

# Investigation of Architecture and Structural Deterioration Factors of Historical Kutahya Houses

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## Abstract

*Kutahya is a city of civilization which has hosted many civilizations. It has made a name for being the center of many civilizations and an important point of passage in history for an eight thousand-year period. The way of transferring to the future the cultural heritage of Kutahya, which carries the noticeable marks of the beginning period of the Turkish Republic, to the is to maintain the architectural tissue and to scrutinize the current situation in order to give reference to the future. In this study, the characteristics of the Historical Houses of Kutahya, the materials used and the structural causes of deterioration have been investigated. Also, the relationship of this system with other social areas has been observed.*

**Keywords:** Kutahya Houses, structural deterioration, protection

## Tarihi Kütahya Evleri Mimarisinin ve Yapısal Bozulma Etkenlerinin İncelenmesi

### Özet

*Kütahya birçok uygarlığa ev sahipliği yapmış medeniyetler şehridir. Sekiz bin yıllık dönemde birçok uygarlığın merkezi ve önemli geçit noktalarında tarihte adından oldukça söz ettirmektedir. Cumhuriyet Dönemi'nin başlangıç izlerini hissedilir şekilde taşıyan Kütahya'nın, kültürel mirasını geleceğe en iyi bir biçimde aktarmanın yolunu mimari dokusunu korumak ve geleceğe referans verebilmek için güncel durumun da irdelenmesiyle devam ettirilebilecektir. Bu çalışmada Tarihi Kütahya Evleri'nin karakteristik özellikleri, kullanılan malzeme ve yapısal bozulma nedenleri incelenmiştir. Bu sistemin diğer sosyal alanlarla ilişkisi de gözlemlenmiştir.*

**Anahtar Kelimeler:** Kütahya Evleri, yapısal bozulma, koruma

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## 1. Introduction

The main purpose of the protection of the architectural heritage is to transfer the integrity and original properties of cultural values to next generations. To do so, information on construction systems, construction materials and architectural formability etc. has to be collected and evaluated correctly. That kind of evaluation offers an opportunity for next generations to have visual and written data about cultural properties that is disappearing [10].

Cultural and social values of societies enable them to have architectural works by being integrated with structures that will be constructed. In this respect, architectural works are the best witnesses of the human history. Two fundamental factors that affect the formation of architectural works are materials and construction technologies within the bounds of those materials [11,13].

When we look at the construction methods of the traditional Turkish houses, the main material is wood and method is half-timbered, the way in which the panels between timbers are filled. In addition to maintaining the tradition, the existence of materials in Anatolian and Rumelian forests and earthquake risk played important roles in preferring this method. Masonry constructions were commonly used in regions lacked of wood because they require less wooden material than timber framed constructions. Turkish houses had effects on regions within the borders of Ottoman Empire after the 17<sup>th</sup> century but they started to regress in the 20<sup>th</sup> century in terms of style. They sustained their construction characters in little towns and villages of Anatolia; however they lost their importance because of changing life style and new developments. Again, various reasons like unplanned urbanization and fires cause important architectural heritage to disappear off the face of the earth day by day [12].

## 2. The History of Kutahya

Kutahya exists nearly for a thousand years and is an imperial city that has hosted many cultures like Hittites, Lydia and Macedonia. It was an important part of the Roman Empire and after the crash of the empire it became a part of Byzantium. Then, the city was conquered by Malik Mansur in 1074 entering into the domain of Anatolian Seljuk Sultanate. It became a border town and by the end of the 13<sup>th</sup> century, it came to be identified with Germiyanids becoming their capital. After the death of the 2<sup>nd</sup> Yakup in 1429, it permanently came under the domain of Ottoman Empire. The city was sanjak beylik at first, and then became the center of Governorate of Anatolia in 1451. Until the crash of the empire, the city that was the second preeminent one after Rumelia Governorate among 34 governors bore witness to the Turkish National Independence War just before the beginning of the Republican period. Eskişehir and Dumlupınar wars occurred in that region. When we look at its cultural values, it is globally famous for its faience described as a flower in fire and it has a unique faience museum in the world. There is no other museum like this one anywhere else. Faience workers entered into an agreement on July 13, 1766, making it the oldest labor agreement throughout the human history. Arizoi antique city hosted the first stock market of the world. Additionally, the temple in Arizoi is the best protected one among Zeus Temples. Evliye Celebi (Saint Celebi) that travelled everywhere in the world and wrote his famous book “Seyahatname” (Travel Book) was originally from Kutahya. Frigya Valley is the other

important place in the city in terms of tourism. Memorials constructed for Osman Bey and his grandmother Mother Hayme, and Supreme Military Command Historic National Park that is national sensuous are other touristic places in the city.

### 3. The Place of Historic Kutahya Houses on Turkish Domestic Architecture

#### 3.1. Characteristics

The main unit that constitutes city structure is houses. Kutahya is in wooden region of Anatolia in terms of domestic architecture. It is in the group of west Anatolian Turkish houses in the line of Balıkesir, Antalya and Usak. Kutahya houses are typical Turkish houses in terms of their pinnacles, wooden buttress outbuildings, room orders, many floors, two or four inclined roofs, half-timbered way in which the panels between timbers are filled, timberwork systems, before the 18<sup>th</sup> century its open and outward sofa style and then middle inner sofa. The oldest house belonged to Hamit Aydın hosted by Lajos Kossuth, the leader of Magyar Independence War. There are many other historic Kutahya houses in core neighborhood like Defterdağ Mansion in Sultanbağı neighbourhood, Hacı İsmail House in Kursunlu neighborhood, Bandımzade house in Gazi Kemal neighbourhood and Germian Mansion in Pirlir Neighbourhood. In civil architecture, houses that has open sofa in 17-18<sup>th</sup> centuries are the most characteristic houses in Kutahya [2].

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Figure 1. Street structure and the location of houses (writer archive, 2014)

The characteristic Kutahya houses are usually big and have a garden. They are simple when we look at them from outside, however, inside them there are built-in furniture, ceilings, cooker hoods, doors, and hand rails which are decorative.

There are adobe-filling and timber frame, two or three floors, and tile web on masonry first floor in Kutahya's houses. Windows frame, framework, main strut and joists, door and outing buttresses are in natural color of wood. Lath and plaster sides are white, yellow, ochre, and indigo blue. After people left window bay and doorway, remaining parts were corrected using plastering with fibered mud, known as half-timbered method. The plan of roofs could be four inclined jerkin head and two and three pitched saddle roofs in separate order. The material of roof covering is pantile. Chimneys were constructed higher than ridge and top of them is covered with four or two pitched roof.

Wooden buttress outbuildings are the most important parts of Kutahya's houses. They are gradually in three floors and represent the desire to be outside. They are also convenient for perception of streets as vertical. In 19<sup>th</sup> and 20<sup>th</sup> centuries in which people preferred middle or inner sofa style, they used mostly window frame, eave, framing and bay window buttress for outside decoration more than inner one [2].



**Figure 2.** Buttress and outbuildings wooden houses (writer archive,2014)

The oldest Kutahya's houses were usually bungalow. Then, houses became two or three floored, so suitability was considered between those floors in application of plan. Even if many houses were considered in their original structures, Kutahya's houses were planned as classical form in terms of plan adjustment and lower floors were planned as stony ground. Stony grounds served as store of agricultural tools or horse's barn. Entrance doors of them are so big that horses can come in. Windows are less and small as possible. There is another door that can be opened to back garden in addition to the street door. It is always open in summer months. In some example, people did not need it and back garden integrated with house floor. There are toilet, cellar, grain bin, coal hole, soup kitchen, trough and a laundry stone in this floor. Middle floors and mezzanines were designed for daily needs. Those floors are also suitable for the winter.

Sofa is called as "life" in Kutahya. Top of the life is closed with roof and outer sides are open. Because houses that are designed like that are usually exposed to cold wind and rain, and do not have privacy, two side of the life is closed. There is a water-tank with a fountain in one side of the life, and a part used to make coffee in the other side of the life. Water that comes from there goes to yard directly or through gargyle. There is an airy seat part in the life or it is added up to its outside later. It is called as throne or kiosk. The floor of the kiosk is higher than one of the life.

Toilets are outside in Kutahya's houses. It is a part that is made later near the hand basin. They are usually in garden and made of adobe or wood [2].

There is usually no room or bathroom for bathing in Kutahya's houses. Since there are hammams that provide hot boiled water in almost every neighborhood, and the climate

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of Kutahya is cold, people did not build a separate room for bath that could construct by heating [2].

There is not any separate part in Kutahya's houses to cook or eat. To do so, they use daily rooms [2].



**Figure 3.** Double-leaf wooden and arched doors (writer's archive,2014)

Doors enable people to come in and be protected from outside. Windows are eyes of houses, and doors are like a mouth that is opened to outside for friends and stop enemies. People can come into houses mostly by using a street door and crossing the garden. House street doors are only decoration of buildings. Doors are usually double-leaf. They are on a wall reinforced with bonding timber, plastered with adobe, whitewashed, covered mostly with adobe and some stone. The duty of arc is not just to determine hinge and also to provide a basis for tri-serial drop nails. It prevents wings from changing shape. Interior doors are single-leaf doors. The duty of door wings is to save doorway. They are usually small. Most doors are opened to bottom of terrace. They all have sill. When the door wing is opened, it is provided that door is opened to area left inside of wardrobe width because people wanted inside of rooms not to be seen. There are mirrors and interlaced doors in Kutahya's houses. Even though there is much care and effort on the life's side, they have a rough appearance on the interior sides [2].

It is important that windows can be opened in several directions in empty rooms. Therefore, room is airy and gets sunlight, has a good fine view. Windows in the rooms are sorted in according to certain gaps. They are thin and long. There are frequent intervals between them. Since glass was very expensive in that time, windows were divided to 2-4-8 sections. People could use small pieces of glass when windows were broken [2].





**Figure 4.** Sectional windows (writer's archive, 2014)

There are domestic built-in wardrobes and cabins on almost every wall except windowed ones to meet several needs. They were called in according to their purposes. They could be used as store of goods, strips, jugs, quilted turban, napkins, and lambs etc. An example of that kind of names is the gap of lazy. These wardrobes were important because there were not any bedroom and kitchen. Beddings were collected and put into wardrobes in mornings. All goods related to kitchen like plates, pot and cooker were in them. Wardrobes and shelves were set up within accessible distance and tops of them were sometimes fixed wall or timber cover [2].

Kutahya is one of the cities given importance for its houses. There are various shapes made of sticks shapes on timber ceiling covering. Veneer is stuck under ceiling joist. Geometric shapes and sticks are put together on veneer. There is a ceiling rose in the middle and a quarter of it in the corners of ceiling. That ceiling rose is called wheel of fortune which is "carki felek". Also middle of the main rooms has faience plates in some Kutahya's houses. They could be uncolored, golden blonde, straw yellow, red, dark green, white or black [2].

Stairs' are made of wooden. Step boards which have 3-4 centimeters thickness are put onto two lemon joists. The width of stairs doesn't exceed 25 centimeters. The height of stairs is more than 17 centimeters. Main floor is accessible by stairs from two separate mezzanines [2].

There was an oven in the yard of Kutahya's houses because everyone made their bread in that time. When yards became smaller, people started to use ovens in the neighborhood. After notion of bread selling, the number of those stone ovens also decreased. In that stone oven in shape of hollow hemisphere, brush was burned. In old neighbourhoods there are special rooms for laundering. There are places of furnaces for water heating in those rooms. Wood is used as fuel in these furnaces. Water is heated by putting three legged metal sheet and caldron. In those laundries, there are stones for washing clothes. There are gutters where the water flows and places where the water gathers for clothes to be rinsed. As there is a laundry like that in every neighbourhood,

people do not wash their clothes in their homes. In the gardens of some houses, there is a washing stone and sometimes caldron is set up in the garden and clothes are washed on that stone [2].

Downstairs of every house were allocated for those purposes. Ground of those regions is compacted clayey soil. Parts of houses except hayloft have no windows or a small window. Ground floor was designed as stony place. Those places were used as horse barn or agricultural tools' store [2].

Fountains of Kutahya are the most excellent production of Turkish culture, human love and visual pleasure. Water resource is seen as a God's gift and public fountain is built upon the water resource. Because there is fountain almost in every street, there is no water in the houses. Either in front of the door of neighbourhood or on the other side of their wall of garden, there was a fountain. In the yard of the some houses there was also a shaft system. That's why waterworks were set up so late in the houses [2].

### **3.2. Neighborhood relations and streets**

Row housing on both sides of the Street, the way that bay windows do not obscure each other and do not disturb other residences' windows enable neighbourhood relations to come to an agreement. The merits of respect, cooperation and love of neighbourhood relations play an important role in the shape of the street. Generally, the ground floor of the house but on the upper floors they go beyond their houses with the bay windows that provide them with a larger sight. Sometimes, eaves are about to touch each other but still do not prevent the sight of houses from the layout of row housing. The streets, narrowing and enlarging from place to place, creating fountain gatherings at the corners and giving rise to surprises with sudden chops and changes are the product of good and happy neighbourhood relations.



**Figure 5.** Row housing with bay windows (Author achieve, 2014).

## **4. Structural Impairment Factors**

#### 4.1 Geographical position related impairments

The buildings wear out under various effects of nature for long years and if continuous maintenance is not provided, serious damages are observed. The construction materials are exposed to frost on hot summer days and with temperature differences and cyclic action of freezing and thawing, they consume away. The movement of the water with the capillarity phenomena also results in damage to the building. The moisture rising from the ground can cause to weathering, physical and chemical impairment of the wall when it evaporates, because it overloads the conveyor system by moisturizing the structure.

When the rain water is not removed speedily from the roof coating or valley, it sets up the suitable environment for growth of moss and weed. The moss locates on the environment of the ruined part, fungus grows on the wooden roof and flooring. These defects that can be the signal of further serious impairments should be taken care of with continuous maintenance [6].

The primary environmental problems of the city are arranged in order of importance as Air Pollution, Water Pollution, Unplanned Urbanization and Pollutant Effluents.

**Table 1.** Meteorological analysis of Kutahya (between the years of 1960-2012) [3].

Kütahya	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
The Average Values Over Many Years (1960-2012)												
Average Temperature °C	0.4	1.7	5.2	10.0	14.6	18.4	20.9	20.6	16.6	11.8	6.7	2.6
Maximum Temperature °C	4.7	6.5	11.0	16.2	21.3	25.2	28.2	28.5	24.8	19.0	12.7	6.6
Minimum Temperature °C	-3.3	-2.5	0.0	4.2	7.9	11.1	13.4	13.2	9.4	5.8	1.8	-0.8
Sunshine Duration 'h'	2.1	3.1	4.3	5.6	7.3	9.2	10.1	9.3	7.3	5.6	3.3	2.0
Number Of Rainy Days	14.5	13.2	13.5	13.0	12.1	7.6	4.0	3.3	4.7	8.8	10.4	14.7
Rainfall kg/m <sup>3</sup>	66.7	59.1	60.0	55.3	52.1	34.3	18.6	14.4	21.4	42.1	51.8	85.4
<b>The Total Maximum Daily Rainfall</b>	18.12.2001 92.2 kg/m <sup>3</sup>		<b>Daily Maximum Wind Speed</b>		05.02.2003 99.4 km/h		<b>The Highest Snow</b>		26.01.2006 60.0 cm			

Home heating, industry and traffic can be considered among the reasons of air pollution. When the last three years' air quality values are observed, it can be seen that there has been a considerable air pollution prevention depending upon the rise in the consumption of environment friendly fuels. According to regulation about making changes in the Air Quality Assessment and Management Act, it is seen that PM10 values are high especially in winter and when looked at 2013 targeted air quality short-run limit values, it is clear that they have approached to the targeted values for 2013. The dominant air pollutant of the city is (PM10) the particulate matter. One of the main important factors of air pollution is the topographic structure of the city.



Especially in winters an incidence is observed in Kutahya in which the wind blows to the opposite direction and moves from slope to the ground after it gets cold on the surface of the valley, where the city locates between the mountains, and pushes the air upward until the inversion level. This incidence is reported as it leads to the rise of cold air layer during night that covers the city and it disappears by getting warm slowly on the other day. This layer that appears as dirty and foggy can be seen easily by naked eyes especially in winter months.

The problem of unplanned urbanization is because this city is an old settlement and thus it is related to geographical position. The fact that old settlements are in narrow areas and many of those are under the protection of “Cultural and Natural Heritage Preservation Board” limits the renovation of infrastructure or other important works. The inner-city transportation roads are affected by these old settlements. Manisa-Kutahya-İzmir Planning Region 1/100.000 scale Environmental Plan entered into force after 31<sup>st</sup> August, 2007 and urbanization works are carried out in accordance with this plan [1].

#### 4.2. Ground related impairments

The factor that increases the risk of destruction of a structure is its location on a fault line or crevices [6].

Formation of shear cracks on the walls of the load bearing, masonry construction, their oversetting outside of wall plane, the breaking apart of walls in the corners and separation and collapse of the flooring from the wall are the damages that can be encountered during the earthquake.

Another effect of earthquake occurs when the seismic waves increase the pressure of ground cavity water and fine-grained sandy ground behaves like liquid which is called liquefaction. The liquefied ground cannot hold the construction and collapses [9].



**Figure 6** .Kutahya regional earthquake map, Republic of Turkey Prime Ministry Disaster and Emergency Management Presidency Directorate General of Earthquake [4].

This map was prepared with the help of present information and entered into enforce in accordance with the decision of the Council of Ministers dated 18<sup>th</sup> April, 1996 and numbered 96/8109. Different from the previous maps, earthquake zones were

determined on the basis of contour map which is drawn according to the probability calculus. According to this, it is estimated that a normal structure, with 90% probability, will not be exposed to a more loading than these acceleration values in its 50 year economic life. For important structures or the structures with longer economic life, the highest acceleration values that they may encounter need to be calculated.

**Table 2.** Turkey Earthquake Regions Map index [5].

KÜTAHYA CITY			
PLACE	EARTHQUAKE ZONE	PLACE	EARTHQUAKE ZONE
Kütahya	2	Emet	1
Köprüören	2	Örencik	1
Sabuncu	2	Gediz	1
Altıntaş	2	Hisarcık	1
Zafertepeçalköy	1	Pazarlar	1
Aslanapa	1	Simav	1
Çavdarhisar	1	Dağardı	1
Domanıç	2	Şaphane	1
Dumlupınar	2	Tavşanlı	1
		Balıköy	1

#### 4.3. Human related impairments

Humans can cause the destruction of historical structures with actions such as dilapidation, relinquishing and intentional destruction. The other factors can be sorted as fires, wars, public works, tourism, air pollution and traffic [6].

#### 4.4. Structural design related impairments

If there are sizing errors related to conveyor system of buildings, serious damages can occur. Walls with insufficient cross-section buckle over time, and if this happens in the buttress, it can cause to openings in the arch, vault and dome it fortifies [8].

#### 4.5. Defective use of materials-related impairments

The choice of materials in historical structures has always been an important element. Along with the proper choice of materials, simultaneous use of proper materials is also important in the sense of long survival of the historical structures.

Historical buildings were constructed by use of natural characteristic materials such as stone, brick, and adobe. The quality of the materials used is important in terms of durability of the structure and impairment process. For example, the presence of clay stratum and other inclusions leads to rapid wear and rupture of the stone from the part of inclusion. It should be paid attention to the frontispieces during stone dressing and stone must be shaped in compliance with the layers of quarry. If the stone is located without paying attention to those layers, it is seen that the stone is eroded backward and even fragmentize without resistance. Also, endurable structure causes to easy disintegration and deflocculating of the stone.

In brick structures, hard-burnt brick is an essential factor affecting the durability of the structure in a positive way. In walls that are not made of hard-burnt bricks, damages like rapid wear, spalling, disintegration and deflocculating are observed. The use of hard and

dead wood in wooden structures extends life of the structure. Because insects have difficulty in nidification on hardwood, they prefer soft wood. Thus, deterioration of soft wood happens more easily. Furthermore, the chopped tree has to be grown one. Green wood is mostly preferred by insects. Also, the wood for use is to be desiccated necessarily [7].

#### ***4.6. Bad workmanship and construction procedure-related impairments***

The integration of the constituents with proper materials and techniques is necessary for durability of the structure. Metal elements like iron are used as junction piece in stone structures. The main negative impacts of the corrosion of these materials are stretching of the metal and compression fracture after pressing the stone. The reason of this situation is the use of metals without taking precaution against corrosion. In addition, the reason of the yellow-brown spots on the surface of stones is the oxidation of sheet bar that are used in identification of the stones [7].

### **5. Results and Suggestions**

Wooden roof system contributes to carry loads and own weight knitting the wall as a network. Because the use of nails in joints could not provide sufficient rigidity in earthquakes, the necessity to use metal elements (blades) in joints has appeared.

The other most widely used construction material in buildings is adobe brick. Adobe material is used as filler in wooden roof and wall material in masonry structures. Although adobe's mechanical properties are not sufficient for building materials, being affordable and easy for people in the region, providing insulation, preventing condensation make it usable as building material in buildings.

Side effects of rain water resulting from the position of the structure and contact with the building is reduced by making drainage.

Especially in winters an incidence is observed in Kutahya in which the wind blows to the opposite direction and moves from slope to the ground after it gets cold on the surface of the valley, where the city locates between the mountains, and pushes the air upward until the inversion level. This incidence is reported as it leads to the rise of cold air layer during night that covers the city and it disappears by getting warm slowly on the other day. This layer that appears as dirty and foggy can be seen easily by naked eyes especially in winter months.

In order for the protection of historical houses of Kutahya in long-term and transfer to the next generations as cultural heritage, its geographical position and many deterioration effects have to be examined. The city of Kutahya is exposed to physical and chemical interaction, because most of the historical structures are densely located at the city centre and in areas that are widely-used during daily life. Another purpose is to operate the structures that are made with purpose of protection and reuse without ruining the core of supplements.

Kutahya is a city that reserves an extensive cultural heritage in terms of tourism. It carries the deep traces of The Independence War and The Republic of recent history. Kutahya, which is at the centre of location, draws attention of domestic and foreign

tourists with its proximity to Mediterranean, Aegean, Central Anatolia and Marmara Regions.

The restoration works carried out with taking notice of these details are going to be main constituents of economic development based on protection of cultural heritage. On behalf of starting these renovations, the support of institutions and organizations will return with many other acquisitions.

Work flow diagram and programme formed during restoration works can constitute a functional ordering for other historical structures of our country. Preliminary projects and preparation phase that are carried out with this awareness will provide time, cost and source recovery.

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