

The usage of adobe as filling and sustainable material in construction of traditional houses of **Safranbolu**



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ABSTRACT

Purpose: One of the principles of SDG is: “Making cities safe and sustainable means ensuring access to safe and affordable housing, upgrading slum settlements, investing in public transport, creating green spaces, and improving urban planning and management in a participatory and inclusive way”. Since the first ages of mankind nearly passed to a settled life, in many locations in Turkey and in the world, Constructions with timber frame and adobe (mud brick) buildings met basic life needs of people like safe -keeping and sheltering. Along the next periods, by using stone materials some heightened and cutted their direct connection with the floor those buildings still have been used and continued to be built nowadays. Recently, the irreplaceable consumption of the natural environment and energy resources and the alienation of artificial environments to humans and nature have necessitated new approaches to the understanding of architectural design. Proposing these approaches for their intended purpose and discovering the right solutions is only possible by understanding the material use and techniques of exemplary buildings built in history.

By mixing and drying the straw and mud, i.e. completely with the usage of natural stones produced of adobe fitness ability with the timber frame as a construction element is enormous. It enables to create the living quarters which not involved chemical products and built with the materials proper to the human health. Through its permeability, by discharging the over damp it does not cause to dampness. It provides heat and sound insulation. Also by damping energy it enables us to build more durable buildings. Understanding the benefits of the wood and soil people began to use those buildings centuries long for various purposes begin with living in it, protecting their agricultural products, etc. Usage of adobe as a fill material in timber frame system named as HALF-TIMBERED in the literature. In this study, the advantages of half-timbered to human life will be explained.

Theoretical reference As a construction element adobe is prepared by drying the mud in wooden moulds for use of put up a wall. Makeup of adobe and its scales in various locations show too few difference. The amounts of mixed straw also locally change. Overuse of straw causes to porous and rough occurrence in the adobe. In the soil which will be used in adobe made desired not to be found stones bigger than 2.0 cm. and vegetable soil. Though adobe soil includes in proportion 19%-65% clay, the optimum proportion is 29%-45%. The soil is crushed by mixing it with water and straw. After waiting it one day the composed mixture again by mixing it with water is moulded by casting it into the before prepared wooden moulds which have desired rectangular scales. The subject of this article is sustainable materials balanced building design in history.

Method: The subject of this article is sustainable materials balanced building design in history. At first conducted through a literature search. This stage was mostly studied

theoretically and then the Safranbolu protected area was evaluated in terms of climate balanced building design parameters.

The method stages used in the article can be evaluated under two main headings, theoretical and practical.

Results and Conclusion: While an earthquake occurred the frame can oscillate so not fracturing, in this way provided that influencing forces do not make damages or make few damage. With the implementation of timber framed buildings more of an square, rectangle like forms, and with symmetric plan solutions, enabling the buildings can resist to twisting which an earthquake will create.

Implications of research: Placed between the timber sewing distent adobe blocks as for provide the building attribute more powerful against the horizontal forces which formed with earthquakes by virtue of frictional forces between each other. About its application, the casting process should be made on a flat surface, and the mud should be well compressed so much so that it has not contain gaps within it. While the remaining over mud cleaned on the top then the material is put to dry. About ten days long it is dried in open air under the sun. After the completion of the drying process the moulds are raveled out, and so the adobe is gained in regular forms.

Originality/Value: Adobe filling fits to timber frame system better than timber, stone and brick if compared, and by reasons of naturality, permeability, isolation and flexibility it helps to compose conditions which will support human health and increase their security.

Keywords: Timber frame, Half-timbered, Traditional architecture



Figure 1. Adobe Made workshop (Anonym)

1 MADE OF TIMBER FRAME BUILDINGS

Its roots coming from an Italian word “carcassa”, frame means “body” in its lexical meaning. In the construction language as for, it is used to express the frame of a carrier system. Buildings which its carrier system constructed by timber materials with various scales are said made of timber frame buildings. In practice by timber beams horizontally and timber sewing vertically, with various methods binding the building frame is formed. [2]

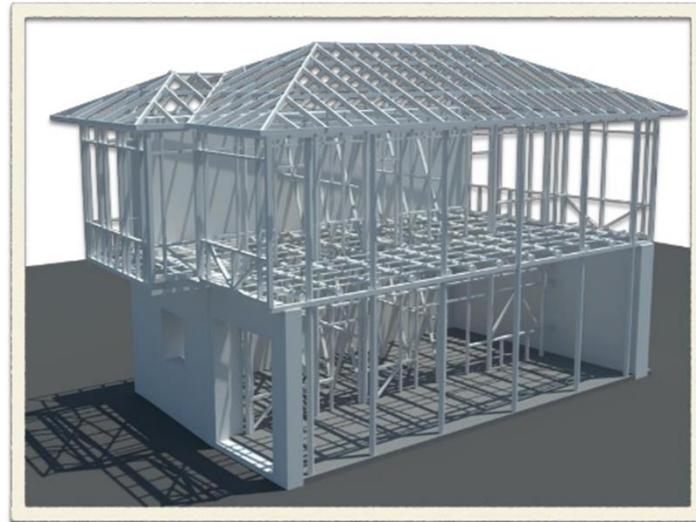


Figure 2. Timber Frame Construction Section (Dr. Erdal COŞKUN,2010)

Between the timber elements joined horizontally or vertically, mostly occur gaps in square form. Between the vertical sewing and beams which will constitute the walls of the construction existing those gaps are called as niche. These niches are filled with wood, stone, brick or adobe. Walls made by this method are called niche filling wall.

During formation of the timber frame, the secondary sewing are arranged according to the kind of filling material. In the construction with adobe fill, if the filling will be thick than the frame, secondary sewing are less frequently, they are placed by 10-50 or 80 cm. intervals. The adobe blocks are ranged like a half brick wall, they are placed one block on top of another. If the adobe filling will not be thick than the frame; then the intervals of sewing can change between 22-37 cm. Formed gaps are divided from one point at the normal story height level, as for at the higher parts from two points with horizontal connections. Adobes are placed diagonally in the gaps. When the process is finished, the surface is plastered with mud mortar. Coming up to the fronts of the timber frame, in which places while the plaster fall off in a short span of time, on the frame system will not be made mud plaster. Timber structures mostly remain as visible. . [3]

When the filling with adobe block implemented by inclined blocks, between them occurred frictional forces provide absorption of earthquake energy, consequently are avoided from an energy cumulation that earthquake forces created in the building. Through these frictional forces between the adobe blacks the building can move more powerful against the horizontal cutting forces of earthquake. Although the adobe filling brings an additional weight to the building, because of it is a rigid material it brings the environment in which it's found rigidity feature too. When it's applied as filling into the formed gaps in the timber frame surface, conditionally its well attachment on to the timber by moving together with the frame, especially by constituting a diaphragm under the earthquake influences it increases the durability of the system.

2 COMPARED WITH THE OTHER FILLINGS WHY IS ADOBE FILL MORE ADVANTAGEOUS?

Due to some its features like it's an economic and ecologic material, it causes not to moisture, provides heat and sound isolation, and helps to absorb earthquake energy which should be preferred as a building material. Now, it will be approached to a detailed analysis on what this material that provides .In historical Safranbolu houses, mud, the raw material of which is soil, was used as a binder. By shaping mud, as a filling material in timber buildings, mud brick was built as masonry in the construction of the hearth, which is an indispensable architectural element of the chamber culture of Turkish houses. In most of the timber buildings in Safranbolu, mudbrick was used as both filling material and plaster. Most of the mud of Turkish style tiles used in houses was taken from Bostanbükü villages and Çamlıca locality. The tiles are placed in a mold, shaped by hand, dried in the sun and then baked. In some applications, flaxseed oil was added to the mixture to provide impermeability against water (Pehlivan 2019,Gezer, 2013).



Figure 3. A Sample of Half-Timbered: One Safranbolu House (Abdurrahman PEHLIVAN,2019)

3 AS AN ECONOMIC BUILDING MATERIAL THE ADOBE

Construction process of made of timber frame, of adobe filling half-timbered can be implemented with lower costs. Raw materials of half-timbered are soil, water, straw, wood, lime and nails. Can be gained even from the nature these materials provide big advantageous in economic terms during production. Even without a high technical knowledge need and experience it enables to be built. There's no need to use construction instruments with high technology. Especially in the towns like Safranbolu or villages of Anatolia people can made their own dwellings, storehouses, schools and other public spaces on their own. Produced very simple and quick half-timbered also causes not to over energy consumption. When these, its features considered that it is pretty economic.

4 USAGE OF ECOLOGIC NATURAL MATERIAL

Both timber and adobe are reewable materials. During their production, an appearance of materials which give damage to the environment is far less when compared with the other production methods. During processing raw material, energy consumption exists less. Accordingly it averts consumption of some energy sources like oil and electric. During construction, chemicals which known harmful to human health are not used. [3] Due to used lime in the construction also can be struggled against insects with natural methods. The most used wall type in Safranbolu is adobe filling and then the blend brick filling straw construction technique. Stone masonry is generally used in the ground floor of Safranbolu houses. Adobe masonry is also seen on the ground floors, but is a minority. It is mostly used as filling material in the carcass system. Based on the information obtained from the Safranbolu houses examined, the wall types are listed in the table below. As a result of this study; As a construction technique, four materials are predominant: wood, stone, mudbrick and threshing brick. It has been observed that two types of construction systems are used, namely, rubble and masonry.

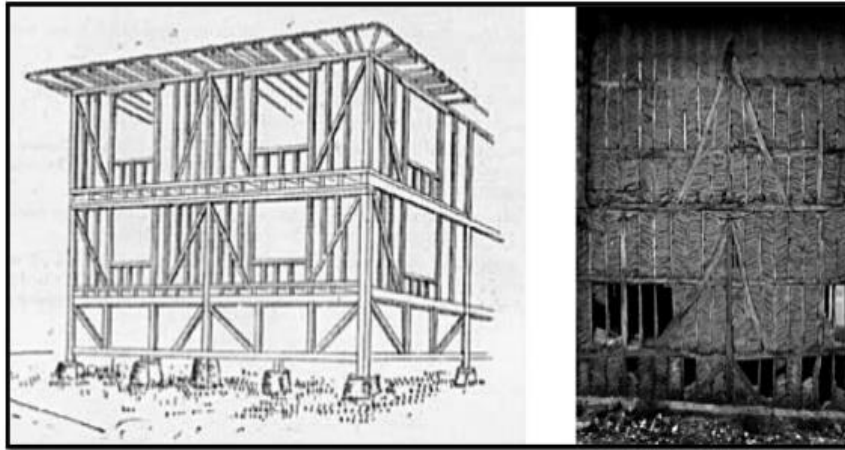


Figure 4. Traditional Structural Systems and Problems (Dr. Erdal COŞKUN,2010)

5 RESISTANCE TO MOISTURE

In timber frame, made of adobe fill half-timbered a moisture accumulation is prevented by virtue of adobe's ability to moisture transmission. Because of occurred moisture within the building easily passed from the walls, on the outer walls and ceilings. A condensation is not seen. By preventing the timber frame and other construction elements from the damages of moisture its life time is extended. Also caused to many illnesses on the persons removing of moisture from the building is provided. Even in Anatolia, in many locations like Safranbolu it's seen that "Within adobe houses rheumatism may not be seen."

6 HEAT AND SOUND ISOLATION

Under favour of that adobe has a natural fine-mesh structure, also within it found straw, no one can deny that it provides heat and sound isolation. For durability, big heat differences in the space and on the construction materials should non-being. As being the best energy saving material after water, soil stores the heat energy within it. Besides adobe providing respiration of the building, also it helps to reduction of negative agents which sourced from environmental factors.

For the wellness of materials' heat insulation features, its thermal conductivity amount should be less than other materials. How close is that amount to 0 (zero), depending its level the material has such a heat insulation feature extent of Thermal Insulation Rules in Buildings (TS.825) given calculation values for the walls. In accordance with it made analyses, it's appeared that adobe walls provide desired condition of building physics and required a comfort.

This condition also causes reduction of energy consumption especially in the winter months.



Figure 5. A Mansion Constructed Wooden Frame with Adobe Filling(BURKUT, K. 1996)

7 RESISTANT TO EARTHQUAKES

In the half-timbered- with timber frame and adobe fill, while some features of timber frame like its ductility and a well energy distribution combined with the energy absorption feature of the adobe blocks which used as filling the resistance rate to earthquakes increase. Especially during the 1999 earthquakes (occurred in Turkey) it's been seen that those constructions remained standing.(6)

Timber is a slight construction material. Therefore it's affected less from the earthquake forces. It's known that on timber frame buildings with accurate construction whether any or too few damages observed after the earthquakes occurred until now. Timber materials both are resistant to endurance and pressures. Because of the material slighthness the building loads anyway decrease. By virtue of it can attribute elastic against the over loads which may sourcing from environmental factors (snow, raining, etc.) and forces (like earthquake, wind, etc.), while the temporary influences disappeared, it can come its past form again. Specific to them of timber elements ductility also decreases the impacts of earthquakes on the building. Placed between the timber sewing distent adobe blocks as for provide the building attribute more powerful against the horizontal forces which formed with earthquakes by virtue of frictional forces between each other.

8 CONCLUSION

Half-timbered- made of timber frame and adobe fill, when evaluated in terms of human health and security, these type of building system provide many advantages compored to other building systems. Seeing its first examples since seventeenth century, this traditional building system's protection aim is important to provide its continuity of existence.(7) Considering some conditions, such as when the ground conditions make multiple dense housing impossible in earthquake regions, as safely as possible preferring the half-timbered is useful for the protection of human life. A willingness to continuity of constructing these buildings, also will help us to provide recovery of identity in our cities, towns and villages substantially they losing.



Figure 6. General view of SAFRANBOLU (Dr.Fatma SEDES, Abdurrahman PEHLİVAN 2019)



Figure 7.A row in Safranbolu two sides existing restored half timbered houses (Dr. Fatma SEDES ,Abdurrahman PEHLİVAN,2019)

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