"Himis" construction system in traditional Turkish wooden houses

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ABSTRACT: In Turkey, where the Bosphorus serves as the meeting point of Europe and Asia, a country of critical importance both in terms of strategy and the wealth of its cultural mosaic, most of the traditional wooden houses are produced in the *himis* structural system technique. Despite cultural interactions, houses built with the *himis* technique, which is an authentic structural system, have found widespread usage due to the facts that its construction technique is quite selective and that it can be adapted to various types of planning. Sofas with large space, which cannot be attained with stone material, abodes with plenty windows which can be established with modular system, bow-windows which remove in the upper floors the obligation to fit the parcel in the street texture which develops unsystematically are all possible, thanks to the alternatives provided by the wooden system. Until the beginning of the 19th century, due to poor economic situation and lack of transportation means, these structural systems presented in the declaration had been produced in a similar way - despite a few differences in details- with local materials and techniques which were often limited to what the local sources offered. This study deals with the *himis* system within a structural context, and provides local original examples.

1 INTRODUCTION

Traditional wooden houses in Turkey are produced under the effect of the regional characteristics of Northern Anatolia, Middle Anatolia (the areas of settlement on the frontiers of North-Western Anatolia and Marmara Region), West Anatolia, Southern Anatolia and Marmara Region, which have some similar characteristics. In these regions, except for the Middle Anatolia, the topography is characterised by coasts and increasing height towards the interior parts. These regions also have similar climatic characteristics and flora. In these regions of Turkey, which is located in temperate climatic zone, annual average temperature is above 12.6^{o}C, average precipitation is not less than 600mm. 80% of the woodland of Turkey, which is shaped up under the effect of temperate and rainy climatic zone, is within these regions. Therefore, wood, which has easy access in the region, being a strong material resistant to earthquakes –keeping in mind that Turkey is located in the 1st grade earthquake zone- is observed to be widely used in these regions in the construction of houses.

Traditional secluded Turkish family structure, the place of family in the society, the effect of its general features in daily life and Islamic beliefs have similarities with the planning of houses. In houses under the influence of these factors, downstairs which have service spaces which have no access to outside and have a garden or a courtyard in the inner part; whereas upper stairs are composed of a common living place into which other rooms have access. Structural system of

houses are generally in *himis* technique, while minute regional differences are observed. *(See the Map of Traditional Himis System Examples in Turkey).*

This exposition is supported with other examples given in the announcement and *Himis* systems from the five different regions of Turkey, namely Northern Anatolia, Marmara, Middle Anatolia, Western Anatolia and Southern Anatolia, are described with structural drawings from the roof to the foundation.

Installation of Himis System; This is a filled-in system, which is made by forming a bearing structure by means of fixing woods on the foundation or on the heap (of rocks, adobes or woods), and by placing adobes, rocks or bricks between these vertical and horizontal bearing elements and the frame that the beams form. Walls of traditional construction are plastered both in the interior and in the exterior surface, while the exterior surface is sometimes left unplastered or covered with woods. Types of wood used in the bearing system have varied depending on regional characteristics. In Northern and North-Western Anatolia chestnut, yellow pine, ash tree; in West Anatolia oak, yellow pine; in Southern Anatolia cedar are generally used. *Himis* system which is generally similar in all districts can be studied in two sections: a) Bearers (continuous bearers as well as limiting walls and foundations), and b) Roof:

Constant Bearers; The foundations that were the extensions of a wall were made in two forms; constant stone bearers, independent stone or wooden bearers. The material used for foundations usually were unhewn stone and they were arranged in the form of a constant base. Constant Stone Bases; In this form of foundations, which were used in general, the earth is dug deep into a strong ground (~1.00-1.50 meters), big foundation stones are placed in the bottom and foundation wall is erected with mud mortar. This base which is extended to the level of the ground surface turns into stone or mud bricks on the ground floor, depending upon the ground floor wall system. If the ground floor walls are of a wooden skeleton system, the base is elevated from the ground a little higher. The most employed system was that the stone heaps ground floor walls were tied and braided by wooden reinforcing beams ~60-90 cm in width, in 1.00-1.50 metres intervals and wooden skeleton system was built upon them. The insulation between the basic components and the joint points of the wooden structures was not considered, but instead, a solution for a smooth bed surface among bottom floor, carrier column and stone base was sought so that secure connection details of two different components have been sufficient. Independent bases; the wooden bases that were rarely used were generally very simple structures and used in summer houses *(Kafescioglu, 1955)*, in rainy sloppy regions (Bolu, Sinop, Surmene), depending upon the characteristics of the wood. Because of their characteristics, chestnut tree and wood were used in foundations. It was determined that the hardness of chestnut trees increases under soil and water with time and after a long time it attains a stone like structure. The wooden pillars were nailed into the soil ground in processed or spherical form *(Alioglu,1991)* and the connections with the upper structure was made. The independent bases that were used as stone, on the other hand, were placed under the carrying wooden columns of the house in huge sizes.

Walls; The carrying walls have always been a structure component in wooden house system that conveyed the loads coming from the surface to the foundation, and carried the loads coming from themselves and the surface. In general, the ground floor carrying walls were stone or mud brick of approximately 0.60-0.70-0.90 meters and stretched through the base walls in a wooden reinforcing beam of massive system in 1.00-1.50 meter intervals. These simple structure stone or stone-mud brick walls were made in good works as plain walls of hewn stones with delicate patterns where reinforcing beam were buried in hidden walls *(Eldem, 1984)*. In some cases, the ground floor stone walls were supported with wooden skeleton. The inside of walls and outer floor were covered with reinforcing beams, tied up on certain points, and were connected with supportive columns of 1.00-1.50 meter intervals. The good big foundation stones were placed to the points where the main columns are founded. The spaces between the columns were made by a strong weaving technique to form a supportive wall. The walls that looked at the north or contained a stove were built as stone in the first floor. In the houses that were middle floor, these floors were made approximately 1.50 meters higher than ground floor. Also decorative designs were made on these walls that looked without plasters until 19th century. From this time

on, the walls were begun to be coated with plaster. The plaster was made down to the first reinforcing beams and the region between the reinforcing beams and the ground floor were left without plaster (approximately 0.50 meters). The supportive ground floor was built on the body wall with a wooden skeleton system made of trees like scotch pine, poplar oak and was turned to be a wall component with filling materials or through coating. Although some local differences are seen, the most prevalent material that was used as filling material was stone, mud brick and rarely wood. The walls were usually described according to the filling or coating material in the concrete skeleton system.

Brick Fill; Brick fill wall, without plaster, has been used from the 16th century to the beginning of the 18th century. By the deterioration of the wooden workmanship, this technique which requires meticulousness was no longer applied. Wooden ferro-concrete frame system is formed by large sectioned (18/18 or larger) oak-tree pillars which are supported by props and placed in every 2.00 meters. Horizontal connections are formed from pillar to pillar or pillar to prop, bordering the upper and lower windows. Floor heights are 3.50 to 4.00 m. The gaps of the pillars end in profiles. Bricks are connected to the ferro-concrete frame system by the help of tiny borders. Into the bricks which contact these woods, hollows are opened. In another method, smaller sectioned trees are used with a wooden system with more frequent intervals in the same form. The thickness of the fill wall is around the size of a half-brick. *(Eldem, 1884,Eldem, 1996)* The weaving technique is shaped into horizontal, vertical, crosswise or in herring-bone pattern. Intermediate separations reduce to as down as approximately 0.25-0.35 meters; examples of straight or crosswise brick fill applied with mud or lime plaster are seen. In the bricks applied in the form of herring-bone pattern, rain waters flowing in between the pointing is a solution for not giving much harm to the woods. (Onal, 1975) Bricks with pointing and bricks with plasters were used together until the first half of the 18th century; bricks plaster was then used first on the wooden surfaces and then over all surfaces. Notchs are cut in wooden sections and plastered in their natural forms. Corner pillars and beam borders are not plastered and this form was applied as a principle in the structure system.

Sun-dried brick Fill; The most primitive form of filling the spaces between the wooden ferro-concrete frame systems is plastering with sun-dried bricks. The main pillars placed in every 1.00-1.50 m are separated by intermediate pillars with 60-70 cm spaces in between. Ferro-concrete frame which is formed by pillars and floors is connected in a way to carry the fill by means of pillars and diagonal beams. The spaces are filled with a sort of weaving made by tree branches of 3 cm. each and plastered with sun-dried mud both from the interior and exterior. *(Onal, 1975)* In every period, this technique is applied in villages and simple houses. Filling the spaces between ferro-concrete frame system and plastering them with mud had begun almost at the same period of sun-dried brick plastering, made with the same technique of the brick fill and had been intensively used beginning from the first half of the 18th century. In our day, one can see these examples in all centres except Istanbul where wooden houses were built. In all these centres, sun-dried brick fill and wooden ferro-concrete frame walls are used. Although the sun-dried brick sizes are close to one another, they show diversity (such as; Kutahya *(Eser,1955)* 9x12x30-15x30x60, Sivas-Divrigi(Sakaoglu,1978,23); 15x25x30-15x50x50). The most extensively used dimensions are 40/40/12 cm main sun-dried brick, 40/20/12 cm and 20/10/5 cm lime. Vertical supporters and intermediate pillars are placed with wider intervals in between; that is as wide as 0.80 m. and arranged with lime elements in between in compliance with brick weaving rules with special attention not to put the pointing one on top another. Vertical pillar intervals are 0.20-0.30 m and lime filling material is shaped in cross-wises. Vertical pillars are connected from various particular points on floors, upper and lower side of windows.

Stone Fill; Wooden pillars are supported by props, connected from upper and lower points of windows, the spaces in between are filled with stones and plastered from both sides. These walls, approximately 0.20 m. in width, are generally formed by separating the wooden ferro-concrete frames by small triangle frames and weaving these spaces with tiny sand and lime mortar.

Tree Fill: Trunk shells are transformed into a filling material by sand and lime mortar and plastered from both sides. One can see the examples of such walls in Mugla and Milas. After this general description of *himis* structure system, the system of *himis* is related below with Regional examples.

2 NORTH ANATOLIA REGION HIMIS

The carrier system in traditional wooden houses of North Anatolia Region are classified in three groups: Wooden heaping, Wooden ferro-concrete frame (*himis*), Complex Systems. In the most frequently employed *himis* system, *(See, Example of Structure System 1)* the existence of wood and consequently, of materials of pillar and beam ensured the construction of houses with a wooden frame system. Often, the wood making up the basis of the frame are not much notched. Heads of beams and columns are moderately notched so as not to harm the wooden texture of the tree. Mostly, houses are placed on a wooden and high floor. In this system, how the house was constructed and how it stands upright can be plainly seen. The walls of the upper floor are filled. In the past periods, fills in the form of bricks with no plasters lost their original features in time and ultimately the wall surfaces were plastered. Along with brick fill, lime fill was also used. The interior surfaces of walls are covered by lath and plaster work or wood, whereas the outer surfaces are either plastered or non-plastered or wooden plastered. Wood, which is most observed in the coastal areas, fills with the mixture of stones or wooden coverings are replaced in interior regions by lath and plaster in outer surfaces, giving a different touch to the Interior Blacksea region houses. Wooden houses in ancient periods are made completely by interlocking systems. In latter periods, this technique partially lost ground to either nailing or interlocking techniques. The wood used in constructions were primarily chestnut tree growing in East Blacksea Region. This tree, quite resistant to humidity and rainfall which can hardly be put on fire, is applied in its natural color. This particular tree is also so hard that no worms can give harm to it. Red tree, pine, valonia oak and fir-tree were mostly preferred over the expensive chestnut tree, which darkens in time and gives an aesthetic touch to the structure. (Ozguner, 1970) The Upper Cover; In North Annotation Region, the upper cover system of all wooden houses in North Anatolia Region appear in the form of sloping roof. Under the influence of a heavy rainfall, roofs with wide eaves were covered by grooved tiles. Easy access to forest products facilitated roofs with wide-sectioned wood. *(Kafescioglu, 1955)* The roof systems used in the region; sloping to a single direction, sloping to two directions, sloping to three directions, sloping to four directions.

3 MARAMARA REGION HIMIS SYSTEM

As in the case of the plan type, Edirne in Roumelia region, Bursa and Istanbul in Anatolia region developed their original structure systems and had influence over their nearby regions. The region's construction system was wooden ferro-concrete frame system which evolved in time. The houses that could be studied from 15th century on were constructed as filling wooden ferro-concrete frame system until the 18th century. The most original and the oldest examples of this period is seen in Bursa. A house in Muradiye that was known as the house of Murat II which was built in the 17th century has been preserved to our day. (see Sample Construction System 2) At that period, the ground floors were of stone built by mud bricks and stones, and upper floors were of wooden ferro-concrete frame with spaces filled by bricks. Through this brick fillings, in some houses, decorative surfaces were formed with different motifs, especially cypresses. No house of this era is available today in Istanbul; this technique was seen only in the ruins of a house on two walls. The wooden skeleton system that was formed with columns erected by wide spaces and with widely set braces using supports and props were arranged with a clean workmanship. With the degeneration of workmanship, the plaster surfaces became most apparent and it turned to be a technique of painting patterns on the limed plaster as the last

phase of this technique. Plastering method of the filling walls have been applied until the beginning of the 18th century in Istanbul. The same system has been also seen in Roumelia (Edirne-Tekirdag) and Anatolia (Bursa, Bilecik, Osmaneli, Balikesir, Ayvalik, Edincik) *(Eldem,1984)*. At the beginning of the 18th century in Istanbul, plaster was started to be applied lath and plaster work which led to the deterioration of the wooden ferro-concrete frame system. In Edirne and Bursa, lath and plaster work was adopted and was extensively used in the 19th century. Towards the end of the 18th century, outer surfaces of houses were also covered by wood. Without the use of filling material, leaving spaces between the wooden ferro-concrete frames, wooden covering on the outer surfaces and lath and plaster covering on the inner surfaces provided a distant touch to the architecture in the capital and the regions in its vicinity. Upper Covering; In the region, the upper cover is a roof construction sloping either to two directions or four directions.

4 MIDLE ANATOLIA REGION HIMIS CONSTRUCTION SYSTEM

Sun-dried brick is an important element in the general structure of the construction in the region. Except for the places in North-east, North and West Anatolia, where wooden houses are built, houses are constructed with sun-dried bricks or stones. Wooden houses, on the other hand, are constructed with sun-dried bricks in the ground floors and wooden ferro-concrete frames with sun-dried bricks fills on the upper floors. In the province of Divrigi (Sivas), under the influence of changing vegetation of regional differences, wood were also used in constructions together with sun-dried bricks. Until 25-30 years, it is stated in the resources that wooden houses were constructed with this technique. In the houses of the well-off, wood was the main structure of the house, the wooden skeleton was filled and provided strength with mud, lime, stuffing and straw. *(Sakaoglu, 1978)* The lime filled wooden ferro-concrete frame system generally referred to as *himis* is defined as “meteris” in the province of Divrigi. *(Sakaoglu,1978) (See, Example Structure System 3)*. Except for the regional variations in Corum and Cankiri bordering the Blacksea region in the north, the same construction system is used. In Corum and its vicinity, the ground floors were generally built with stone whereas the walls of the upper floors facing north were of wood ferro-concrete frame with spaces filled with lime. *(Akok,1951)* In Cankiri and its vicinity, the north walls of ground and upper floors were of wooden ferro-concrete frame whereas in Corum and Cankiri gypsum was extensively used as a plaster and mortar material in all houses since it had an easy access in the region and lime fill was made by gypsum mortar. *(Kafescioglu,1949)* In the regions of West Anatolia border of Middle Anatolia, Eskisehir, *(Arseven, no date)* Kutahya *(Eser,1955)* and Afyon, sun-dried bricks and the flora of the region are together used as construction materials. Lath and plaster work peculiar to West Anatolia is also used in these towns as exterior surface coverings.
Wooden skeleton spaces are filled with lime as well as bricks. When the intermediate filling is bricks, walls are plastered from both sides and the exterior surface is left without plaster. Bricks provided a decorative touch to the walls. In time, the front changed and the surfaces of walls were completely plastered. *(Komurcuoglu,1950)* Upper Covering; The upper covering of the wooden houses of the Middle East Region was roofs sloping either to two or four directions. Generally, they had simple shapes with no details. The notches on the plan were often ignored.

5 WEST ANATOLIA HIMIS SYSTEM

The main construction material of the region was stone and wood together with bricks and lime. The construction system of wooden houses: stone in the blind walls of the ground and upper floors, wood, stone in between ferro-concrete frame, lime or, albeit minor, filling with bricks. No plaster is applied on the outer surfaces of stone walls and upper floor walls were generally plastered with lime or mud with straw after the fill. Lath and plaster work is seen on plastered walls and generally applied on eaves and cantilevers. The general construction system of the

region is as mentioned above and despite variations in materials due to regional differences, the main principle remained the same. In some regional formations, wooden ferro-concrete frame is made and the spaces are filled with sand, lime mortar, pebbles or trunk particles and plastered.*(Aladag,1991)* In all these centres, and in Birgi *(See, Example Construction System 4)*, Milas and in their vicinities, we observe lime or stone filled and, in some regions, plastered construction systems of which lath and plaster work is applied. Since the houses constructed after the 18th century are still available today, traces of baroque style can be seen. In general, the upper floor ferro-concrete frame system is kept under plaster and only the corner pillars, cornices are left uncovered. In latter periods, lower floors are partially plastered and the main floor border and the floor in between are covered and fortified with beams, wide moulding and profiles. Regionally, colored embroidery over plaster which is shaped in baroque style is seen Upper Covering; The upper covering of the houses of the West Anatolia Region was roofs sloping either to two or four directions and were covered with oriental tiles.

6 SOUTH ANATOLIA REGION HIMIS STRUCTURE SYSTEM

The wooden ferro-concrete frame constructed on the stone ground floor is generally covered and plastered by lath and plaster work borders. The structure of skeleton systems- whether with fills or spaces- changed depending on the provinces. In Isparta, Burdur, Antalya (See Example Structure System 5) the fill material of houses built with this system were stone, sun dried brick and, though limited, tiles. Roofs with slopes were covered with grooved tiles. The wooden architecture which evolved in the province of Tarsus (Icel) is the wooden ferro-concrete frame complying with the standards of the regional architecture with filled walls. Roofs are either straight or have a slope. *(Sener,1984)* Generally, houses of Adana with straight roofs are constructed with fills in wooden ferro-concrete frame. *(Karaman,1992)* Upper Covering; Traditional roof structures related in other regions is also valid for this region.

7 CONCLUSIONS

Wood, the basic construction material of *himis* houses, is a weak material in cases it can not be protected against exterior factors. Due to rapid deterioration of this material against physical forces, today we encounter limited number of these constructions. In the *himis* system, in the observations made in various regional structures, the most damage are observed on upper cover structure, eaves, covering elements, wooden structure and other structural elements. This conclusion is arrived after the examination of 23 houses. The filling material making up the wall system is the material receiving the least damage, that is, the structural element which upheld the whole structure. The protection of this structure system should primarily start from the upper cover and proceed with strengthening the structure, that is, protection or partially renewal of the damaged elements. To convey this heritage to the next generations with the structural originality intact, destroying the structure and then rebuilding should be the last method to be employed, and if possible, not a method at all to employ. The suggestion which we define as strengthening is a method oriented to the preservation of the structure; primarily, the structure maintenance projects should be prepared for components that should be changed, added or the elements which will go under maintenance. For the himis systems to be resistant against exterior factors, they should be insulated against air, wind and water and this should be taken as a primary protection precaution. In walls where the outer surface is without plaster, water insulation should be made by interior plaster. In surfaces vulnerable to exterior factors, through the control of material and renewal, the destruction having repercussions on the interior of the house should be prevented. 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. In cases, on the other hand, in which current traditional structural system can

go under a maintenance, maintenance solutions oriented to the principal of keeping the original elements in the form of records should be employed. For the restoration works to be effective in preserving these systems, routine maintenance should be made. The rules related to preservation in force today in Turkey include items pertaining to the preservation of the original structure. To ensure the application of preventative decisions which will hinder the extinction of original wood house structure systems, dissuading sanctions, employment of experts in restoration works who have received preventative-oriented education, protection-conscious people, and most importantly, pertinent state-supported preservative politics are essential. Since in our country these problems still persist today, these *(See the Map of Traditional Himis System Examples in Turkey)*, like all other construction systems, go rapidly extinct, and except for a few locations, no preservation can be ensured.

REFERENCES

Akok, Mahmut. 1951. Cankiri'nin Eski Evleri .*Arkitekt,* issue 22/ 261-262, p.145. Istanbul.
Akok, Mahmut. 1951. Corum'un Eski Evleri*. Arkitekt*, issue 20/ 237-238, p.171.Istanbul.
Aladag, Ertugrul. 1991. *Mugla Evler*, p.95. Mugla
Alioglu, Fusun .1991. *Geleneksel Yapi Elemanlari.* p. 10. Istanbul : YTU Mimarlik Fakultesi.
Arseven, Celal Esat.. *Turk Sanat Tarihi.* VII Fasikul, p.558. Istanbul.
Cobancaoglu, Tulay. 1998. Turkiye'de Ahsap Ev'in Bolgelere Gore Yapisal Olarak Incelenmesi ve Restorasyonlarinda Yontem Onerileri. *Doktora Tezi*. Istanbul: MSU Mimarlik Fak.
Eldem, S.H. 1984. *Turk Evi*, issue I, II, ,III,p. 161-182. Istanbul: TAC Vakfi Yayini..
Eldem, S.H. 1996. *Bursa Evleri*, p.191. Istanbul : Yapi ve Kredi Bankasi Yayinlari.
Eser, Lami .1955. *Kutahya Evleri*. p.180. Istanbul: ITU Mimarlik Fakultesi
Kafescioglu, Ruhi.1955. *Kuzey Bati Anadolu'da Ahsap Ev Yapilari,* p.102. Istanbul :ITU Mimarlik Fakultesi.
Kafescioglu, Ruhi.1949. *Orta Anadolu'da Koy Evlerinin Yapisi*, p.42. Istanbul: ITU Mimarlik Fakultesi .
Karaman, Figen. 1992. Adana Geleneksel Konut Mimarisinin Incelenmesi. *Yuksek Lisans Tezi.* P.47. Istanbul: ITU Mimarlik Fakultesi
Komurcuoglu, Eyup. 1950. *Ankara Evleri.* p.56. Istanbul: ITU Mimarlik Fakultesi .
Kuban Dogan, Turk ve Islam Sanati Uzerine Denemeler, 1995, p.227. Istanbul
Onal, Hakki. 1975. *Ahsap ve Yurdumuzda Yoresel Uygulamalari*, p.43-50. Istanbul:YTU Mimarlik Fakultesi.
Ozguner, Orhan. 1970. *Koyde Mimari*, p.22. Ankara: ODTU Mimarlik Fakultesi Yayini.
Sakaoglu, Necdet. 1978. *Divrigi'de Ev Mimarisi* . p.23. Istanbul: Kultur Bakanligi Yayinlari 274
Sener, Hasan .1984. *Alanyada Geleneksel Konutlar*, p.11. Istanbul: ITU Mimarlik Fakultesi
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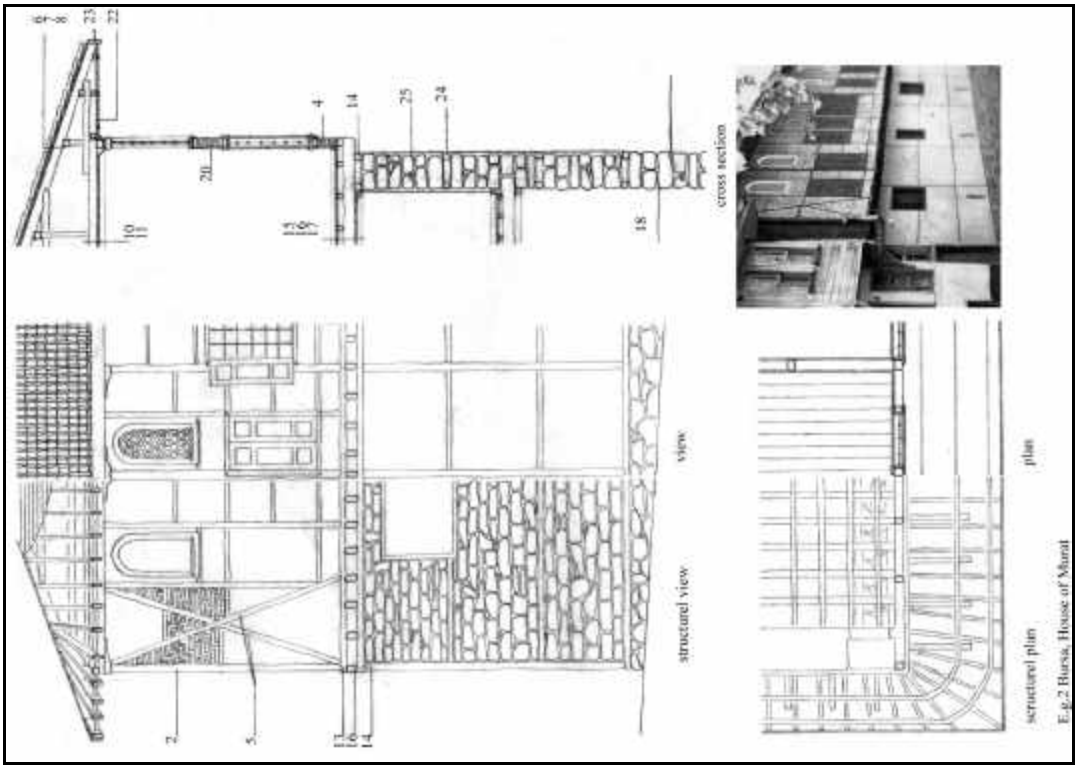


Figure 1

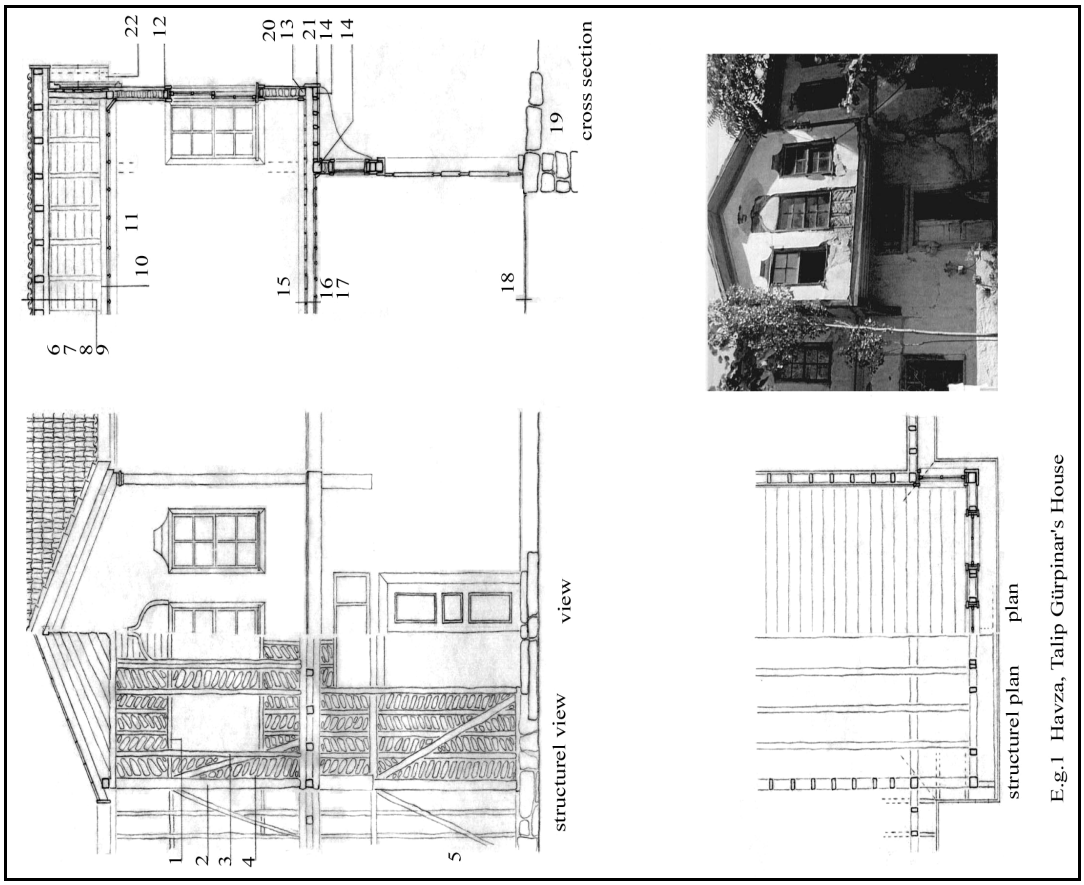
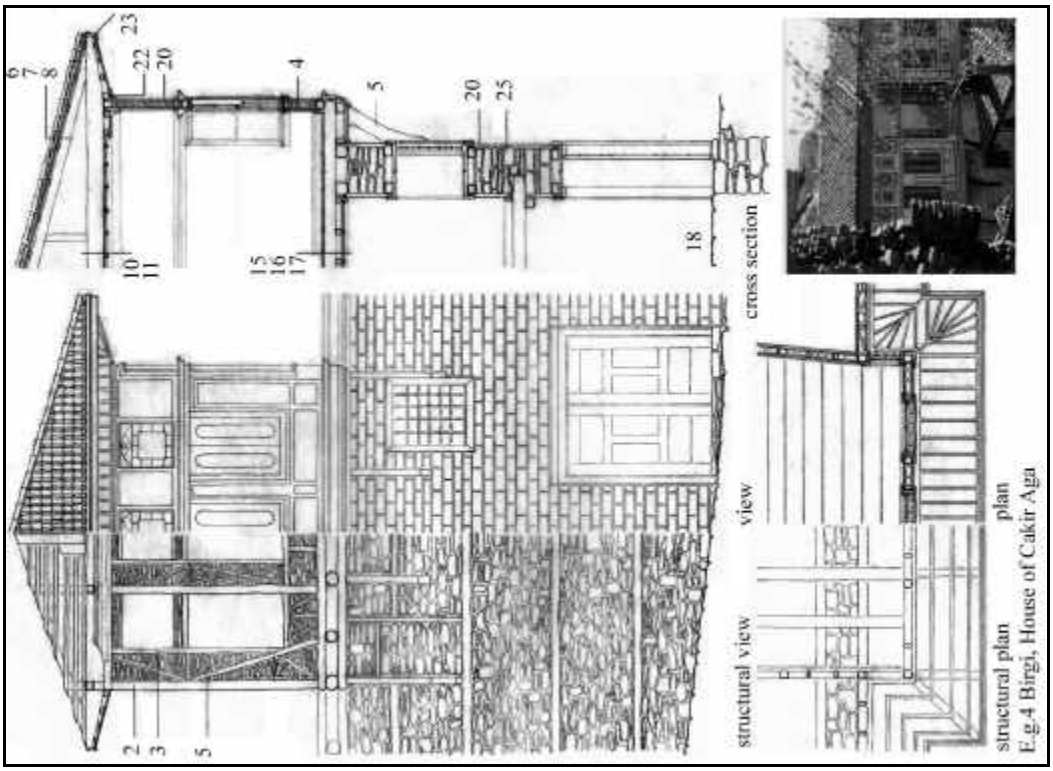


Figure 2



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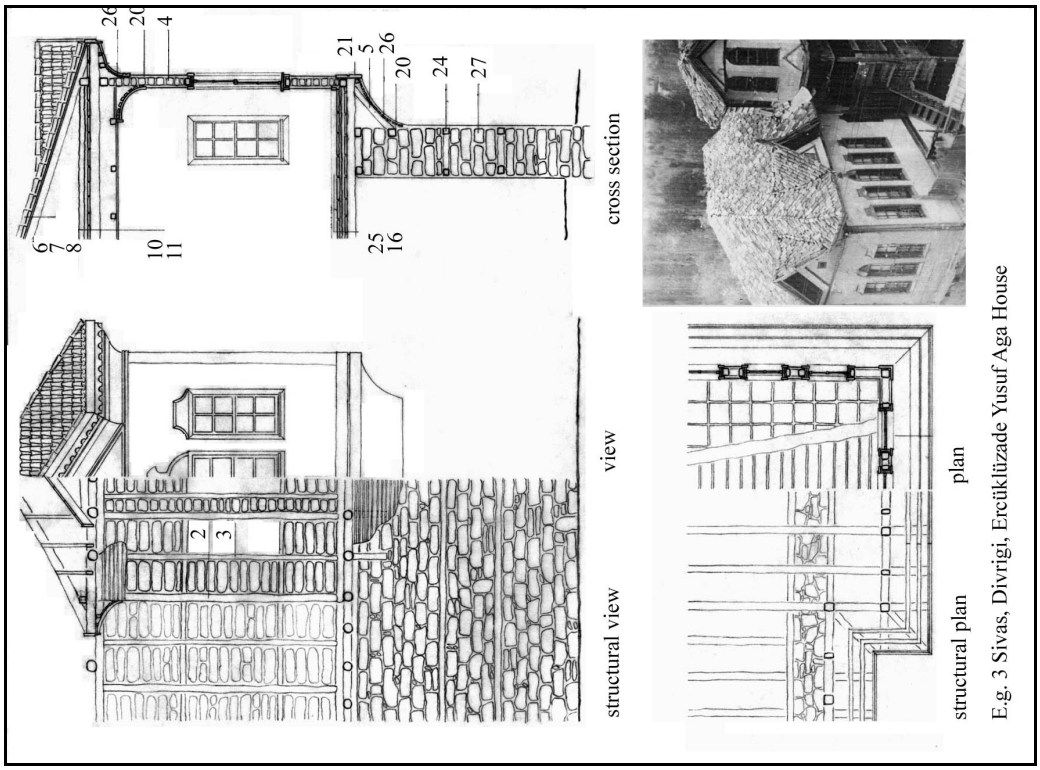

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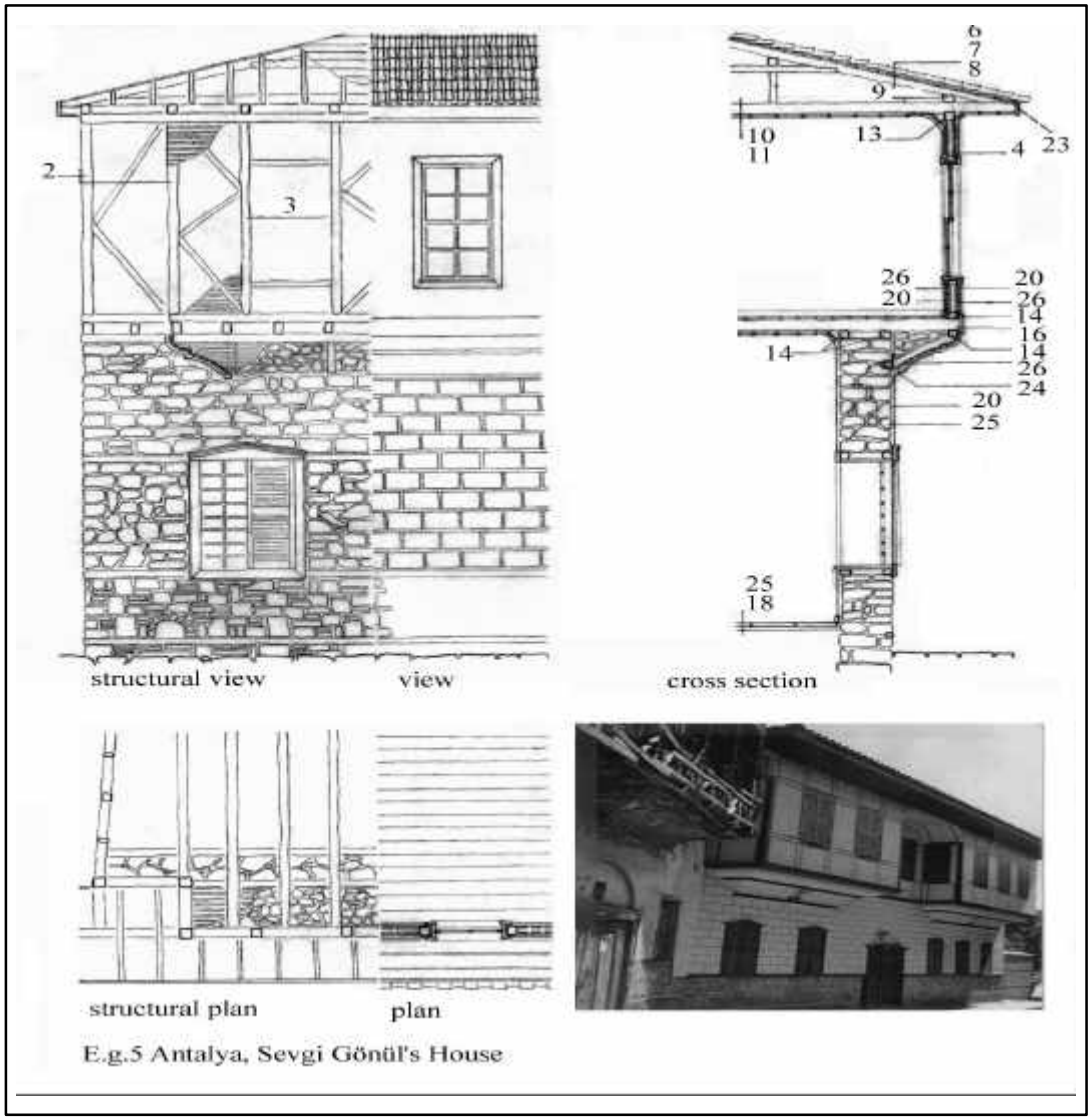

Figure 5

List:

1-upper chord

2-main column

3-intermediate column

4-fiil

5-diagonal

6-groved tile

7- wooden covering

8- rafter

9-purlin

10-roof beam

11-wooden beam

12-upper chord

13- upper chord

14-lower

15-wooden floor covering

16-floor beam

17-wooden ceiling covering

18-hard soil floor

19-stone base

20-plaster

21-border

22-covering on cover surface of eawes

23-front covering for roof system

24-horizantal beam of timber

25-stone

26-lath and plaster work

27-adobe

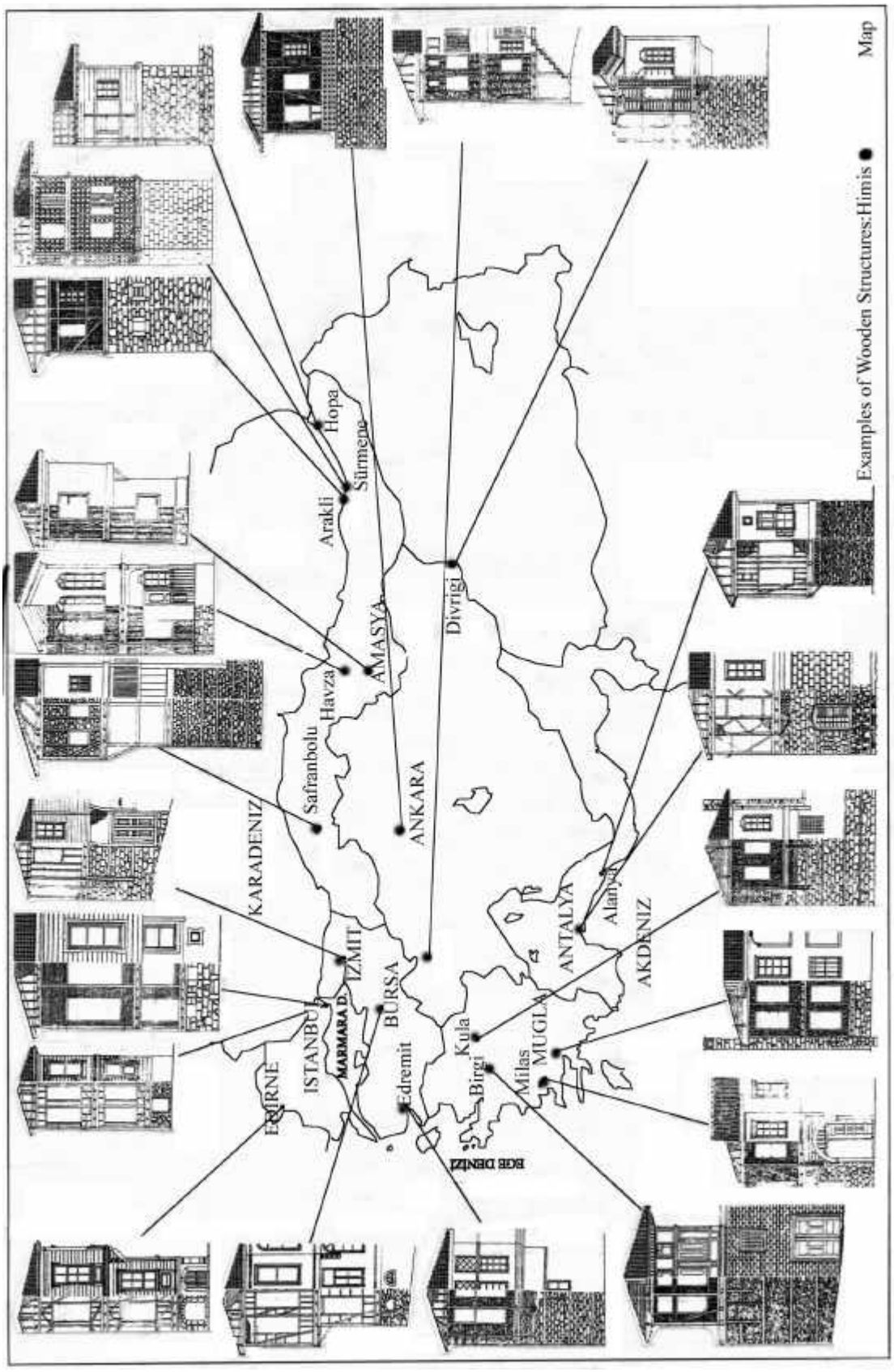
Examples of Wooden Structures:Himis ● Map
Hopa
Sürmene
Arakli
AMASYA
Havza
Safranbolu
KARADENIZ
ANKARA
Divrigi
IZMIT
BURSA
MARMARA D.
ISTANBUL
EDIRNE
Edremit
Kula
Birgi
Milas
MUGLA
ANTALYA
Alanya
AKDENIZ
EGE DENIZI

Figure 6