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A UNIQUE EXAMPLE OF VERNACULAR CONSTRUCTION IN ANATOLIA: THE CONSTRUCTION TECHNIQUE IN TRADITIONAL CAPPADOCIA HOUSES

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Abstract. *The region called Cappadocia is located in the center Anatolia in Turkey. It is has been a World Heritage Site with the name of "Göreme National Park and the Rock Sites of Cappadocia" since 1985. Cappadocia now is a fantastic and popular tourism destination which hosts averagely 2 million tourists per year.*

The site has attracted a great deal of attention due to its distinguish topographic/geological structure. Volcanic eruptions covered the land with a tick tuff layer. This layer was formed by the effects of wind, rain and snow in different shapes and formations which named as fairy chimneys. Geological formations also provide a unique and spectacular architecture in the region. In early times the housing requirements have been supplied by carving these tuff formations. People have shaped the natural environment as their needs and used these rock-carved spaces as barns, houses and sacred spaces. By this way natural environment and built-environment became interlocked. In the previous period beside they started to cut the rock mass as building stone, they also opened quarries to get construction stone. Thus, a distinctive housing architecture has been generated by stone constructions, rock-carved constructions and mixed type constructions.

This study aims to define the vernacular construction of Cappadocia houses. The material, construction technique and features of these elements were analyzed. The rock- carved houses and stone-built houses were studied in detail from foundation to roof. Different details were drawn on the changing points of the construction technique. The mixed use of rock and stone material were also studied.

Consequently, the construction process in traditional technique was determined. The methods of reshaping the natural environment as built-environment were examined. Thereby, a unique example of vernacular construction was analyzed.

1. INTRODUCTION

The region called Cappadocia is located in the center Anatolia in Turkey. The administrative districts of five provinces which are Nevşehir, Aksaray, Kırşehir, Niğde and Kayseri involve the region Cappadocia. Geology of the area has gained a reputation over the years though site has attracted a great deal of attention due to its distinguish topographic/geological structure. That geological structure had been generated by volcanic eruptions of the nearby mountains Hasan and Mount Erciyes. Volcanic eruptions occurred several times had covered the land with a tick tuff layer. In the course of time this layer has formed in different shapes by the effects of temperature differences between night and day and climatic factors such as wind, rain etc. Thus valleys covered with tuff and formations named as fairy chimneys have been generated in time. Over the years fairy chimneys, huge rock masses and valleys have been used in order to settle down. Soft structure of the tuff provided opportunity to build spaces and to found new settlement areas. Thereby today couples of underground cities, many of rock-carved spaces as churches, houses, and stores can be seen easily. Göreme, Uçhisar, Ürgüp, Avanos and Derinkuyu are some of the settlements in which that kind of spaces can be found frequently.

Due to these distinguished features of Cappadocia, the site listed by the Turkish authorities as “protected area” in 1976 and as “national park” in 1986. Also, the region has been a World Heritage Site with the name of “Göreme National Park and the Rock Sites of Cappadocia” since 1985. The site provide the requirements of the world heritage criteria of I, III, V and VII which mean representing a masterpiece of human creativity, having an exceptional testimony to a civilization which has disappeared, being an outstanding example of traditional human settlement, having an exceptional natural beauty and aesthetic importance. Cappadocia is now a fantastic and popular tourism destination which hosts averagely 2 million tourists per year.

Geological formations and topography of the land also provide a unique and spectacular architecture in the region. In early times the housing requirements have been supplied by carving these tuff formations. People shaped the natural environment as their needs and used these rock-carved spaces as barn, house and sacred space. So the rock carving progressed by being one of the major characteristic of vernacular architecture. Moreover, natural environment and built-environment interlocked to each other by this way. In the previous period, beside they started to cut the rock mass as building stone, they also opened quarries to get construction stone. The various stone quarries in the region determine the major construction material as soft, yellowish, easy shaped tuff stone. Thus, a distinctive housing architecture has been generated by stone constructions, rock-carved constructions and a special construction type which both techniques are used together.

This paper aims to identify these three construction techniques through the field surveys done in the region and interviews with the local masons. According to these surveys construction techniques used in traditional houses can be classified in two groups: rock carved construction technique and masonry construction technique. As a de facto it is known that people started to build a house first by carving rock and opening some spaces, then continued by constructing masonry structure in relation with rock carved spaces. However field surveys showed us these two techniques are used together in many cases. So that in this paper the subject is considered according to the building parts and it is tried to define how they were constructed.

2. CONSTRUCTION TECHNIQUES

Cappadocia house is genuine typology that exhibits perfect eurhythmy with the local natu-

ral conditions. It is built as two or three storied and originally flat roofed. Since the houses are sat on slopes, it naturally generates terraces. The traditional Cappadocia houses are categorized into three main groups: rock-carved houses, mix type (rock-carved & masonry) houses and masonry houses (Erençin, 1979).

Rock-carved houses constitute to the earliest housing type. In this kind of houses, spaces are generated by carving out valley slopes or fairy chimneys. The houses carved into valley slopes reproduce with new spaces by again carving out the rock mass horizontally or vertically. The houses, constructed in the mixed technique of rock-carving and masonry are generated by addition of a wall, an aiwan (a rectangular space of which one side is open while the other three sides are enclosed by walls) or a masonry room in front of the main rock-cut space. Masonry houses are one, two or three storied buildings which are decorated with stone carved ornaments to show the wealthy and statue of the owner. In earlier examples the houses dragged back of the building lot while the later examples are faced to road. This last type masonry houses is considered as the last stage of other two construction techniques (Binan, 1994).

Figure 1, İbrahimpaşa- Ortaköy, traditional settlements of Cappadocia

Foundation

The foundations beneath the masonry walls can be made entirely of stone, of rock or partially stone/rock. The width of foundation wall changes according to masonry wall and its height depends on the ground"s condition. Foundation wall is constructed with two or three stone row and the gap between stones filled with mortar about 5cm thicknesses.

As a result of field studies, the foundations of 16 houses and 23 different details belong to these houses could be reached. The types of foundation materials, width and height of foundation walls, connections with rock ground and relations with inner and outer space levels are examined.

In stone foundations, foundation walls are either placed on a canal formed by carving rock ground or directly sit on the rock ground. Construction of foundation walls starts with opening several gaps of approximately 40cm on the rock ground. The main function of these gaps is to transfer the building load to rock ground. The dimensions of gaps changes according to structure of the ground. Upon these gaps which are around 2 rows of stone, the foundation walls are raised 30-100 cm more till the ground floor level. In this way 70-80 cm level difference emerges between inner ground level and outer ground level (see Fig. 2). With this level difference it becomes possible to keep away ground humidity and bad weather conditions as rain, snow. The thickness of foundation wall usually changes between 40cm and 70cm.

Rock foundations are formed by carving ground rock to produce foundation walls. This type exists in 11 of 23 details. In rock carving technique which is seen very often because of

geological structure of the region, the rock itself works as foundation with its long durability. Thus stone foundation walls are not needed frequently (see Fig. 3). While it is anticipated to see rock-carved foundations in rock-carved houses, it is a common practice also in masonry structures (see Fig. 4).

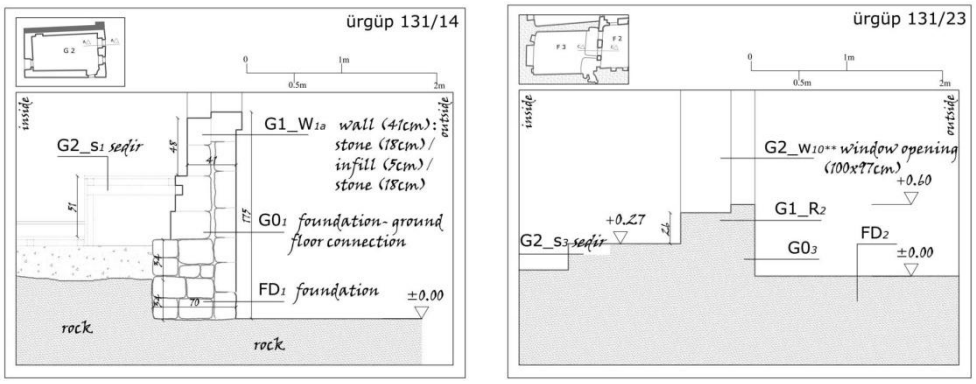

Fig. 2-3, Detail of foundation type 1- Detail of foundation type 2

Fig. 4, Foundation type 2 (Ürgüp, block/lot: 131/21)

Walls and rock as a part of structure constitute to the vertical structural elements in traditional Cappadocia houses.

Walls

The masonry walls are constructed with local stone which is called "Nevşehir stone". The stones used in constructions are fine cut-stone and rough cut-stone. Rough cut- stones which quarried and then shaped roughly are mostly used in storages and service units. Some rare examples show us rough cut-stone can also be used in main building walls (see Fig. 5). Rough-cut stone usages in main building walls are related with the owners‟ economic status and/or the quarries‟ situation in times of construction. Most of the buildings are constructed with fine cut-stone which brought as blocks from quarry and reshaped elaborately.

Ground floor walls are built in two rows with infill and/or mortar between the rows. The gaps between the rows are filled with rock and stone pieces which called "*kesek*". The special binding mixture called "*şillez*" is poured into the wall gaps. *Şillez* enables *kesek* to adhere to wall rows.

In terms of construction techniques 3 types can be seen:

Wall Type 1: Thin Double Sided Wall

This type of walls is constructed on the foundation walls in ground floor and on the arches of aiwan in upper floors. Total thickness of thin double sided walls changes between 40cm to 60cm. The technique of construction of the wall is as follows: Two stones of 18-25cm are put together side by side; between these two stones 5cm gap is left and this gap is filled with rubble and mortar (see Fig. 7). Thus, the total thickness reaches to about 40cm.

Thin double sided walls are usually built with fine cut-stone. When the wall is constructed with cut-stone, only the outer sides of stones are cut finely, inner sides facing to gaps are left roughly (see Fig. 6, 7). Thereby, infill and mortar become integrated with stones much better. It is observed in demolished parts of buildings that the gaps between these two stones are filled with broken pieces of stones and rock. There are also a few instances of walls which constructed in the same technique with fine cut-stone and rough cut-stone used together with gap. In this condition, the inner sides of wall is constructed with fine cut-stone, the outer side is constructed with rough cut-stone.

In some houses these two techniques are used together. In this combined type, at corners and nearby the corners both sides of wall are constructed with cut-stone; at the middle part of the wall, one side is constructed with cut-stone and the other side with rough cut-stone. Mix technique is seen in only one of surveyed houses. It is clear that cut-stones on the wall corners keep the building steady and prevent the wall loosening from corners (see Fig. 5).

Wall Type 2: Thick Double Sided Walls

Thick double-sided walls are also constructed with two stones and filled gap between them. The thickness of stones varies between 20 and 30cm and the total thickness of wall changes between 60cm to 85cm. Main differences of this wall type is the width of the gap between the stones. This gap which can reach to 35cm in some houses is filled with particles of stones and rock called „*kesek*" and „*kayır*" locally (see Fig. 8). Because the wide gap can cause structural problems, stones 60- 85 cm in length are set perpendicular to others along the wall. These orthogonal stones are usually located randomly. They can be distinguished on facades by their square shaped bases among rectangular stones of the wall. It is known that this construction technique was also used in buildings in ancient settlements such as Labraunda (Altınöz and oth., 2013).

It is noted that thick double-sided wall technique is used especially on the walls which constructed with fireplace. This type of wall is usually made with cut-stone however in one house rough cut-stone was observed. Rough cut- stones are used for both layers on this 68cm width wall and the gap between the stones is again infilled.

Although not as systematically as in single-sided walls, iron tie bars can be seen on upper floor double-sided walls. Tie bars on thin double-sided walls are used on the front and side facades. Another similar technique is using timber tie beams instead of iron tie bars. At three surveyed house, timber tie beam is found approximately two times in every floor and located above or under the door/window openings if exist, otherwise located along the wall close to the floor level (see Fig. 9). Different than iron tie bars, timber tie beam is hidden on building façade; there is no tightening system outside of the wall.

Wall Type 3: Single-Sided Walls

Single-sided walls are built with stones varying 18-30cm in thickness set in one row. This type was found in ground floors very rarely. These were inner walls built in single row on rock ground in order to enclose entrance of an interior rock-carved space (see Fig. 10).

In upper floors, single-sided walls are constructed with cut-stone upon double-sided walls of ground level. For that purpose, the 40-60 cm thick wall of ground floor is extended to second floor level and conjoined with it by using cornice inside. After its outer surface is coated with cornice in order to underline the start of next floor, the wall is continued to be built in single row the thickness of which varies between 18cm and 30cm.

Upper level single-sided walls are attached with iron tie bars to hold them together (see Fig. 11). The dimensions of these tie bars are 0.3 cm in thickness and 3cm in width. They are located under or above the window openings and went along with wall and fastened up with another 50cm length, 0.3cm width vertical bar which is pulled through the hole on the top edge of tie bars (see Fig. 12). Walls are strengthened to the lateral load by applying this technique to all building walls. It is also revealed that horizontal tie bars are used right above the inner cornices at interior walls. Iron tie bars are seen eight of twenty surveyed houses.

Fig. 5, Rough-cut stone on buildings (Ürgüp, block/lot: 182/10- 185/12)

Fig.6, Infill between the stones of wall (Ürgüp, block/lot: 131/14)

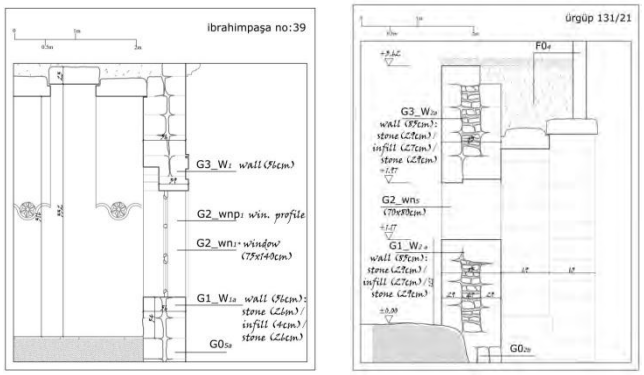

Fig. 7-8, Wall type 1a (cut-stone/infill/cut-stone)- Wall type 2a

Fig. 9, Timber tie beams on the wall (Mustafapaşa, block/lot: 73/5112-B)

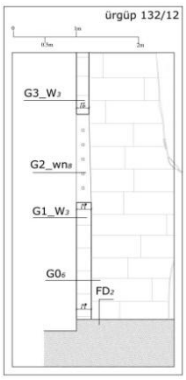

Figure 10, Wall type3

Figure 11, Tie bars on the wall (Ürgüp, block/lot: 131/45)

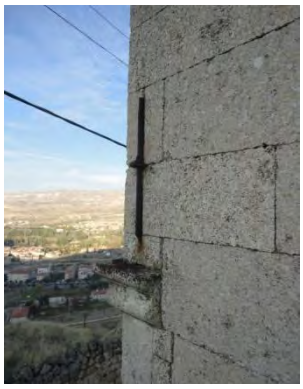

Figure 12, Tie bar (Ürgüp, block/lot: 131/14)

Rock-cut Walls:

Rock is frequently used as a part of building in foundations, walls, roof and architectural elements. In addition to formability, due to its structural features rock plays an important role as a vertical element in buildings. Thus, necessities of adding load-bearing walls in rock-carved spaces disappear.

People shape rock into different length, width and depth to make spaces more functional in accordance with their needs. In some cases rock is carved in to generate a space; in other cases it works as a separator between two spaces. In both situations, architectural elements such as niches, cupboards, fireplaces are made of carved rock. As a vertical structural element, rock can be classified according to the technique by which it is processed. In this respect, there are two groups to examine the use of rock as vertical structural elements.

First group comprises the rock elements which are constructed with rough carving technique that traces of carving tools can easily be noticed on the surfaces (see Fig. 13) and the dimensions of window and door openings are not standard.

The second group consists of rock elements that are finely carved which have smooth edges (see Fig. 14). Space units built by this technique are in regular geometric forms thus sometimes it is possible to confuse the stone surfaces and lime-washed rock surfaces. Elements such as niche and window/door openings are also constructed very accurately.

Rock structures are usually used in ground floors. In houses located on the edge of a big rock mass, ground floor spaces are made of carved- rock while upper floors are built with masonry. As it was observed in other examples, rock mass is conjoined with masonry room or aiwan and if needed, upper floors are built with stone masonry. Rock structures can be pre-

ferred in upper levels according to quality of rock mass. It is seen only one of twenty house that both ground floor and second floor were rock-cut structure.

Materials and Spanning Elements of Flooring:

Ground floors are constructed with stone floor coverings. Flooring sets on the rock ground while stone masonry wall is rising up (see Fig. 15). Before floors are set, rock ground is covered with pumice around 3-10 cm in thickness in order to protect floor from ground dampness.

Another type used in ground floors is to raise the floor with timber posts. In this type, floor is elevated on 50-100cm high timber posts in order to keep away the floor from ground dampness. This floor is usually completed with a timber *sedir* (a fitted architectural element which is used for sitting and lying down). It is also possible to use lower timber posts to elevate the floor however in this case the gap is filled with pumice. In some instances pumice is covered with clay mud and timber beams, which carry the floor, are located on clay mud (Interview, November 2011).

In almost every rock carved houses, floor is also built with rock without using any other flooring material (see Fig. 13, 14). Similar techniques are also used in upper floors. Timber beams are placed on inner cornices and then floor boards are set on these timber beams.

There is a distinctive ceiling system in the region called as *hezen*. *Hezen* is barked tree trunk and used to span over openings. In ceilings of ground floor and/or first floor they are covered with infill and straw, upon which floor boards are set. In last floor ceilings *hezen*s, covered with straw, infill and clay soil, form the roof.

Another widely used system is to cover ground floor with vaults which also forms the floor of next story. There are examples of this floor type with stone *sedir*.

Aiwan‟s vault built in front of a rock mass and rock are also generated the upstairs‟ floor. Top of the vault is filled with pumice in order to have a flat surface and then stone floor coverings are placed on this layer. This type of flooring is used very common in the region where rock-cut and masonry systems are frequently faced with together. In houses which ground floor and upper floors are both constructed with carved rock, floor of upper level is also formed by carved rock. The thickness of floor varies in these houses.

Arches and vaults as Spanning Elements

Horizontal structural system which produced with arches and vaults is one of the significant construction techniques of the region. It is considered an indigenous feature to Cappadocian Architecture.

In local traditional technique, rib arch and cover arch are built next to each other to support vault, which are known locally as *atkı kemerli tonoz*. (See Fig. 3.16). These vaults are frequently used as structural elements and the spaces which have these vaults, are named in the region as „arched room (*kemer oda*)‟.

The construction technique of arches and vaults was revealed via interviews held with local craftsmen and surveys in the field. According to all information the process of construction will be defined step by step. Firstly, four sides of the room walls are constructed up to the impost line which is locally known as „foot level‟. After reaching impost line, front and rear walls are constructed. In the meantime, a wooden vault framework is located between side walls and then arches are started to be constructed on inner sides of walls. The front and side surfaces of voussoirs are fine cut while back surfaces are rough cut.

Rib arches (locally called *kaburga kemer)* which act as main bearing element are constructed in dimensions varying between 60cm and 80cm width. Rib arches are located with

60-80cm intervals and these intervals are covered with secondary row of arches which called cover arch (locally called as *„kapak kemer"* or *„ara kemer"*). Cover arches are placed on 5-10cm wide indents locally called *„Jamba"* which are opened on both sides of voussoirs of rib arch (see Fig. 18). Cover arch which is around 20-25cm wide is usually thinner than rib arch. When necessary, it is built as self-supporting element. The width of rib arches" voussoir is about 20 to 30cm. The wider the opening covered with arch, the thicker the voussoirs are needed. Thus, vaults varying 500 to 700cm in length are generated by constructing rib arches and cover arches together (see Fig. 16).

When arch profiles are analyzed, it is seen that in arch rooms height of arches" top points change from 300cm to 400cm. This height rarely exceeds 400cm in the rooms. In aiwans, the top points of arches are usually higher than 400cm. Between rib arches and cover arches there is always 5-10cm difference in thickness and 10-20cm difference in height from ground level.

The space between arch and wall, which begun to be set together and separated at impost level, is called *„arch seat"*. This space is filled with light material called *„kesek"* which consist of construction rubbles, pieces of broken stones/rock and pumice. Soil is not preferred as an infill material as it causes extra load; however it is used when *kesek* and pumice are not available (see Fig. 17).

When the vaults are used in ground floor, first floor or aiwan, it also forms the level of next story. Vault is covered with pumice in order to produce a plane surface, and then stone coverings which measured 30-40x50-70cm are placed (see Fig. 17). Compared to other stone materials used in different parts of house, these floors are more enduring since they are more resistant to abrasion and dampness. In some houses, coverings are set on a deeper pumice infill measured from 5 to 40cm. If a *sedir* (a fitted architectural element which is used for sitting and lying down) is used in upper floor, it is constructed above the same infill (see Fig. 18). In order to construct roof, vault is filled with *kesek* and pumice and then covered with earth.

Timber beams as Spanning Elements

Timber beams are the second most common horizontal elements. Timber which has a limited area of usage in Cappadocia is often used in floorings. In surveys it was detected that the classified timber floors are installed in ground floors and first floors.

This technique is usually used in upper stores. Timber floors are placed on inner cornices which are constructed together with walls. These inner cornices varying 15-30 cm in depth, are built on inner surface of the wall and 50-60cm above the level of outer cornices (see Fig. 19).Usually, in front of the window two rows of rough cut-stone are placed above the cornice for timber *sedir* which is constructed at the same time with timber flooring. Strength of inner cornice is important for the strength of spanning elements. If the cornices are stable, when needed, timber flooring can be renewed without causing any deformation in the building. For this reason, stones of inner cornice are selected from more durable local stones (Interview, November 2011).

The measure of timber beams used in ground floor is 5x10cm and in first floor is 15x15cm. These timbers are rarely in regular geometric form; they are usually shaped roughly or used as trunks. Timber beams are located parallel to short side of the room above the inner cornices with 30-50cm intervals. Baseboards measuring 30cm in width and changing in length are set on these timber beams. The bottom sides of main timber beams are covered with ceiling of downstairs. If *sedir* is going to be used in the building, the posts of *sedir* are placed on timber beams of floor and its 5x5cm horizontal beams are installed on rough cut-stones above the inner cornices (see Fig. 19). It is also seen that baseboards are constructed up to the *sedir* level or close to it.

It was noticed that this type of floor is also used in ground story. In this case, ground is filled with pumice and this infill is covered with clay mud in order to keep the floor away from ground dampness. After that, 5x10cm floor beams are set and covered with wooden planks (see Fig. 20).

Timber beams are also used in elevated floors of ground story. The purpose of this usage is to keep away dampness. In order to do that, 40-100cm high vertical timber posts are inserted directly on rock or on filled ground, along the central long axis of the room with 60-90 cm intervals (see Fig. 21). Then 15x15cm beams are set horizontally on these posts along the same axis. Upon these beams, another row of 10x10cm beams are placed orthogonally. After that, timber planks are fixed onto these beams with nails. All the timber beams are also placed into hollows opened along the wall.

The timber floor beams called locally as *hezen* can be used in first story floors and roof floors as regular geometric forms or as trunks. *Hezen*s are located on inner cornices, hollows or holes on walls. They are placed adjacently or with 20-60cm intervals. After *hezen*s are located on wall, they are covered with layer of straw and lastly filled with pumice. Floor construction is completed by placing 5x5cm or 5x10cm timber laths on pumice infill and nailing timber boards upon these laths.

Figure 13, Rough carving technique (İbrahimpaşa, no: 39)

Figure 14, Smooth carving technique (Mustafapaşa, block/lot: 131/23)

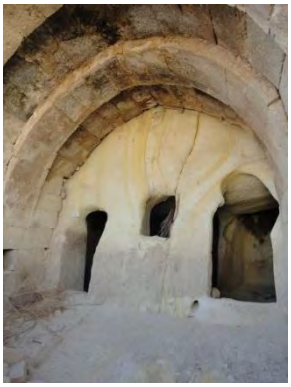

Figure 15-16-17, Vaults (rib arches and cover arches)
(Ürgüp, block/lot: 182/10) (İ.paşa, no: 26b) (Ürgüp, block/lot: 131/23)

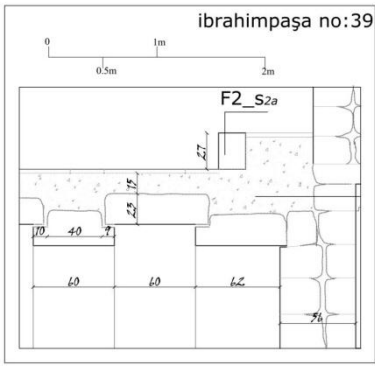

Figure 18, Vault detail (İ.paşa, no: 39)

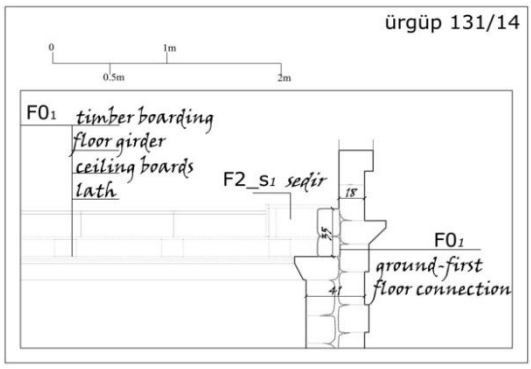

Fig. 19, Timber floor

Figure 20, Timber floor beams
(M.paşa, Topakoğlu Konağı)

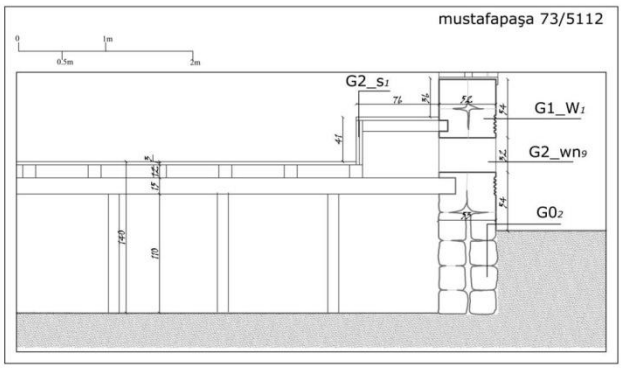

Figure 21, Elevated timber floor and *sedir* (Mustafapaşa, block/lot: 73/5112-1)

Roofs

Timber Roofs

Timber roofs are constructed with timber boards inclined in one way or in two ways as hipped roof and they are used in wealthy peoples‟ houses.

As it is mentioned before, exterior and interior cornices are placed while building walls are being constructed. As in story cornices, exterior roof cornices also emphasize the floor ends and interior cornices support the beams of roof floor (see Fig. 22). Another function of roof cornices is to act as a drip for rain and snow water coming from the roof. For this reason, some exterior cornices are constructed as extruding. Wall continues 40-60cm more after these cornices and ends with two or three rows of stone according to pitch of roof.

Roof beams measure 10x10 cm and are placed on the interior cornices parallel with the short side of space. Then an intermediate stringer is placed on these beams perpendicularly (see Fig. 17, 23). If the intermediate stringer is not used, 15x15cm floor beams are preferred. After that, 10x10cm or 15x15cm posts of roof are located on this intermediate stringer. Heights of posts are adjusted according to building dimensions and pitch of the roof. In Cappadocia traditional houses, timber roofs are usually constructed as hipped roof with inclination of 35%. Braces are nailed between the posts in order to prevent the roof brake down (see Fig. 24).

Angle rafters are placed after posts adjusted to pitch. 15x15cm or 10x10cm timbers are placed to act as purlins. It is seen that the timbers used in angle rafters are not always in a regular geometric form, they are often used as logs. 5x10cm fine cut purlins are located with averagely 150cm intervals. 5x10cm, sharply cut rafters are placed on purlins perpendicularly with 50-60cm intervals.

Rafters are covered by 20-25cm wide and 2cm thick timber boards. Mediterranean tiles are placed after timber boards. It is important to stabilize first row of tiles to prevent sliding of tiles. For this reason, averagely 5x5cm sized laths, lengths of which are the same with the tile, are nailed with 20- 50cm intervals on timber boards. For the same reason, tiles sometimes are linked by wires to each other (Interview, November 2011). After placing timber boards of roof, 5x10cm rafters are nailed perpendicularly and hip tiles are put on these rafters.omp

Rafters also generate the eaves of buildings if they are extended 15-20cm over the building. Eaves under are closed with timber boards and edge of rafters are capped by fascia board in order to prevent birds entering inside.

Earth Roofs

Earthen roofs are commonly used roofs in the region to cover vaulted spaces or *hezen*s (see Fig. 25). Upper parts of rib arches and cover arches are filled with pumice and broken pieces of rock/stone and then a mixture of soil and water which is also called „*şillez*" is poured into the wall to adhere infill materials. Clay soil is laid on infill and compressed with the tool called „*yuvak*". Thereby, earth roof is constructed (see Fig. 27). This type of roofs are re-compressed and weeded on every autumn in order to be ready for winter (Interview, November 2011). Clay soil is preferred especially in parts which can be exposed to dampness and rain such as roof and floor, because clay"s water absorbing capacity is higher than the other soil types (Interview, November 2011).

In spaces where *hezens* are used, a straw is laid on *hezen*s. Pumice and stone/rock pieces are filled and again roof is covered with clay soil. Finishing stones called *kafa tahtası* are located on outer cornices also in the earth roofs. Earth infill and finishing stones are almost at the same level (see Fig. 25).

Rock Roofs

Rock- cut used in horizontal and vertical structures also generates the roof of some buildings (see Fig. 26). An extra superstructure isn"t needed in the rock-carved spaces or in the spaces built by masonry& rock-cut mix systems.

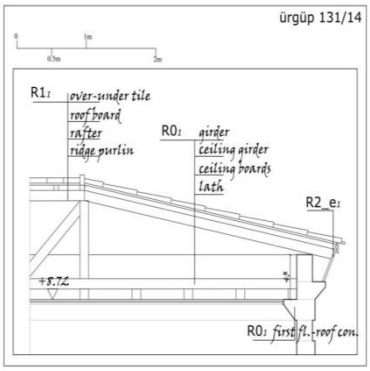

Figure 22, Timber roof on cornices

Figure 23-24, Intermediate stringer, Timber roof (Ürgüp, block/lot: 131/45)

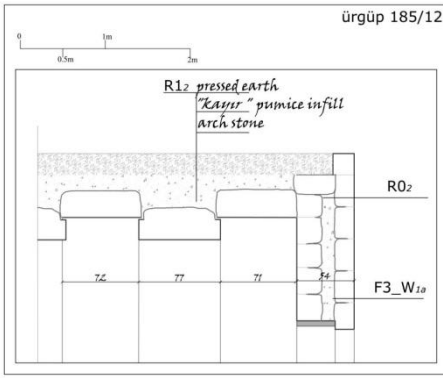

Figure 25, Earth roof and *kafa tahtası*

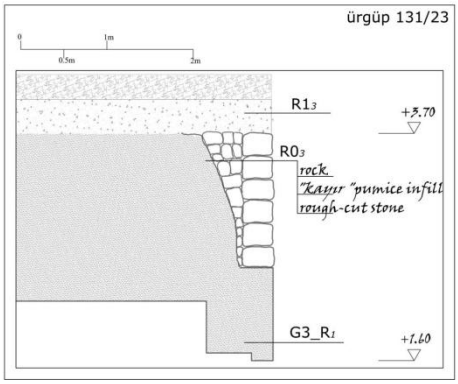

Figure 26, Rock as a roof

Figure 27, Earth roof (Mustafapaşa, block/lot: 73/5112-1)

3. CONCLUSION

In Cappadocia, it is obvious that geological structure of the region forms the local construction technique. Rock has been used for many years since it is a convenient and easily shaped material. At first, rock itself provided the housing requirements. People lived in spaces which were carved into rock. Due to it is not needed to pay for any other construction materials, rock carving was also economic. It was also compatible with the climatic conditions of the region. As keeping heat inside, rock-cut spaces provided suitable inner conditions; cooler during the summer and warmer in the winter. Wide usage area of rock has offered local people an employment opportunity. Today, in the region rock carving is still considered as an important working area in construction.

In the course of time, people started to add masonry structures to their rock-cut houses since the requirements of some extra spaces. Additions which could be either a single wall with a vault or a stone masonry room were built according to needs. Thus, this situation created cubical mass configuration which formed a settlement pattern unique to this region. Economic conditions of the society and the construction techniques were developed simultaneously. Since there were many stone quarries in Cappadocia, it was an advantageous to find constant construction materials in the region.

Today, masonry buildings and rock carved spaces are used together. Field studies show us that cut-spaces are still a part of today‟s construction. Almost in every building part such as foundation, floor and roof as well as in every architectural element, rock and rock-cut technique are used. Furthermore, rock carving is one of the significant features which provide continuation of the architectural characteristics of the region. In Cappadocia, traditional houses become reproducible with these rock-cut spaces. Local people carve rock without any plan and regulation which means there is not a systematic space organization of rock-cut buildings. The main principle is to respect to the rights of neighbors.

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