

ANALYSIS OF TRADITIONAL BUILDING TECHNIQUES AND DAMAGE ASSESSMENT OF TRADITIONAL TURKISH HOUSE: The Study of Timber-framed Kula Houses

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Abstract

Western part of the Anatolia is one of the most important regions of the World that many civilizations have lived during the history since ancient times. Kula is an important historical town dating back to 17th century and is hosting important timber framed structures (mansions) unique with their space organizations, architectural features and structural system. This study creates an analysis model which is based on a detailed case study, defining structural system and damage causes for the upcoming restoration works within the region, and this methodology can be applied for other traditional regions as well.

Keywords: *Traditional Turkish Houses; Kula; timber structures; traditional building techniques*

INTRODUCTION

Having a shelter, in other words, having a house is one of the oldest needs of human-being since the beginning of the life. Depending on the social, cultural and physical properties of society and also depending on the properties of the place, many different formations of vernacular settlements have been existed during the history. Some of these settlements do not exist today while some of them survived and some of them have been transformed into today's modern way of living. Western part of the Anatolia is one of the most important regions of the World that many civilizations have lived during the history since ancient times.

With a general point of view, most of the traditional vernacular settlements may have similarities, because of the limited kind of building materials and limited construction techniques. They were non-engineered structures but were results of long term experimentation and classical trial and error period. A fast examination on these settlements may form an idea of complete difference at every comparable element. But a closer look could point out to some similarities of the formation of the settlements. These can be the materials, construction techniques, and formation of the house plans according to the weather conditions and sunlight or the topographic features of the environment.

In other words, the building practices that performed well were replicated and further improved. One of the most important examples of vernacular architecture in the Western Anatolia is Ottoman style Traditional Turkish Houses which are very important part of our cultural heritage.

In this study, Kula, a small city near Manisa, has been selected as the case study area because of its preserved traditional housing. Kula has a quite large and well preserved traditional pattern where one can follow traces of the traditional architecture and construction system. In this context, this study aims to put forward the historical building techniques and deterioration reasons of the timber framed Turkish Houses dating back to 18th-19th centuries located specially in Kula Settlement which are one of the parts of this important Cultural Heritage. By learning or/and understanding the rules of these traditional constructions it is aimed to develop more effective conservation techniques/issues and to get some useful ideas for new constructions.

With this idea, in the first part of the paper, traditional Kula Houses is described according to the general analysis of whole settlement. Then, case area has been narrowed to be able to make more detailed structural analysis and damage assessment as well as to be able to make more definite comparisons between cases. So, some cases that located on Akgün district have been chosen and examined, because Akgün district has been a less studied area of Kula by comparing the other districts that include different examples of traditional housing. Other reasons of the choice of this area can be explained as; originality of the houses within the district, accessibility of cases within the district, similarity of houses in the context of structural, constructional and spatial organization.

DESCRIPTION OF THE HOUSES IN TRADITIONAL KULA SETTLEMENT

In this part of the study, general properties of traditional houses (see Figure 1 and 2) in Kula will be described in 3 main titles:

- Spatial organization
- Structural system and its components
- Architectural building components



Figure 1. (Left) and Figure 2. (Right) Urban pattern of traditional settlement (Source: Authors, 2008).

Spatial organization

These houses are located in a courtyard, which is surrounded by high courtyard walls for obtaining privacy to the house. The ground floor is used for service facilities such as barns, depots and also it is surrounded by thick stone walls and these facility rooms have no openings to the street. All the openings of the house are viewed from the courtyard, while rooms located on the first or second floor can also have openings to the street. North facades of the houses have solid surfaces to prevent the interior of the houses from cold, and south facades have open surfaces to obtain sun and breeze in the interior of the houses. All the rooms located in the first and second floors are opened to a semi-open space called as 'sofa'. Most of Kula Houses have scheme system with outer sofa which has a strong relation with the courtyard (see Table 1&2).

Table 1. Spatial Organization of Houses (Source: Re-arrangement of the drawings of a Kula House from Akgun District Documented in a Summer Practice in 2000 supervised by Dokuz Eylul University, Faculty of Architecture, Branch of Restoration).

	<p>Ground Floor Plan of a Kula House, without projections.</p>
	<p>First Floor Plan of a Kula House, without projections.</p>

From the point of view life experience in the house, the two striking aspects of the Kula House were the courtyard and the hayat-sofa (hall). Courtyard is both like a large, open room for the activities of the household and it is also the edge space between the compound and the outside; through the wall of the courtyard, the household and the visitors can move in and out of the compound.

Table 2. Spatial Organization of Houses (Source: Re-arrangement of the drawings of a Kula House from Akgun District Documented in a Summer Practice in 2000 supervised by Dokuz Eylul University, Faculty of Architecture, Branch of Restoration).

 <p>Masonry Base</p>	<p>Ground Floor Plan of a Outer Sofa House, with two projections</p>
	<p>First Floor Plan of a Outer Sofa House, with two projections</p>

The hayat-sofa (hall) is more than a circulation area between the rooms and the staircase; it is a semi-open multi-functional living space on the upper floors (see Figure 3). With its strong visual connection to the courtyard and to its natural setting as well as to the rest of the town with its projections both to the courtyard and the street, hayat-sofa (hall) is a unique part of the house. In other words it serves as connection point between the courtyard and the rooms. Many of the daily activities occur in Sofa space due to its semi-private character. A raised wooden platform for sitting on one, two or three sides oriented towards a vista/panorama is the architectural elements

of this space. A semi-open projection with a lattice-window, a projection to the street and/or to the courtyard, staircases, projected and raised platforms for resting, a rectangular planned space open at one side, either in the form of an extension of the Sofa or as a single semi-open space acting as a Sofa are the other important features of the Sofa.



Figure 3. A typical sofa space (Source: Authors, 2008).

Shortly, ground floor closed to the street with a stone or adobe wall and an upper floor which sits on either load bearing stone walls or wooden studs characterizes the house type generally seen in Kula region. The upper floor(s), which are built by timber frame construction system consist rooms. Room; often with an elevated platform that was used as a seating area by day and a place to lay sleeping mattresses by night. Room is the main private unit of the house and designed according to ergonomic requirements (Asatekin, 2005). Repetition of this unit is the basis of the typology (Kuban, 1995). In Kula region, the number of the rooms differs from each other depending on how big is the family of the house. For example there are houses in the settlement called with their family names, as Beyler, Bekir Beyler, Palanduzlar, Gödeliler, and these houses are built as mansions with repetition of numerous of rooms. The rooms are planned with square or square like forms and are about 12-15m²; the height of the rooms are approximately 3 meters. One of the rooms serves as main one and called as 'baş oda'. This main room usually differs from other rooms not only with larger dimensions but also with a projection to the street.

There may be differentiations of room use including: summer/winter rooms. Summer rooms are mostly placed on the upper floors with larger openings to street or courtyard, and the winter rooms are placed mostly at ground floors with smaller openings and thick walls. Surfaces of the rooms are carefully designed both horizontal and vertical surfaces are designed to express the hierarchy of the space. Rooms also have some sub units named as; 'sekialtı, sekiüstü and seki'.

Sekialtı; is the entrance of room, a special space for taking off one's shoes; it is separated for hygienic reasons, and can be covered with timber planks. Sekiüstü; is the main platform of the room, this space is differentiated from Sekialtı space by using dissimilar timber floor covering like altering the direction of planking, and sometimes by using timber balustrade separation. The timber floors of the room can be covered with carpets to obtain the heat isolation of the space. Seki; is the sitting timber platform in the room. This platform is raised between 20-60cm (early

examples are rather low) from the floor, and placed on one, two or three sides of the room, the windows are placed at a higher level (see Figure 4&5). There is a wooden shelf called as 'Serge' which turns the surfaces roundabout just to respond it to human scale.



Figure 4. (Left) and Figure 5. (Right) A typical sekialtı and sekiüstü space (Source: Authors, 2008).

The middle floor, if there is one, has a low ceiling and is either a mezzanine floor or a whole floor. The top floor has, through time, become ever livelier with several projections and with multitude of windows which are of a standard size. The standard size of the window creates a sense of unity with its recurrent rhythm, not only in each house but also throughout the town. The roof always slopes on all four sides. This is one of the main discriminating characteristics of Traditional Kula House (Günay, 2007).

Definition of structural system and its elements

Structural systems of Kula houses consist of both masonry and wood as main construction materials. Most of the houses have two stories. Houses are surrounded by load bearing masonry walls mostly made of local Stone called 'küfeki' at the ground floor level, including courtyard. Most of the time, this heavy stone wall is continued through the upper floor at the North side (facade) of the house by considering the climate. Masonry walls are supported by horizontal beams called as 'hatıl' at vertical intervals of about 1.0 - 1.50 meters. Wooden beams (hatıls) that placed with particular distances (also in today regulations advice that the vertical distance between hatıls should be 2.0 - 1.5 meters) help to bind the stone layers together without interrupting the continuity of the masonry construction. In addition to strengthening the masonry structure by connecting the wall surfaces hatıls decrease the ratio of height to width and help to determine the location of the first crack. The decay of these wooden elements mostly by the effect of water causes the masonry wall to be collapsed (Hughes, 2000). In the ground floor, system can be defined as a "semi" load bearing masonry system without having a solid floor like reinforced concrete which has to be used in conventional load bearing masonry system according to Turkish Earthquake Code.

Upper floor is constructed with the infill frame system and this structure called as 'hımış' in Turkey (see Figure 7). This is a typical wooden frame structure that small pieces of row materials (brick, stone etc.) are used as infilling material. This is a common use of wood and masonry in vernacular settlements in other regions of the Turkey as well as the different seismic regions of the World. This issue has been underlined by Langenbach with following words; "*The timber with brick infill vernacular construction is documented to have originated as early as the 8th Century AD. There is much to support a hypothesis that this building tradition traveled from Europe into Asia as a result of the reach and influence of the Ottoman Empire, which at one time extended*

almost from Vienna to the Caspian Sea. The Islamic Religion, which extended farther, may also have provided a cultural connection helping to further extend the construction method. The infill frame style of construction may have followed these same lines of cultural influence” (Langenbach, 2000).

Before the construction of the upper floor, the timber wall plates are placed on the inner and outer edges of the ground floor main walls. Also, free-standing posts placed in the semi-open circulation spaces known as “taşlık” are connected horizontally to the main beams, forming a base for the upper floors. In the upper floors, Posts (studs) and secondary posts are placed on a timber beam which is called as the sole plate (usually 12/12cm a square section element) as a base on the masonry wall. Usually with a dimension of 10/12 or 12/12cm posts made of yellow pine tree are installed in approx. 1 meter distance with each other on sole plate (yastık-traditional name of sole plate). These posts are connected with a wooden beam on the top level as well which is called as the top plate. These posts are supported with the secondary diagonal timber elements with 8/8 cm dimensions. In the cases of a need of openings such as windows or doors, secondary posts are used for to obtain the necessary void for the openings. Two secondary timber beams, one in the bottom of the opening and one at the top of the opening (lintel) are used to obtain door or window openings on the surface of the wall. These beams are connected to the main posts with nails. Usually the walls are filled with ‘küfeki’ stone to form the surface. The construction is plastered by tow ‘kırıklı sıva’ which is usually made of mud and tow. Use of the ‘hımış’ technique on the first floor helps to decrease the dead-loads.



Figure 6. (Left) and Figure 7. (Right) Masonry and Wooden Frame (Hımış) Wall Examples
(Source: Authors, 2008).

Floor Construction

In traditional Kula houses first floor is constructed with timber floor beams that covered with timber boarding. The floor construction can be seen from the ground floor since it does not have a ceiling covering. Floor beams are generally supported by stronger elements in section with about 2.00-2.50 meters intervals depending on the room size. This floor construction is connected to the masonry ground floor walls by horizontal timber beams called as ‘yastık’, but sometimes it is seen that floor beams are simply tied to the masonry without any other wooden element or insulation layer (see Figure 8).



Figure 8. Floor Beams (Source: Authors, 2008)

Floor beams (joists) which have usually 8/15 cm dimensions in sections, are spaced at approximately 50 cm intervals. The spatial dimensions are usually determined according to the size of the available materials, whereas in some larger spaces such as the sofa—the main circulation hall in Ottoman houses—and taşlık where a wide span is required, long timber beams with a relatively larger cross-section (like 15*20, 20*20 cm) are used to support the secondary joists. Then the floor is covered with a timber boarding which is nailed to the joists. The floor system that consists of timber joists moving in one direction. Floor has an important role against the lateral forces especially in case of earthquakes since it connects all the masonry walls of the structure as well as the roof.

Projections

Another important element of the first floor is projection spaces that are commonly used in traditional Turkish House. And Kula Settlement has numerous unique examples of projections. To build projection (çıkma in Turkish) on the upper floor, the load-bearing elements constructed according to the type and extension of the projection and put in place at this stage. Main beam(s) is extended and the floor beams placed on/between them. And the timber cantilever beams are supported by diagonal bracing elements (see Figure 9).

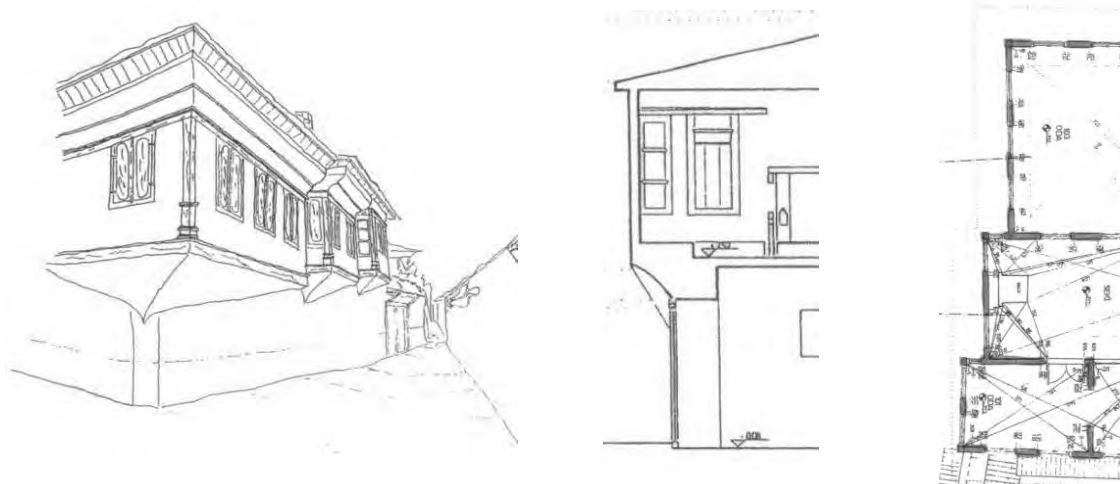


Figure 9. Plan, section and axonometric view of a projection (Source: Some drawings of a Kula House from Akgun District Documented in a Summer Practice in 2000 supervised by Dokuz Eylul University, Faculty of Architecture, Branch of Restoration).

Projection spaces are commonly used architectural elements in Kula Settlement and have numerous unique types. In the point of view of space organization, two types are obtained in the pattern, one a semi-open space which is the extension of sofa space to street, and one a close space which is the extension of room or several rooms to street. The semi-open projection of sofa space to street is usually isolated from the street by wooden fences.

Roof Construction

The outer shell of the house is finished with a wooden roof covered with tiles. The use of timber beams and joists are very similar in both floor and roof structure. The main difference is the slope of the roof. To construct the roof, rafters are placed on the top plate of the frame but in some cases a secondary beam-a purlin can be used as well on the top plate. Rafters are connected to the beam on top of the roof. This beam is supported by posts in approximately 200 cm intervals. Like the floor rafters are covered with firstly a timber boarding, then tiles are placed on this timber layer. In some cases especially in lower income houses rafters cannot be covered with timber boarding, in this case tiles are placed on the rafters which are placed parallel to the long side of the roof directly. The roof construction usually cannot be seen inside the rooms since the ceiling of the room is covered with timber boarding, this coating layer is supported by ceiling joists similar with the floor joists. The ceilings of the important rooms are usually ornamented. The mouldings are used in the connections of wall and ceiling surfaces (see Figure 10).



Figure 10. Roof System Details (Source: Authors, 2008).

With the features that are tried to be described above, this long construction tradition has been proved to be quite effective against earthquakes. Especially after the big earthquakes in Marmara region in 1999 and 2000 it has been seen that traditional houses could survived while conventional reinforced concrete buildings collapsed and caused to die of many people (Doğangün, et.al, 2005). Earthquakes have been an important part of life in Anatolia during the history. It is not a certain issue if these houses were built by considering earthquakes as a design parameter or not, since neither the science of earthquake nor the science of building were not defined as a separate professional activity at that times. But by considering the logical selection of the construction system and size of the building elements it can be said that earthquake could affect the construction process as a criterion. Besides the earthquake resistance, these traditional houses are important examples of optimum use of local sources and building materials.

Architectural Building Components

Timber is used as the building component as well as the structural system element in Kula houses. The timber components used in Traditional Turkish house architecture can be considered as the art works within its period. These elements can be classified as;

- **Doors**, door ornamentations and doorjambs
- **Windows** and window ornamentations,
- **Fireplace** and fireplace ornamentations,
- **Cupboards** and its ornamentations,
- **Ceiling** and its ornamentations,
- Wooden facade ornaments such as plasters,
- Ornament Elements on wooden projections,
- **Stairs**, balustrades, and handrails and their ornamentations
- **Eaves** and their ornamentations,

Wood is the common material of the **doors**. There are two main door usages in Kula Houses as inner and outer doors. Inner doors are major decorative elements often embellished with geometric, floral and calligraphic patterns. The doors approximately have 200-240cm height and 90 cm width. Decorative inner doors are made up of small pieces of wood laboriously fitted together. On doors with complex angular patterns, the number of pieces may easily run into the thousands. This type is called as “Kündekari” doors and have supporting panels on the inside (much like on a panel door), which provide for support of the kündekari pieces. The Kündekari doors are used as the entrances of the most important rooms of the house and are carved with geometrical and floral patterns in Kula. Less important inner doors, such as toilet doors were left plain. They are made up of a number of panels placed between stiles and rails. The rigidity of panel doors depends on the quality of joints between the stiles and rails. Panel doors have similar appearance front and back (Uluengin, 2007).

The outer doors are the entrances to the house from the street; they are batten doors the plainest doors of the listed above. They are usually used where they will not be highly visible. To build a batten door, the carpenter lays square-edged or tongue-and-grooved boards side by side, and joins them with additional lateral boards.

Before the sheet glass became widespread in 18th century only shutters were used in the **window** openings then wooden windows were started to be used mostly with shutters in front of them. The sash windows commonly used in Traditional Turkish houses is the main type used in Kula settlement. Decorated wooden balustrades are the second element that is used in front of the windows as well as the shutters. Knotted grille is the common type of balustrades used in Kula region. Since sheet glass was not available different types of windows had to use for ventilation and light to interior space. Shuttered windows placed at a level where a sitting person could see outside were used to provide views and to ventilate the space. Upper windows which formed a second row above the lower windows only provided light to the interior. After the use of sheet glass lower window assumed both the functions of lighting and ventilation but upper window continued to be used as a decorative elements.

Stairs are another important wooden component in Kula houses; their construction details are as simple as the other structural elements of the house. Two main beams (limon kirişi) carry the ladder steps. The steps approximately have 25cm width. The riser heights of the steps are 17cm. The ladder steps which are made of wood are usually fitted to the beams. The beams carry the wooden balustrades as well, and the balustrades are the most ornamented element of the stairs, the decoration of the balustrades has usually of geometrical and floral pattern.

Wooden columns as posts are used both as structural and the decorative elements of the Sofa, in all floors of the house. The capitals of the wooden columns are decorated with geometrical and floral patterns in the façade of the sofas in the floors which have high priority.

There are two types of **fireplaces** in houses used both cooking and heating. The hearth of the fireplace is commonly set about 10 cm above floor level and the smoke is collected by a large conical hood called as 'külah', this part is placed above a decorated 'yasmak' (Uluengin, 2007). The latter encloses the sides of the hearth, and it is usually ornamented. Fireplaces are the centres of attention, so an extra care is invented for their decoration. The ornaments are usually decorated with geometrical and floral patterns.

Closets in Kula region are the main compound in a room made of timber used for different purposes, varies for the functions, the main function is storing mattresses and clothes, and sometimes a small ablution space is hidden in it. There may be other closets placed on the walls of the room and they are especially niches for gas lamps, flowerpots, beverage containers, both can be ornamented if used in the important rooms, and decorated with geometrical and floral pattern.

Ceiling as a part of decoration element of Traditional Turkish Architecture has some diversity in the context of adorned techniques and construction techniques. Cause of diversity of construction and adorned techniques are financial strength of owner, talent of craftsman and function of room. With awareness of these factors appropriate ceiling type was preferred for the traditional buildings. While service sections of the buildings usually decorated with simple ceiling, the most important rooms (main room) and the main hall which are the most used spaces in the house have been decorated with adorned ceilings. The simple and most seen type is called as "Flat Ceiling" Ceiling structure is not seen by user. Structure of ceiling is covered with board. Joints between the boards and wall are veneered with lath.

Traditional Turkish House Ceiling adornments are grouped also in the context of type of laths, type of joint of boards, techniques of adorned ceilings' cut and carve techniques, painting and picture techniques. In Kula houses, two types of adorned ceilings, adorned with lath and carved wood techniques are used. In the first technique, and the widespread one, desired pattern is obtained with lath, curved or diagonal laths are fixed on flat ceiling surface. Flat roof on the ground is created with the ceiling. In the second technique, a geometry drawn on the board is cut with a saw for obtaining a decorative wooden shape. And then this wooden geometry is nailed to the ceiling surface. The decorative wooden shapes are geometrical and floral patterns (Uluengin, 2007).

Eaves; especially in the southern and south-east facing facades, where the openings are more in numbers, are kept wide for keeping the structure from natural factors such as rain or the sun, varying in size from 80-150 cm. the eave elements that are located in Sofa or Facades facing south, are covered with plates. In the houses belonging to important families, the decorative coverings are used for eaves. The eaves located on the façade facing north direction are shorter than the other directions of the house because of the reason that there is less and small dimensioned openings in these facades. The dimensions vary 30-60cm in length.

STRUCTURAL ANALYSIS AND DAMAGE ASSESSMENTS OF CASES

To identify the structural features and damage assessments, 10 houses have been studied from Akgün District. These cases are chosen by the criteria below;

- They are similar in the context of dimension (number and dimensions of the rooms)
- They are similar in the context of spatial organization
- They are similar in the context of owner profile (number of family members, economical character of the family)
- Accessibility of cases within the district during the measurement and evaluation process.
- Ease of analysis and monitoring of structural and constructional organization
- Originality of the houses within the district.

Cases are numbered as follows:

- Case01 Zabun House (Akgün District 86 Street No:7/A)
- Case02 Akgün District 26 Street No:24
- Case03 Akgün District 26 Street No:28
- Case04 Akgün District 25 Street No:14
- Case05 Akgün District 26 Street No:38
- Case06 Akşehirli House (Akgün District-88 Street-No:21)
- Case07 Akgün District 86 Street
- Case08 Akgün District 18 Street No:26
- Case09 Refik Aksoy District No:5
- Case10 Akgün District 84 Street No:15

Zabun house (Akgün district 86 Street No: 7/A)-C01:

Zabun House is the example of the external sofa typed house, with its sloped roof and courtyard, and is typically a two-storied building. The building is a unique example among the settlement when both the plan layout and the use of timber elements is analysed. The construction system of the ground floor is stone masonry; second floor of the building is timber frame structure, unlike other surfaces of the building, all stories of the north facing wall is constructed with stone masonry system. Considering the period of the building it can be said that the upper walls of the timber frame structure is made of Himiş Technique.

The building stands on the corner therefore; the courtyard of the building has two individual entrances from both of the two streets. The hayataltı space, one storied annex building and a wooden staircase that leads one to upper floors is located in the courtyard of the building (see Figure 11).



Figure 11. Floor Construction – Hayataltı Space (Source: Authors, 2008).



Figure 12. Projections of the house (Source: Authors, 2008).

The first floor of the building has additions throughout time as a result of today's requirements such as the transformation of the external sofa space into a closed space. This approach turned all of the wooden openings of the rooms (doors and windows) into an interior space element, and by this way all of these architectural timber elements are protected from the atmospheric conditions. Now that the building carries on its original usage as a residence today, the periodic maintenance of the structure can be achieved during the historical period.

Four rooms are located on the first floor and are all opened to Sofa space, one of them is overlooked to the main street and the other three are situated side by side and prolonged to the other side of the street by angled projections (see Figure 12). The rooms are decorated with unique wooden architectural elements such as cupboards, fireplaces.

The masonry stone wall thickness varies between 65 and 75 cm on the ground floor, and varies between 50 and 60cm on the first floor. The length of the span of the masonry ground floor wall is 11 meters on the west direction, and 16 meters on the south direction and surrounds not only the rooms but also the courtyard. The masonry wall on the west direction is supported by walls with similar thickness but the masonry wall on the south direction is not supported by any wall element. When this finding is compared to nowadays standardizations, it can be said that due to regulations it is not eligible to build a masonry wall longer than 5.5 meters length without any support element in first degree seismic zone areas. The researches show that; when traditional dwellings suffer from earthquakes in Turkey in recent years is analysed; the less-damaged or undamaged cases show that the wall length of masonry unsupported wall is not more than 10 times of the thickness of the masonry wall (Aksoy & Ahunbay, 2005). In our case the ground floor wall thickness varies in between 65-75 cm, according to what have been discussed in previous sentences, the unsupported span should not be more than 6.50-7.00 meters. When the length of the ground floor masonry walls is taken into consideration, it can be said that, the flexible behaviour and lightweight of the timber structure that is constructed over the masonry wall, and the timber elements (hatıl) that are used within the masonry wall as support elements stabilize or exist in the system without creating any risk in terms of structure system.

The depth of sofa space is 3 meters, and length of this space is 11 meters. 15*15 cm cross-sectioned and 2.65 meter long timber beams that are in the sofa space are placed at intervals of 2.00 meters. The main room, also the biggest room, which is opening to sofa space, has 5,50x4.30 meters dimension. The second biggest room opening to street on both south and west directions has 5.00*5.00 meters dimension. The smallest room on this floor is room 105 and its dimensions are 2.45*5.00 meters. The structural timber beam intervals can be read throughout the façade organization of the house and it is approximately 1.00 meter. The window openings are 0.80 meters long. The floor is constructed with timber floor beams that covered with timber boarding, the timber beam elements are used as they are taken from the forest without any carpentry work. According to the analyses that are made for the rooms plan scheme, the main floor beams passes about 5.00 meters span in maximum and are supported approximately by 0.25*0.18 m cross-sectioned beams within 2.50 intervals. The secondary beams radiuses are approximately 0.10 meters, and are placed on the main beam with 0,45meters intervals.

The long eaves, which are covered with bagdadi technique, of the building is very characteristic, and surround the three side of the building for preserving the timber structure from atmospheric conditions such as rain. The curvilinear beams supporting the projections are covered with bagdadi as well. All the significant indoor and outdoor architectural elements of the building such as windows, shutters, doors, ceiling coverings and etc. are made of wood, the wooden plaster elements are used on the facades as the ornaments.

It can be seen that now that the building ensured the continuity of its building use, the deteriorated architectural elements are replaced with new elements during the historical process. By this attempt, the original first floor windows and doors, the floor coverings of sofa space and the staircase are replaced with new timber elements. The repairs that have been maintained by the owner the house are made by using the same quality wooden structural and architectural elements. These attempts lead the building to be preserved to nowadays with its original features. Even if the periodical repairs have been done during the process, some deterioration on the facades of the building caused by atmospheric conditions such as colour changes on wooden elements can be occurred (see Figure 13).



Figure 13. Color change of the wooden eaves
(Source: Authors, 2008).

Akgün District 26 Street No: 24 - C02:

The building is a two-storied, an external sofa typed small scaled house with a courtyard. The sofa space establishes a relationship with only courtyard, and is not projected to street. The construction system of the ground floor is stone masonry; second floor of the building is timber frame structure. The masonry walls are not plastered on the outer facades so the timber diagonal beams placed between the masonry walls as the support elements (hatıl) with some intervals can be seen from the surface. The masonry wall thickness on the ground floor is approximately 0.65-0.85m, and on the first floor is 0.70 m.

The masonry stone wall is approximately 17.5 meters long throughout the 26th Street where the entrance is obtained from, and is an unsupported wall. The other two ground floor masonry stone walls situated perpendicular to the entrance wall are similarly maintained as unsupported masonry walls with 17meters and 12 meters length.

The biggest room on the timber structured first floor has dimensions like 4.35*4.50 meters. This room is projected to the street about 0.70 meters with a simple projection; the projection is supported by three curvilinear timber elements. The floor is constructed with timber floor beams that covered with timber boarding, and these beams are carried by posts with 0.15*0.15 meters cross-section situated on the courtyard with different intervals. The floors main beam passes about 4 meters span. The secondary floor beams are situated on the main beam on the opposite direction and used as they are taken from the forest without any carpentry work.

The first floor timber post elements on the sofa façade have 0.15*0.15 meters cross-section and are placed within 1,5meters intervals. The wooden eaves of the building are projected both to courtyard and to street about 0.70 meters. The eaves on the street side are covered with bagdadi.

The wooden architectural elements of the building such as windows, doors, shutters, balustrades, and etc. are unique elements, and very well preserved during the historical process. There are no replacements, but there are some several deteriorations on the wooden elements now that the building is emptied since 1950's.

The structural system details of roof structure can be easily seen from outside because of the loss of roof coverings, according to this the rafter elements are used as they are taken from the forest without any carpentry work, and placed in intervals randomly according to the size and section of the timber element. The most important degradation type observed in the house is

material loss. The wooden materials of roof coverings, eave coverings are partly lost, there are colour changes obtained on the architectural façade elements.



Figure 14. Case 02 The entrance façade of the building (Source: Authors, 2008).



Figure 15. Case 02 the external sofa and the roof structure (Source: Authors, 2008).



Figure 16. Case 02 Timber roof structural elements and wooden fences (Source: Authors, 2008).



Figure 17. Case 02 the building and its surrounding (Source: Authors, 2008).

Akgün District 26 Street No: 28 - C03:

The building is an external sofa typed, two-storied, timber structured characteristic house with a courtyard. The ground floor is built with a stone masonry structure system supported by timber beam elements (hatıl). The building ensured the continuity of its building use as a house.



Figure 18. Case 03 The building and its surrounding
(Source: Authors, 2008).

The masonry stone wall is approximately 15 meters long throughout the 26th Street where the entrance is obtained from, and is an unsupported wall. The biggest and the main room on the timber structured first floor have dimensions like 4.35*4.70 meters. The whole building is projected to the street throughout the all facade about 0.50 meters with a simple projection, the projection is supported by three curvilinear timber elements, and covered by bağdadi system and plastered. The first floor timber post elements on the sofa façade have 0.15*0.15 meters cross-section and are placed within 2.00 meters intervals.

The owners of the house live in a one storied new house which they have built in the courtyard of the building during the recent years. During this process, the building has also suffered from wrong repair attempts as well. The external sofa space is partly closed, the hayataltı space is closed with a concrete extension, and some new openings are added to the façade of the building. The atmospheric conditions caused to degradations as well such as the material loss and colour changes on the wooden eaves, ceiling coverings and floor coverings.



Figure 19. Case 03 Situation of external sofa space, deterioration of the wooden material of sofa ceiling (Source: Authors, 2008).

2.4. Akgün District 25 Street No: 14 - C04:

This case consists of two individual buildings sharing the same small courtyard. One of these houses is a two-storied, external sofa typed house, and the other is a one storied external sofa typed house. Their façade organization is very simple. The one storied building has stone masonry walls with a thickness of 0,75 meters supported by timber beams in 3 directions. The courtyard façade of the building is made of timber frame construction system. The stone masonry wall of the rectangular one-storied building facing the street passes a span around 10.5 meters without any support. Six timber post elements carrying the Sofa space have 0.15*0.15 meters cross-section dimensions and are placed within 2.00 meters intervals on the courtyard direction. The two rooms of the building are produced with similar dimensions, and the dimensions of the rooms are approximately 4.20*4.00 meters. The length of the Sofa space is 8 meters and the depth of Sofa space is 2.56 meters long.

The two-story building is surrounded by stone masonry walls with a thickness of 0.75 meters supported by timber beams on all four sides on the ground floor, and only on two sides on the first floor, the façades facing both the courtyard and street are constructed with timber frame structure. The two rooms situated on the first floor differ from each other when the sizes are compared. The room facing the entrance façade's dimension are 3.70*4.60 meters and the other rooms dimensions are 4.60*4.75 meters. The length of the Sofa space is 10.30 meters and the depth of Sofa space is 2.90 meters long. Six timber post elements carrying the Sofa space have 0.15*0.15 meters cross-section dimensions and are placed within 2.00 meters intervals on the courtyard direction.



Figure 20. Case04 Sofa and Courtyard of the House (Source: Authors, 2008).

The deterioration types that have been identified can be listed as, fungi attacks, infestation, material loss, colour changes. There are fungi attacks, colour changes and infestation on the post elements carrying the Sofa. There are material losses and colour changes on the coverings of the eaves. There is deflection on the first floor carrying system, and some material losses and colour changes on the floor coverings.



Figure 21. Deterioration Problems of the Posts (Color change, holes caused by insects and sectional material loss) (Source: Authors, 2008)



Figure 22. Case04 Deterioration Problems of the Roof (left) and Floor (right) (Color change) (Source: Authors, 2008).

Akgün District 26 Street No: 38 - C05:

The building is an external sofa typed house. The linear plan schemed house establishes a relationship with the street, by using the slope of the topography the building is established as two individual buildings standing edge-to-edge, one block facing the street with three stories, and the other block with two stories. The top floor integrates the two buildings.



Figure 23. Case05 Exterior View of the House
(Source: Authors, 2008).

From the courtyard with a seven stepped staircase, one can reach to the semi floor and a unique wooden staircase leads one to the top floor. The ground floor of the building is made of a stone masonry wall, the upper floors are made of timber framed structure, unlike other surfaces of the building, all stories of the north facing wall is constructed with stone masonry system.

The rooms in the mezzanine and first floor are placed parallel to Sofa space. The timber post elements carrying the Sofa space have 0.15*0.15 meters cross-section dimensions and are placed within 2.00 meters intervals. The posts carrying the upper floor are established with a height of around 4.00 meters, especially buildings two-storied place.

It can be seen that now that the building ensured the continuity of its building use and it is restored since the recent years, it is not possible to obtain any important deterioration problem within the structure system and the materials of the house. The restoration attempt of the building, replaced the deteriorated architectural elements with new elements by preserving the uniqueness of the building.

Aksehirli House Akgün District 88 Street No: 21 - C06:

The building is an external sofa typed house. The building is situated on the corner facing two streets, and the courtyard of the building is getting its access within these two streets with individual two courtyard doors. The ground floor of the building is made of a stone masonry wall with a thickness of 0.70cm. The upper floors facing south directions and 88th Street are made of timber framed structure, unlike other surfaces of the building, all stories of the north and north-east facing wall is constructed with stone masonry system. The room facing south direction and south part of Sofa space are projected to Street number 88 about 0.80cm with a simple projection; the projection is supported by three curvilinear timber elements, and covered by bagdadi technique and plastered.



Figure 24. Case06 Exterior View of the House (Source: Authors, 2008).

Timber post elements carrying the Sofa space have 0.15*0.15 meters cross-section dimensions and are placed within 2.00 meters intervals on the courtyard direction. The two rooms opening to Sofa Space are organized in 420*485cm and 420*455cm dimensions. The stone masonry walls of ground floor are supported by masonry walls on the opposite direction, but contrary to this situation, the masonry walls on the first floor are unsupported walls with dimensions of approximately 12 meters on one direction and 11.5 meters on the other direction.

The deterioration type that has been identified within this case is the colour changes mainly on the wooden elements. During the historical process; a one-storied building is built in the courtyard of the house as an extension. The original space organization of the ground floor is changed due to this extension spaces. This new addition space organization changed the façade organization as well with new openings on the masonry walls.

Akgün District 86 Street - C07:

The building is an external sofa typed, two storied house. The construction system of the ground floor is stone masonry; second floor of the building is timber frame structure. Considering the period of the building it can be said that the upper walls of the timber frame structure is made of Himis Technique. This small scaled house is a typical Kula House with its hipped roof, courtyard, its space organization, and the type of timber architectural elements used within the building. The life of the building is ensured its continuity only on the ground floor, first floor is emptied.

All the architectural elements used on the façade and interior are made of wood. The main room of the building is projected to the street. This projection is a very simple by supported by three curvilinear timber elements, and is not covered by bagdadi technique and plastered. Because of this, the floor beams can be easily seen from outside. The floor beams are used in the building like it is once collected from the forest without any carpentry work. In order to establish the projection, the floor beams are extended to the street about 0.80 meters long. The three curvilinear timber elements that support the extended floor beams have different sizes.

Now that the upper floor of the building is emptied, the maintenances that should be done periodically could not be provided during the process, and the building is suffering from physical deteriorations. The deteriorations started from the roof structure of the building, the plasters and the bagdadi coverings of the eaves have material losses and colour changes. This kind of deteriorations can be observed within all the abandoned houses within the territory.

The ground floor of the building ensured the continuity of the building life so some new windows are opened on the stone masonry wall surfaces while transforming the ground floor uses (space organization) to first floor uses with wrong workmanship, and with a wrong restoration manner.



Figure 25: Case07 Exterior view and Material Loss on the Eaves of the building
(Source: Authors, 2008).

Akgün District 18 Street No: 26 - C08:

The building is an external sofa typed, two storied, timber framed house and have more than one projection to the street. The construction system of the ground floor is stone masonry; second floor of the building is timber frame structure. The building is abandoned the maintenances that should be done periodically could not be provided during the process, and the building is now suffering from physical deteriorations such as material loss and colour changes.

The deteriorations started from the roof structure of the building, the plasters and the bagdadi coverings of the eaves have material losses and colour changes. The causes of rain can be easily seen from the shelter of the building such as; colour changes on all the wooden architectural elements like wooden shutters, wooden balustrades, and wooden façade elements. All of the projections are established very simple supported by three curvilinear timber elements, and the covering materials of the projections are lost due to the physical deterioration factors.



Figure 25. Case08 Exterior View of the building
and Deteriorations on façade (Source: Authors, 2008).

Collapsed House Akgün District 18 Street No: 5 - C09:

The building is an external sofa typed, two storied house with a courtyard. The construction system of the ground floor is stone masonry supported by timber post beams (Hatıl Construction Type); second floor of the building is timber frame structure. The building is desolated and because of that reason the masonry wall facing the street has collapsed. Especially the deteriorations on timber elements caused deformation of the structural system.

The main deterioration factor can be seen within the case is suffering from humidity. Humidity caused colour changes, fungi attacks on timber element. Different from other cases, insect invasion can be obtained in this case on the timber beam elements that support the masonry stone wall. The insect invasion fragmented and reduce the cross section dimension of timber elements.



Figure 26: Case09 The collapsed part of the house (Source: Authors, 2008).



Figure 27: Case09 Courtyard View of the building (Source: Authors, 2008).

Akgün District 84 Street No: 15 - C10:

The building is an external sofa typed, two storied house with a courtyard. The construction system of the ground floor is stone masonry supported by timber post beams (Hatıl Construction Type); second floor of the building is timber frame structure. The building has a rectangular plan scheme. The ground floor is used like a depot and the upper floor is used for living facilities. The rooms on the upper floor are placed on the long side of this rectangle plan and directly open to Sofa Space. The sofa is projected both to courtyard and to the street. Sofa space has differences in elevation. This elevation differences separated this space for different uses such as sitting spaces (seki). The seki space is projected to street. There are three rooms on the upper floor. The main room is projected to the street as well. The projections are very realized very simple.

The wooden elements used within the house have preserved their authenticity and uniqueness. The doors (kündekari doors), windows, shutters, and floor coverings (ornamented with floral patterns), furnace, closets, timber post elements, staircase and balustrades of staircase are realized very unique as the evidences of Typical Kula Houses architectural details. The eaves of the building are extended to the courtyard side as a console about 2.00 meters. The eave is covered with a wooden covering. The eaves are extended to the street similarly, and cover the street from the top.



Figure 28. Exterior view- Long eaves of the house (Source: Authors, 2008).

Timber post elements carrying the Sofa space have 0.15*0.15 meters cross-section dimensions and are placed within 2.00 meters intervals on the courtyard direction. The house is in good condition in the general point of view. Deterioration can be seen within the building is some material loss on the eaves of the building. A second thing can be seen within the building is a wrong restoration attempt example which is a one storied space added under the sofa space of the building and this space demolishes the space organization of the ground floor.

EVALUATION OF THE CASES

In this part of the study, structural and damage assessment will be described in context of Structural and Damage Assessments.

Structural Assessment

Structural systems of the selected cases have been evaluated in terms of dimensions and span length of wooden elements and the length of the load-bearing masonry walls between

supporting walls. A comparative summary of all the cases can be seen in table 8, when one examines the cases; it is seen they are quite important examples that have the continuity of building use. Effective use of materials which is one of the important aspects of structural design is also identified as one of the main aspects within the evaluation of cases. Even if many deteriorations can be seen within the cases, the ones that ensure the continuity of its building use have no serious structural deformations.

Table 3. Features of the structural system (Source: Authors).

	Definition of Structural System					
	Masonry wall Thickness (m)	Length of load-bearing masonry wall between two supporting wall (m)	Span of main beam (m)	Span of Floor Beam (m)	Dimensions of Projection (m)	Dimensions of main Post (cm)
C01	Ground Floor: 0,65-0,75 First Floor: 0,5-0,6	11-16	4.30	2.75	4.3*0.8	15*15
C02	Ground Floor: 0,65-0,85 First Floor: 0,7	17.5 -12	4.35	2.25	4.4*0.7	15*15
C03	Ground Floor: 0,70-0,80 First Floor: 0,7	15	4.35	2.35	9.5*0.5	15*15
C04-A	Ground Floor: 0,75	10,5	4	2.10	-	15*15
C04-B	Ground Floor: 0,75-0,85 First Floor: 0,70-0,80	6	4.6	2.5	-	15*15
C05	Ground Floor: 0,75 First Floor: 0,6-0,7	7	5	3.2	4.3*0.8	15*15
C06	Ground Floor: 0,7 First Floor: 0,5-0,6	11.5 -12	4.20	2.40	4.2*0.8	15*15

When table 3 is examined, another important aspect is impossibility of building such a structure by considering the actual earthquake codes. According to actual code, the maximum length of load-bearing masonry walls between two supports is limited to 5.5 meters, and the length of the openings (in horizontal plane) is limited as well. Despite the lack of compliance with the regulations, the reason of their being standing still can be explained by the flexibility of the system rather than stability because of the wooden frame structure standing on top.

Damage Assessment

Deterioration factors of all the monuments are classified mainly as internal factors and external factors. The location of the building, incorrect methods of constructions, wrong choice of materials, defective workmanship, ground-soil properties are defined as the internal factors, long-term outer effects (Fungus, invasion of insects, frost, wind), natural disasters (earthquake, flood, etc.), man-made reasons like abandonment, incorrect methods of construction, wrong choice of materials, fire, wars, vandalism, air pollution, lack of laws in protecting the structures (Ahunbay 2004: 38-45) (Tampone and Messeri 2006).

During the evaluation process on the selected houses, deteriorations have been described individually for each example, in this part it is aimed to summarize them to be able to define most important factors that needs to be solved. In this context, main deterioration factors have been grouped in three main titles;

- Physical factors
- Biological factors and
- Deteriorations caused by human factor

Chemical factors and fire damage have not been taken into consideration since their affects are rare by comparing other factors around Kula district. In general, most of the deterioration factors affect the wooden elements of the house first due to the natural features of the material, and then corruptions spread all the building in time. This issue shows that wooden elements within the structural system have an important role.

Physical Factors

Most of the examples are suffering from physical factors, especially the effect of moisture and water, since most of the building elements are made of wood. Main sources of the moisture/water can be listed as rain, ground water, evaporated water within the building and leaks from the plumbing system by considering the cases. Such deteriorations grows fast by the effect of abandonment, because when the houses are left their own, necessary simple repair or maintenance work cannot be made in time, so building elements are exposed to atmospheric forces directly. Most of the time, by the damage of tiles, that covering whole wooden roof construction, water can reach to the wooden elements and moisture content of the elements changes. This can be observed by the color change and by the time decay of the elements. Also increase of the moisture content creates suitable environmental conditions or accelerates grow of existing fungal attacks.

When other atmospheric forces like wind and earthquake are considered, cases can be considered as quite effective due to the flexibility of the system rather than stability. In addition, simple details of construction system accelerate deterioration of wood material, as well as simple and sometimes wrong workmanship details. Especially, connection points, where the load bearing elements like beams fastened to the masonry base/walls directly accelerate deterioration process due to the water content within the masonry components.

Biological Factors

During the study, main biological factors that have been seen are fungi and/or insect attacks. Most common observed traces of fungal attacks are color change and decay of the wooden elements. In addition, in some cases it is possible to see many holes or/and material loss within the wooden elements.

Deteriorations caused by human factor

When Kula is examined in deterioration reasons framework, the most important factor of the deterioration seen in this settlement is the abandonment. Abandonment can be accepted as the starting point of the other deterioration factors. The owners of these big timber structures moved to the new developing part of the town, to reinforced concrete multi-storey apartment buildings, rented their houses to people with lower-income, or left them to their elders whom cannot take care of the repair expenses of the buildings, or left them as they are. The new owners of the houses prefer to live in the courtyards of the buildings where they built new one storied concrete houses, or if they prefer to live in the old structures, they modify them with defective workmanship, incorrect attempts at restoration, incorrect methods of construction, changing the sizes of windows, closing the sofas with aluminum joinery. The emptied timber structures are exposed to long-term outer affects especially rain and wind, which causes fungi attacks, and insect invasion.

CONCLUSIONS

Akgun District of Kula is one of the important areas of traditional Turkish houses and is focal point of this study. Reasons of the choice of the area is described before as; originality of the houses within the district, accessibility of cases within the district, similarity of houses in the context of structural, constructional and spatial organization. Authors have had several analysis studies that identify the architectural and structural features as well as damage assessment of the house stock in district. During the fieldwork, it is found that main issue is the preservation of existing traditional building stock to make them compatible with the today's conditions in order to sustain life in the area. It is inevitable to make various intervention to the buildings during the process of protecting the cultural heritage. In this sense, the intervention to be made to the structural system of the construction will naturally allow the entire building maintaining. To achieve this aim, local authority carries on or sometimes supports restoration projects of houses, although they are individual attempts and are not enough to achieve sustainability of life in the traditional part of the town.

In order to perform a correct application and detailing during the process of repair and/or restoration, the current system must be analyzed very well. Proper understanding of the architectural features, spatial organization, construction system and even details of the houses within the settlement will prevent the wrong intervention and the buildings will be able to transfer all architectural and cultural values they have to the future by this way.

In this context, study analyzed the general construction typology of the timber houses dating back to 18th-19th centuries located specially in Akgun district. But this analysis can be evaluated as a pilot-sample work, and a typological study among the whole region due to the similarities of the constructions.

Most of these constructions, as the evidences of house tradition of the region, representing their spatial organization, its period's art concept, traditional design and construction technology, are at risk of disappearing because of lack of care and proper restoration works.

When the damage assessments have been discussed and the reasons for their deterioration have been analyzed within the selected area, it is seen that main factor of damage is abandonment. Because of this fact that when periodically maintenance cannot be applied to the building, the deteriorations start from the timber components of the structural system. In this context, when the interventions done directly to the timber components of the houses are considered, it is seen that in order to stabilize the building, some parts of timber structure are replaced with the new timber elements, and tied to the masonry structure which is conserved in situ. Instead of renewing the damaged timber elements as a first solution, the conservation decisions should be based on professional methods such as; assessment of the structural system as a whole, evaluation of interrelationships among the strength properties of wooden elements (modulus of elasticity, impact bending, hardness, gravity, aging, deformations, defects, etc.) working with conservation specialists, to be able to conserve them in a more sustainable approach.

Abandonment problem should be solved by encouraging locals to live in the traditional houses without harming the original spatial organization and structural system and material use. This issue mainly depends on how successfully houses can be adapted to nowadays use. Local people, who sustain their lives in the district, solve their adaptation problems by their own, with wrong restoration attempts and wrong workmanship instead of consulting from a specialist. The main reason of this behavior is the communication gap between local people and authorities as well as the economic problems of the owners.

The general aims of the principles of preservation of old structures are to conserve the authenticity of the structure and its original function in a condition of sufficient safety. Decisions of repair and maintenance should be taken in accordance with each structure and the features of its structural details. In cases with no possibility of maintenance, details pertaining to the original

structure should be kept as records in the structures. Making some strategic assessment on ancient timber structures one should take these into account and consideration:

- The historical value of the fabric
- The overall condition of the structure and hence
- The scale of repairs
- The options for the future uses.

Sustainability of the life of the area is quite a complicated problem which most of the traditional settlements in Turkey suffer from. For that reason, the solution of the problem depends on mostly macro scale studies in-corporation with local authority and also cultural heritage politics. Within this frame, this study creates an analysis model which is based on a detailed case study, defining structural system and damage causes for the upcoming restoration works within the region, and this methodology can be applied for other traditional regions as well.

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ACKNOWLEDGEMENT

The study is derived from the scientific report of the research project 107M207 supported by TUBITAK.

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