

# Investigation Of Architecture Of Historical Safranbolu Houses With Structural Corruption Factors And Sustainability

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**Abstract**—Historical places and structures are important expressions of the culture and identity of the society. Safranbolu Houses are the most important building blocks of the Turkish city culture that has been composed in hundreds of years and continues to live today.

In this study characteristics of Historical Safranbolu Houses, materials used in the houses and causes of structural deterioration, relationship of the available material resources in the region have been examined. Safranbolu Houses are important among Traditional Turkish Houses in terms of architectural features as well as original features of the cultural heritage of the region for transmission to future generations.

**Keywords**—Historical Structures; Sustainability;

## I. INTRODUCTION

Culture can be accepted as a whole abstract and concrete life characteristics and values of a specific human community. These values are alive, depend on the circumstances, develop and affect their environment like people constituting the culture. Turkish culture which rooted out the beginning of universal culture, has reached advanced level of development in time and has taken an active role in shaping all values of community in ruling geographies. One of the most important social values is shelter and house providing basic needs of humankind [1].

The respect of Traditional Turkish Houses to human, nature and close environment can be accepted as one of basic configuration principles. Positioning of buildings in a way of not closing each other's landscapes, protecting the indoor's privacy, having a garden of each house, hanging on the walls carefully built bird houses, using doorknobs which include specific messages and all details are the signs of Turkish Houses' attention to human and nature. It has been tried to display how the lifestyle which has an important place in Turkish culture and the privacy understanding which has been especially changed after the acceptance of Islam have formed traditional Turkish houses with selected samples. Marks of Turkish lifestyle and especially privacy understanding in traditional Turkish houses are sampled in two main titles as architectural design and reinforcement elements [1].

Safranbolu houses are important in terms of passing on future generations with architectural features and locally original features of cultural assets among traditional Turkish houses. Since 1994 these houses which are in UNESCO World Heritage List have been protected completely. For this reason with this place's suitability of sustainability conditions and architectural configuration, construction technology and material usage of these houses response to today's actual propensity becomes important.

## II. ARCHITECTURE OF HISTORICAL SAFRANBOLU HOUSES

### A. Gardens

The height of the garden wall is more than human size, inner garden can't be seen from the street. The wall is made of stone or adobe. There is tile on the wall which protects it from the rain. Entry from the street to the garden is done by fringed two-leaf door [2].



Picture 1. Stone Braided Garden Wall [Author Archive].

### B. Ground Floor

Parts in the ground floor are below:

**Life:** It is the place entered from the door. Its ground is mostly soil. If the life is covered by stone, it is called stony place. One or two sides of the life look outside. There are building's carrier dikes at regular intervals which are 60-80 cm high and at the same width on foundation wall [2].

**Boiler:** Boiler which is very important in mass food preparation, can be in a wall of life or in a working place passing through the life [2].

**Warehouse:** There is a big warehouse which is two-stage and adjoined to a wall of life [2].

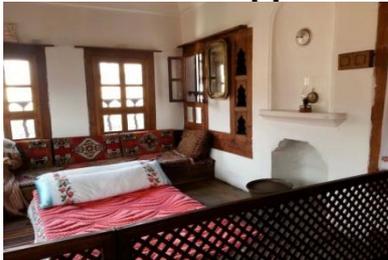
Barn: You exit to the garden through a door, you pass to the barn through another door [2].



Picture 2. Historical Safranbolu House's Door [Author Archive].

#### C. Rooms

Every room of the house has properties for sheltering a family. In every room you can sit, bath, eat and even cook. Middle floor rooms are available for sitting in the daytime and working. Upstairs rooms are available for guest accommodation and as bedrooms. Room plan is square or near square. Room heights are more than 3 m on the upstairs and 2.30-3.00 m on the middle floor [2].



Picture 3. Historical Safranbolu House Room [Author Archive].

#### D. Sofa (Pergola)

The most important element of the house which connects rooms and affects the design of the house is sofa. Rooms are opened to sofa and connected to each other. At the same time sofa receives sitting, eating, working and sleeping activities. We can divide sofa as outer sofa, corner sofa, middle sofa according to the positions of the rooms [2].



Picture 4. The View of Sofa [Author Archive].

#### E. Stairs

Stairs are quite simple. There is a wall on one side of the stairs and mostly a wooden curtain on the other side. So the railing problem is resolved [2].



Picture 5. Stairs [Author Archive].

#### F. Ceilings

Ceilings are directly related with design. The ceiling of the room entrance is lower than the room ceiling and separate. Modifications in volumes are repeated in the ceiling. Pergola patio is lower than the pergola ceiling and simple. In some rooms and pergolas there is a boat ceiling. Middle sofa has a shape of eight-sided with the coming of room entrances to corners, the same shape continues on the ceiling too. Sometimes an eight or more sided ceiling is seen in the rooms [2].



Picture 6. Ceilings [Author Archive].

### III. THE EFFECTS OF TRADITIONS TO THE STRUCTURES

#### A. Harem-Salaam

Religion and traditions close the house to the outside, therefore indoor and gardens are separated by high walls, windows are grilled, ladies can't be seen by men. Sometimes ladies and men live separately in the house. In Safranbolu there are houses divided into two as harem and salaam like these [2].

Ferris Wheel: In the old age because ladies couldn't be seen by men who weren't from the close family in the house, a ferris wheel was made in a cabinet between two rooms for ladies serving from harem to salaam to take and give food, coffee, syrup without showing themselves. Plates put on this cabinet's shelves were delivered to the other part of the house by hand turning [2].

Salaam Mansion: There are salaam mansions in gardens of some houses. These mansions have one or a few rooms. Salaam mansions were entered from the garden through another street door [2].

### B. Ablution

As a matter of religion before worshiping, ablution is necessary. In the house there are ablutions and gushrooms for these things [2].



Picture 7. Ablution and Bathroom[Author Archive].

#### IV. THE EXAMINATION OF SAFRANBOLU HOUSES IN TERMS OF SUSTAINABILITY AND CAUSES OF STRUCTURAL DETERIORATION

Safranbolu Houses are the most important alive building blocks of Turkish city culture which has been formed in hundreds of years. In the town center there are about 2000 traditional Turkish houses which built at the beginning of 18<sup>th</sup>, 19<sup>th</sup> and 20<sup>th</sup> century. About 800 of these artifacts are under legal protection. The houses are grouped in two different parts of Safranbolu. The first part is known as “Şehir” and used in winter, the second part is known as “Bağlar” and used in summer. The city consists of districts that there is a management center in Kale, there is a shopping center in Çarşı, there are houses in Akçasu, Gümüş, Musalla, Kalealtı and Tabakhane. This part is in two low valleys which have been protected against adverse effects of climate. The houses are close to each other, the streets are narrow here. Bağlar is several hundred meters higher, open to air currents and on wider lands. Everybody has almost a winter and a summer house. Locals live in the house in the city in winter and move to the summer house in Bağlar with the good weather in summer. But “Çarşı” production and trade life also continue in summer. All houses are turned to more central public buildings, religious buildings and monument works. From which house you look at, the landscape doesn't close. Close plans of the houses are unsighted, remote plans of the houses are open and continuous [3].

There are heat differences between regions due to the different altitudes of Şehir and Bağlar parts. Bağlar part which is in high altitude, has vineyards and fruit gardens, is used for cottage settlement because it is snowy and windswept in winter, cool in summer. This lifestyle in the past is quite important for protecting the environmental resources of structures. To prefer substitution to environmental control by artificial systems is a correct approach for energy consumption [4].

Roads and streets of the square in the middle of the city are completely stone-covered. Courtyards of monument works and squares are also stone-

covered. The stone-pavement style is suitable for lowering humidity, tree roots to take enough water and resistant to flood water [3].

It shows that with upstairs cantilevers it was built for watching landscape and street rather than space acquisition need. These upper floors lying to the street which can be simple console outputs, beam consoles, jagged projections which are made by binding continuous beams placed in two directions upon each other [5] or shackles bring rich visuals to the street's perspective while taking the light of the outside more abundant and easily. Consoles are positioned in a way that don't interfere their neighbor's daylight. While the flow of life continues in expanding rooms by consoles of upstairs, outward wooden supports emphasize the synchronized state of nature-street-human-house harmony in order of reminding the rhythm of life [6].

The location of Safranbolu (higher than sea level) ensures less temperature changes and low humidity[4].

The location of the structure (slope or creek bed) causes to suffer from its climatic effects more intensely. If no action is taken, a structure on a slope or in a pit is open to threats of floods. As a result of poor collection of surface waters from the slope; after thunderstorms the structure stays in water for a long time, its wooden doors are rot, deteriorations are observed on the floors and on the bottom of walls of the structure [7].

In narrow streets, the corners of the houses are chamfered to accommodate the street, house and human proportions. The chamfers of the wall corners which are common in Turkish, Arabic and Greek anonymous architecture, are entirely respected towards the pedestrian. A similar idea is that the chamfering on the walls facing the sofa in the house is a typological solution to human proportions.

In traditional Safranbolu houses soil takes part as binding, mud, adobe; generally adobe was made of every kind of soil. Soil was used in fireplace and garden wall construction[8]. The “hımiş” technique which is a technique of forming a wall by placing various filling materials in the cavities of the wood frame system, has been widely applied in these houses[5]. Wood which was used in the construction, in the roofs of houses, in building components, in the enclosures in traditional Safranbolu houses, was obtained from the surrounding forest villages. Today 38% of the trees are fir, 30% are beech, 20% are pine and 9% of the trees are oak in Karabük Forest Management Area which covers more than half of the total area of this region. The trees used for the construction are fir (as load carrier in the roof) and pine, very little walnut and poplar. In the roof yellow pine, in the floor larch, in the ceiling, in inner and outer doors, in window casings, in picket fences and cabinet doors, in the paddle box, in the closet floor yellow pine is used. Larch, poplar and walnut are applied in different parts of the house [8].

The wooden material is easy to build, allows manual work and can be easily repaired. The wood is

flexible until the end and allows many applications. This flexible structure also makes the building resistant to earthquake forces. The structure's lightness reduces the destructive effect of earthquake as much as positively in terms of not bringing structural load. The dikes that are used in the skeletons of these houses provide the rigidity of the frame system. Horizontal beams used among "himiş" and framed, beamed construction make these houses durable against earthquake [9].

Wood is a renewable, sustainable material. It can be produced, used and reused in a suitable form with little or no waste from manufacture to final product. Wooden carriers damaged by today's composite materials, such as carbon-reinforced polymer technical textiles, can be squeezed and thus the carrier property can be maintained [10].

In Traditional Safranbolu Houses lime mortar, Horasan mortar and sludge are used between binders. For good lime blue limestone and for sludge all kinds of soil are used. Sludge is applied on the wall bracket and in the roughcast; Horasan mortar made by lime, tile fracture and quilt oil is applied in places where water is effective like pools and storages [11]. In a structure heat escapes are at rates of about % 35 from the walls, % 25 from the roof, % 15 from the floor, % 15 from the heat bridges and escape points and % 10 from the windows.

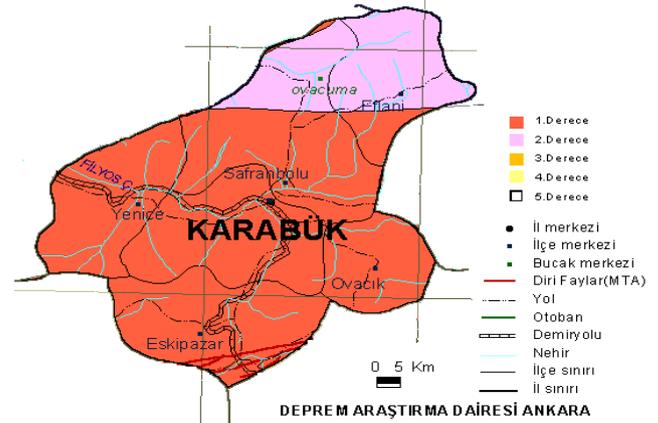
In historical Safranbolu Houses heat escapes are tried to obstruct by applying pine wood coverings whose thermal conductivity coefficient is low on the surfaces of ground, wall and ceiling (pine: 0,13 W/m.K). Protection from the hot and cold and shading are provided by shutters externally on windows.

Waste water is mostly thrown out by a drain hole in washing section. Waste water from houses is drained to toilet pits, dish water is drained to the garden or another pit, it isn't mixed with toilet water[13].

There are pools in some houses for cooling, demanding water in the place and using in fire extinguishing. In pools Horasan mortar is mostly used [11].

As it is seen in Picture 8, Kastamonu is in the first degree Earthquake Region. Low strength of the ground where the structure was built on or being not homogeneous can cause some movements in the structure, visible deteriorations like turning, different seating. If the ground under the foundation isn't homogeneous, cracks on the structure can be seen. It is possible to get idea that cause of damage is originated from whether the ground or not by looking at locations of cracks on the structure and directions. If the structure stays firmly on both sides on the ground and the ground is loose in interim zone, cracks starting from the corners of door and window spaces and expanding towards the sides at 45 degrees can be seen. If there is a solid ground under the middle section of the structure's front, cracks are like wedges, they are in a form of narrow at the bottom, widening upwards. Recognition and correction of damages originated from the ground is ground engineers' expertise; they are consulted for detailed review.

There is a choice of solution according to the state's property: Quite difficult and expensive operations may be required such as ground consolidation or foundation construction to a solid ground. The fact that a structure is placed on a fault line or is built on a rock with cracks in its formation is a factor that increases the risk of deterioration and extinction [7].



Picture 8. Karabük Region Earthquake Map[15].

Our traditional architecture is made of natural materials like stone, adobe, brick, wood. The fact that the materials used are not well qualified, accelerates the deterioration of structures. The presence of clay layers, other foreign materials in the stones causes rapid abrasion and breaking off from the layer or vein in which foreign matter is present. Sedimentary mullets are located in horizontal layers in nature. It is also important that the stone be placed in the building in accordance with the natural stratification of it. During the process, attention should be paid to the future parts of the facade and it should be shaped according to the water in other words. If the block is prepared in reverse to the rock water and is put into place without attention to stratification, the degradation will take place in the form of pouring the layers backwards from the front of the layers. Because the general structure of the stone is unstable, it will easily break apart [7].

The fact that the brick is well cooked in brick constructions is an important influence that increases the strength of the structure. Walls made of bad bricks are subject to rapid abrasion, spillage, surface loss in the form of pits, decomposition, disintegration. The quality of the mortar that combines the main materials in pagan structures is also an important influence on the strength of the building. In walls made of mud or weak lime mortars, the disrupted mortar causes the disintegration of the structure. Using hard wood in wooden structures extends the structure's life. In Turkey the wooden roofs made with softwoods have shorter lives and the traces of a living cultura with the ruined structures are disappeared [7].

Constructions are worn out under various effects of nature for many years and serious damages are observed if continuous maintenance isn't ensured. Materials that expand in extreme heat during hot summer days are exposed to frost during cold winter days; the materials are tired and worn out by heat

differences, freeze-thaw cycles. Movement of the water in the building and water capillarity also cause damage to building materials. As the moisture rising from the ground increases the load coming to the carrier system by wetting the structure and also the evaporation of the salts it carries on the wall surface can cause flowerings, disruptive effects on the physical and chemical structure of the wall [7].

The rain water is ready for the development of algae and grasses due to a distorted roofing or its stream that can't be rapidly removed from the building. Algae are settled around the broken detail, mushrooms grow on wooden roofs and upholstery. These corruptions which may be the beginning of serious damage, must be remedied by continuous maintenance [7].

The abrasive effect of rainwater flowing from the surface can also cause considerable damage, especially in monuments made of easily eroded stones. The frost related to water is also one of the important factors that destroyed the monuments. When the water entering the cracks freezes, it causes cracks to grow and break up large pieces by wedge effect [7].

The frost combined with factors such as neglect, carelessness, poor detailing causes disruptions which are difficult to rectify and often costly. For example; in Ottoman constructions when the fences in the lower parts of the window frames are not filled with lead, the water entering these spaces expands in winter due to the effect of frost, it breaks the part of the window cover that is outside the grate. With growth of the seeds brought by the wind and placed on the roofs, wall cavities and the empty joints it is observed that trees such as fig, aisle root out on the face of many neglected buildings [7].

Animals such as birds, insects and mice are also found in activities that harm monuments. Pigeons enter into the mosques by breaking through the glasses of the mosques, they create a large amount of fertilizer and garbage inside by nesting in minaret spaces. The woodworms weaken the wood by gnawing sneakingly [7].

People can lead to the disappearance of historical structures by actions such as neglect, abandonment, intentional destruction. The abandonment of a historic settlement and the neglect of the urban histo and important monuments are often associated with social and economic problems. Historical buildings whose owners leave to fate with the wish of "destroy, let's build a new one" by dissatisfaction of totally conservation decision of the Ministry of Culture, are also getting worse every year [7].

Misuse, is an important influence that accelerates the destruction. As the owners move to different places, the old houses are given to the use of various families as rental houses and they are getting changed rapidly by the mezzanine, partition walls, showcase opening to street, separate entrance and similar items depending on the wishes of new users. Problems with the misuse of wooden houses in Safranbolu can be seen. Unconscious changes in

historic structures cause overloading or discontinuities in the structure [7]. The opening of the streets of old cities to traffic of trucks and similar heavy vehicles which are arranged according to the traffic of people and carts, causes vibrations in structures around them and damages resulting from pressure on the grounds. The corners of the narrow streets, the historic gates are drawn and damaged by the frictions of the tourist buses or the trucks. In the urban histos that need to be protected it is necessary to create pedestrian zones, to control the traffic and to move them to more suitable places by making necessary planning decisions[7].

## V. DISCUSSION AND CONCLUSION

Stone, adobe, wood materials used in Safranbolu Houses meet the criteria of sustainability in terms of obtaining from local sources, their use in construction, their easy maintenance and their non-waste.

It is a fact that the traditional Turkish house and the equipments in it can't be protected due to the changing culture of life. However due to the universal design concept and pioneering design trends, traditional Turkish culture has been forgotten as it is in most traditional cultures. Traditional Turkish culture, inspired by many civilizations and design concepts, can't be preserved only through the preservation of cultural assets that arrive today. These works should be reinforced by appropriate methods to maintain their function in contemporary life [14].

However, designing new structures and equipments that are compatible with contemporary living conditions, meeting the needs and possessing identity is also important in terms of ensuring cultural continuity. With this project, many reinforcements of traditional Turkish houses such as cabinets, doors, door frames, ceiling belts which are left to the time-consuming effects and are left in an idle condition, are taken under protection and turned into equipments that can meet the requirements of the day in a contemporary structure. However, it has been emphasized that reinforcement elements of traditional Turkish house can be transferred to new applications and contemporary structures can be designed with traditional design concept and cultural continuity can be achieved [14].

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