–	0	0	0,000	0	
	Porch (Guard-rail)	0,01	0,00	–	0	0	0,000	0	
	Water tank/ Well	0,03	0,00	–	0	0	0,000	0	
	Other details	0,01	0,00	–	0	0	0,000	0	
						0,000	0,000	**Partial sum**	
0,01	**Access**								
	Stairs	0,01	0	–	1	0	0	0	
1			1			0		**Partial sum**	
								FINAL RESULT	

Table 90 - Identity diagnosis score table

4.2.2 Calculating the state of buildings conservation

Most of the categories and subcategories have the same weight for the **state of conservation score** that they did in the **proximity to architectural matrix,** with the spans and equipment being the exception.

Next comes the **Spans** with a value of 0,2 (or 20%), it is made up by 5 subcategories Window frames (Material), Windowpanes, Windowsills, Doors (Material) and Door(s) Sill(s), each worth 0,04 (or 4%). After that the **Equipment** value is 0,15 (or 15%), the Fence is worth 0,1 (or 10%), the other elements in this category are the Threshing-floor 0,01 (or 1%) Porch (Support) 0,01 (or 1%), Porch (Guard-rail) 0,01 (or 1%), Water tank/ Well 0,01 (or 1%) and Other details 0,01 (or 1%).

The state of conservation value (1-5) selected by the user, is divided by the maximum value possible (5), to obtain the Input value. Then a True or false verification is run, giving a number to existence (1 if exists, 0 if it does not). After, the input value is multiplied by the element weight to get including element weight. Including element weight is then divided by the category weight to get category relative weight. The partial sum is then obtained by multiplying the sum of the input values for the category, by the category weight and then multiplying it all by 5.

After these verifications and the partial sum calculations, the final result is then calculated by adding all the partial sums. An example table for the state of conservation score is shown in table 91.

Category weight	Category	Element weight	Input value		Existence	Including element weight	Category relative weight	State of conservation	
		Conser-vation						**Conservation (1-5)**	**Results**
0,40	**Exterior walls**								
	Masonry (Type)	0,2	0,00		0	0	0,000	**0**	
	Masonry (coating)	0,1	0,00		0	0	0,000	**0**	
	Masonry (Finishing)	0,1	0,00		0	0	0,000	**0**	
			0			0	0,000	**Partial sum**	**0**
0,24	**Roof**								
	Roof (Shape)	0,1	0,00		0	0	0,000	**0**	
	Roof (Cover)	0,1	0,00		0	0	0,000	**0**	
	Chimney	0,02	0,00		0	0	0,000	**0**	
	Drainage of rainwater	0,02	0,00		0	0	0,000	**0**	
			0			0	0,000	**Partial sum**	**0**

Table 91- Conservation score table – part 1

category weight	category	element weight			Existence	including element weight	category relative weight	State of conservation	
		Conser-vation						**Conservation (1-5)**	
0,2	**Spans**								
	Window frames (Material)	0,04	0,00		0	0	0,000	**0**	
	Window panes	0,04	0,00		0	0	0,000	**0**	
	Window sills	0,04	0,00		0	0	0,000	**0**	
	Doors (Material)	0,04	0,00		0	0	0,000	**0**	
	Door(s) Sill(s)	0,04	0,00		0	0	0,000	**0**	
			0			0	0,000	**Partial sum**	**0**
0,15	**Equipment**								
	Fence	0,10	0,00		0	0	0,000	**0**	
	Threshing-floor	0,01	0,00		0	0	0,000	**0**	
	Porch (Suport)	0,01	0,00		0	0	0,000	**0**	
	Porch (Guard-rail)	0,01	0,00		0	0	0,000	**0**	
	Water tank/ Well	0,01	0,00		0	0	0,000	**0**	
	Other details	0,01	0,00		0	0	0,000	**0**	
			0			0	0,000	**Partial sum**	**0**
0,01	**Access**								
	Stairs	0,01	0		1	0	0	**0**	
1			1			0		**Partial sum**	**0**
								FINAL RESULT	**0**

Table 92- Conservation score table – part 2

4.2.3 Analysis of results

The following tables appear in the *results* tab of the assessment model, (Table 93), shows the final results for architectural matrix proximity, and state of conservation score for all 24 analyzed houses.

ID	Matrix results	Conservation results
1	2,403	4,725
2	2,583	3,393
3	2,268	2,677
4	2,583	4,880
5	2,753	4,960
6	2,799	3,685
7	1,652	4,960
8	2,525	3,747
9	2,615	4,590
10	2,667	2,827
11	2,083	4,810
12	2,867	1,840
13	2,188	4,930
14	2,510	4,960
15	2,413	4,520
16	2,783	3,077
17	1,950	4,503
18	2,185	4,703
19	2,373	4,800
20	2,753	4,250
21	2,607	4,530
22	2,409	4,700
23	2,818	4,440
24	2,844	4,230

Table 93- Results score table

Table 94 separates the architectural matrix results in to three levels of proximity to matrix, level 1 being the furthest away from architectural matrix and signifying that the identity of the building was lost (even though some original elements maybe left), level 2 meaning that some elements may have been removed/added to the original construction, and level 3 the closest to architectural matrix is understood to

mean most identical to the original construction (some element may have been replaced with new, yet original-looking, ones). Numerically, level 1 corresponds to proximity scores between 0 and 0, 99 (out of 3), level 2 corresponds to proximity scores between 1 and 1, 99 (out of 3), and level 3 corresponds to proximity scores between 2 and 3 (out of 3).

Evaluation of the proximity to the architectural matrix:		
Level 1	The identity of the building was lost (even if some original elements are left).	From 0 to 0,99
Level 2	Some elements may have been removed/added to the original.	From 1 to 1,99
Level 3	Almost identical to the original construction (some element may have been replaced with new, yet original-looking, ones).	From 2 to 3

Table 94- Proximity to architectural matrix levels

None of the analyzed buildings are at level 1 of proximity to architectural matrix, 2 (8,3%) buildings are at level 2, and 22 (91,7%) were at level 3.

Table 95 separates the state of conservation results in to five levels of state of conservation level 1 being the worst, and level 5 the best. Numerically, level 1 corresponds to scores between 0 and 0, 99 (out of 5), level 2 corresponds to state of conservation scores between 1 and 1, 99 (out of 5), level 3 corresponds to scores between 2 and 2, 99 (out of 5), level 4 corresponds state of conservation scores between 3 and 3, 99 (out of 5) and level 5 corresponds scores between 4 and 5 (out of 5).

State of conservation:		
Level 1	Very bad condition: Large structural anomalies, not habitable if left without intervention; Ruin;	From 0 to 0,99
Level 2	Bad condition: Medium structural anomalies and/or very extensive non-structural anomalies	From 1 to 1,99
Level 3	Medium condition: Small structural anomalies and/or medium non-structural anomalies.	From 2 to 2,99
Level 4	Good condition: Small or non-structural and easily correctable anomalies.	From 3 to 3,99
Level 5	Very good condition: No need for intervention (may need maintenance)	From 4 to 5

Table 95- State of conservation levels

None of the analyzed buildings are at level 1 of state of conservation, 1 (4,2%) building are at level 2, 2 (8,3%) were at level 3, 4 (16,7%) were at level 4, 17 (70,8%) were at level 5.

The average proximity to the architectural matrix of the analyzed constructions is 2,485 out of 3 (82,8%).

The building that is closer to the architectural matrix is number 12, with 2,867 out of 3 (95,6%), and the furthest to the architectural matrix is number 7 with 1,652 out of 3 (55,1%). (Table 96)

			Nr:
Closer to matrix:	2,867	Building:	12
Average (matrix):	2,485		
Furtherst from Matrix:	1,652	Building:	7

Table 96 – Closest, furthest building and average value of proximity to architectural matrix

The average state of conservation score of the analyzed constructions is 4,197 out of 5 (83,9%).

Three buildings have the best state of conservation score, they are number 5, 7, and 14 with 4,960 out of 5 (99,2%), and the one with worst state of conservation score is number 12, with a score of 1,840 out of 5 (36,8%). (Table 97)

	Value		Nr:
Best conservation:	4,960	Building:	5; 7; 14
Average (conservation):	4,197		
Worst conservation:	1,840	Building:	12

Table 97 – Closest, furthest building, and average value of state of conservation score

Based on the results, the analyzed sample is comprised mostly of buildings that are close to the architectural matrix (91, 7%), and in good to very good state of conservation (87,5%) with 70,8%, meaning they have not been rehabilitated, or those that did have kept their identity.

5 Conclusions

The main conclusions of Chapter 2 are that vernacular stone structures are advantageous, long lasting, ecological friendly and can be found all over the World (as showed in 2.1), including Portugal (as described in 2.2), and Serra de Santo António. Within an overbuilt country, conservation/rehabilitation of these buildings could be a good alternative to new construction.

Point 2.3 showed that although, Limestone started being used in construction in this area, out of convenience, the abundance, and the variety of limestone structures all around the village, decades after modern construction became available and achievable, emphasize how essential this resource was to everyday life, and how crucial it is to its identity.

From Chapter 3 is possible to conclude that the goal of mapping limestone buildings was achieved, since the sample was mapped. Most of the analyzed buildings were isolated, one-story houses, purely made of limestone masonry without any coating or finish, with at least one annex, and adjacent free space (likely a backyard, front yard, or garden). Such as the point 3.2 refers, the majority of studied houses also had a two-slope roof (gable), with Marseille tile as roof cover, a chimney, no drainage of rainwater system, a limestone fence wall (or a wall with decorative limestone), and no porch or threshing-floor.

The goal of using the Microsoft Excel® adapted to the creation of a vernacular limestone buildings assessment model was achieved. Therefore, it was applied to the 24 buildings of Serra de Santo António. Based on the results, of chapter 4, the analyzed sample is comprised mostly of buildings that are close to architectural matrix (91, 7%), and in good to very good state of conservation (87,5%) with 70,8%, this allows an idea of how the state of conservation is, and that the original architecture still there, in most cases, fulfilling another of the goals.

This dissertation went even beyond the traditional domain of civil engineering, when entering the domain of vernacular architecture and deepening the knowledge of Microsoft Excel®, and writing it in English, as this is not my mother tongue, was an added challenge.

Finally, regarding the next steps of research, focused on the limestone buildings in Serra de Santo António, there are a set of other aspects to be studied. Among these aspects is the possibility of extending the area of study to the entire village, or to nearby areas with similar buildings.

Bibliographic references

Harries, K. A., & Sharma, B. (Eds.). (2019). *Nonconventional and vernacular construction materials: Characterisation, properties and applications*. Woodhead Publishing, University of Pittsburgh, PA, United States, University of Southern California, Los Angeles, United States.

Dipasquale, L., Rovero, L., & Fratini, F. (2020) *Nonconventional and Vernacular Construction Materials*. Italy

Smith, B. J. (Ed.). (2010). Limestone in the built environment: present-day challenges for the preservation of the past. Geological Society of London.

Patton, J. B., & Carr, D. D. (1982). *The salem limestone in the indiana building-stone district*. Indiana Geological Survey. 1987 U. S.A.

Zhai, Z. J., & Previtali, J. M. (2010). Ancient vernacular architecture: characteristics categorization and energy performance evaluation. *Energy and Buildings*, *42* (3), 357-365.

Gomes, J. F. M. M. (2011). *Reabilitação de edifícios-construção nova situação na Beira Interior* (Master dissertation, page 3), Universidade da Beira Interior

Mascarenhas, J. (2015). Sistemas de Construção, vol. XV: Arquitetura Popular Portuguesa. Descrição Ilustrada e Detalhada de Processos Construtivos Utilizados Correntemente em Portugal.

Almeida, F. A. D. C. (2016). Aldeias palafíticas fluviais em Portugal: urbanismo e arquitetura Avieiras, Universidade da Beira Interior, Covilhã.

Malpique, P. R. S. AVAL-Nisa: Estudo do Património Histórico Habitacional através da criação de um Modelo no Microsoft Excel™ (Master's dissertation), Universidade da Beira Interior

Siegesmund, S., & Snethlage, R. *Stone in architecture: properties, durability*. Springer Science & Business Media, 2011 – Springer

Asquith, L., & Vellinga, M. (Eds.). (2006). Vernacular architecture in the 21st century: Theory, education and practice. Taylor & Francis.

Vieira, S. (2012). *Aldeias do Carso-estratégias de valorização e desenvolvimento* (Master's thesis, Universidade de Évora)

Legislation

Lei 107/2001, 2001-09-08 – DRE

Webographic references

Dry Stone Conservancy (visited in 2020) at https://www.drystone.org/historyofdrystoneconstruction

INE, I. P. (2012). Censos 2011 resultados definitivos-Portugal. *Lisboa-Portugal: Instituto Nacional de Estatística, IP*.

INE, I. P. (2002). Censos 2001 resultados definitivos-Portugal. *Lisboa-Portugal: Instituto Nacional de Estatística, IP*.

Google maps ((visited in 2020) at: https://www.google.pt/maps

Câmara municipal de Alcanena's site (visited in 2020) at: http://cm-alcanena.pt/index.php/pt/municipio/freguesias/freguesiaserrasantonio

Topographic-map.com at: https://pt-pt.topographic-map.com/maps/gamd/Serra-de-Santo-António/

Annexes

Early diagnostic sheet for limestone building

Diagnostic Sheet for Limestone Building	Village code: |Building code :

Location:

Street:_____Nr: _____

Town:_____Municipality: _____

Fotographs and drawings:

General characterization:

Building type:

Housing ☐

Barnyard ☐

Others: _____ ☐

Inclosure:

Garage ☐

Barnyard ☐

Stockyard ☐

Volumetry:

The totality of the land is built:

Yes ☐ No ☐

Nr of floors: 1 ☐ 2 ☐ Other ☐ Nr:___

Construction type:

Nr of blocks:

1 ☐ 2 ☐ 3 ☐ 4 ☐

Other ☐ Nr:___

Building characterization:

Exterior walls:

Structural:

All ☐

Some ☐

Other cases: _____ ☐

Type of material:

Limestone masonry ☐

Other rock masonry ☐

Brickwork ☐

Others: _____ __ ☐

Plaster and final touches:

Grout Plaster:

Yes ☐ No ☐

Paint ☐

Others:_____ ☐

Roof:

Structure:

Wood ☐

Cement beams ☐

Others: _____ ☐

Ceramic roof tile:

Mission tile ☐

Ribbed tile ☐

Others: _____ ☐

Stairs:

Yes ☐ No ☐

Limestone:

Yes ☐ No ☐

Covered with plaster:

Yes ☐ No ☐

Doors and Windows :

Doors:

Non-existent ☐

Wood ☐

Aluminum ☐

Iron ☐

Others: _____ ☐

Windows:

Non-existent ☐

Wood ☐

Aluminum ☐

Iron ☐

Others:_____ ☐

Porch:

Yes ☐ No ☐

Limestone:

Yes ☐ No ☐

Roof: Ceramic tiles ☐

Others: _____ ☐

Equipments:

Delimitation of the building sit:

Stone Fence Yes ☐ No ☐

100% Stone ☐

Cement on top ☐

Others: _____ ☐

Equipment:

Threshing-floor:

100% stone ☐

Concrete ☐

Others: _____ ☐

Rain gutter:

Yes ☐ No ☐

Material:

_____

Chimney: Yes ☐ No ☐

100% Stone ☐

Concrete ☐

Others: _____ ☐

Others:

_____

Still being used:

Yes ☐ No ☐

Photographs and drawing of the equipment:

State of conservation:

Classification	Element	Level of					Non-existent
		5	4	3	2	1	
Structural	Exterior walls						
Structural	Roof						
Structural	Stairs						
Structural	Outbuildings						
Structural	Porch						
Doors/windows	Doors						
Doors/windows	Windows						
Plaster and final touches	Roof						
Plaster and final touches	Exterior walls						
Plaster and final touches	Stairs						
Plaster and final touches	Outbuildings						
Others	Land boundary wall						
Others	Threshing-floor						
Others	Chimney						
Others	Rain gutter						

Notes:

Evaluation of the proximity to the architectural matrix:

Classification	Element	Level of proximity			Non-existent
		3	2	1	
Structural	Exterior walls				
Structural	Roof				
Structural	Stairs				
Structural	Outbuildings				
Structural	Porch				
Doors/windows	Doors				
Doors/windows	Windows				
Plaster and final touches	Roof				
Plaster and final touches	Exterior walls				
Plaster and final touches	Stairs				
Plaster and final touches	Outbuildings				
Others	Land boundary wall				
Others	Threshing-floor				
Others	Chimney				
Others	Rain gutter				

Notes: