Traditional Timber Turkish Houses and Structural Details

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Summary
Turkey is country with a wide range of building traditions. Timber is available in most part of the country and it has been used in building since prehistoric times. Our traditional houses were built mostly of wood. According to the research on Turkish houses, timber frame construction has developed in the seventeenth century and been continuously used afterwards. They are one or more-storey houses in Istanbul and Anatolian towns.

The traditional timber frame houses were made up of masonry basement and upper floors with timber frame and timber roofs. While the masonry was constructed with stones, the filling of the frame is with daub, rubble stone, unfired or fire brick. The frames of the houses were constituted with posts, studs and diagonal or X braces which were especially used for corners, beams and joist which forms the flooring.

1. Introduction
The main purpose of this study is to introduce types of traditional timber buildings and structural properties in Turkey.

The samples of timber Turkish houses go back to seventeenth century. Timber house construction has widespread till the first quarter of 20th century. However this tradition has scantily continued in rural areas after 1940s.

Traditional Turkish timber houses verify according to mass, plan, façade element, ornamentation aspects. However they share similarities on construction technique. Traditional timber buildings may be mainly classified depending on the structural systems given as below:

A) Log houses
B) Timber frame
   1- Hımsı
   2- Dizeme
   3- Bağdadi -lath technique-
C) Combine construction

1.1 Log houses

The oldest and, in a way, historical method of construction is called “Çanti” (log house) in which logs slightly processed were overlapped and anchored at the ends (Fig.1). Walls constituted with logs make a function both bearing and dividing. Vertical loads transmitted from up to down through logs that lied horizontally and restrained only both ends in the traditional Turkish log houses.

Log system was generally placed on 50 cm rubble or ashlar wall. 20-25 cm diameter wooden logs were locked on corners and placed on one another.

Fig. 1 Traditional Log house, Black Sea Region
1.2. Timber Frame

Timber frame building technique is performed by filling or covering the gaps between the wooden frame and the posts and the beams of the wooden frame. These constructions are classified as himiş, bağdadi, and dizeme.

1.2.1 Himiş Construction

Wooden is the main characteristic element in this construction technique that is commonly called “Himiş”. Himiş construction is simply described as a timber frame with masonry infill such as bricks, adobes or stones (Fig. 2). This type of construction is a variation on a shared construction tradition that has existed through history in many parts of the world, from ancient Rome almost to the present. In Britain, where it became one of the identity markers of the Elizabethan Age, it would be referred to as “half-timbered.” In Germany it was called “fachwerk,” in France, “colombage,” in Kashmir, India as “dhajji-dewari”, in parts of Central and South America, a variant was called “bahareque” [1].

![Fig. 2 Traditional himiş building with bracing elements and stone infill in Safranbolu.](image)

The house constructed with “Himiş” is consisting of three parts:

1- masonry basement and masonry ground floor
2- timber-framed section (floor/floors)
3- timber roof

The massif basement and massif ground floor were whole stone or stone and adobe based on the local conditions. The external wall of basement floor which was constructed on stone basis is strengthened against horizontal loads by connecting with wooden lintel that is at intervals. Internal and external surfaces of the basement floor walls were encircled by sole plate upon passing to timber frame. Beams and joists were placed on sole plate.

If the building has oriel or cantilever (Cumba or Çıkma in Turkish) on the upper floor, the loadbearing elements that carry the oriel or cantilever was constructed according to the type and extension of the oriel or cantilever and put in place at this stage. Then the bottom rail/plates, on which the main posts would be set, were placed at the outer edges of the walls. Subsequently, the corner posts and the main posts of the walls were placed and connected again by the top rail/plates on which the floor beams of the upper floor would be placed. Afterwards, the primary braces were placed to support the main corner posts and then the secondary posts (studs), which divide the voids of the wall frame into equal intervals (30–40 cm) were built. All vertical elements were tied to each
other with braces and tie beams, important elements in increasing the resistance of the building against lateral forces exerted by earthquakes forces.

It is possible to classify traditional hınş construction depending on the structural systems and masonry infill. Here, it is divided into two categories for structural system such as; system contained bracing elements (Fig. 2) and no bracing elements (Fig. 3). The studs were themselves tied by noggings in the systems contained no bracing elements.

![Fig. 3 Traditional timber frame house with brick infill and no bracing elements [1].](image)

1.2.2. Dizeme construction

It is called “Dizeme” if wooden is used for filling material in hınş construction system. In some buildings, wood were used as infill materials instead of masonry, particularly some regions that abound in wood. Short rough timbers elements called as dizeme were used as infill and they were lightly nailed studs or horizontal framing elements in this construction (Fig. 4). The purpose of wood infill usage to avoid their common early shear failure and falling out of the frame occurred for masonry infill [1].

![Fig. 4 Traditional timber framed house with wood infill “Dizeme” construction](image)

1.2.3. Bağdadi Construction

In addition to the use of stone, mud brick, brick or timber as infill material another widely used technique is the “Bağdadi” -lath technique-. The bağdadi is a construction where the voids between timber framing members were filled lighter materials or with trunk shells were transformed into a filling material by sand and lime mortar. The interior surfaces of walls were covered by lath and plaster work or wood, whereas the outer surfaces were either plastered or non-plastered or wooden plastered (Fig. 5).
Wall materials such as stone, brick and mud brick usually cause damage to the buildings during earthquakes, as they add extra load to the structure or in some cases, because they have weak binding mortars. However, in the bağdadi technique, the timber laths increase the resistance of the building against lateral forces.

1.3 Composite Construction

This construction is a composite application of timber frame and massive stone techniques. Timber frame’s duty was to support the stone wall, to tie the first level story wooden frame onto the lower story and to serve as support to first level story overhanging. The houses have been constructed by this technique have one or two story. All external walls of basement floor and first floor have been constructed by composite construction technique. This technique consists of interior timber framework system connected to each other and exterior masonry wall made of rubble stone and brick. Traditional timber frame has been used in all interior walls (Fig.6).

The exterior wall thickness is around 50-65cm. and the main material of this type of wall is stone. Timber framework constituting the exterior wall consists of square-section (14/14 cm) posts placed every 150 cm and rectangular section (10/14 cm) X braces between them. A Rubble wall with 50cm thickness has been built outside the timber framework. The rubble wall also serves as filling for spaces in the timber framework. The walls have been plastered with lime mortar.

All interior walls have been constructed by wooden frame. Interior wall thickness is approximately 17 cm. Interior wall frame consist of 14/14 cm post that has been placed every 150 cm and 6/10 cm studs which have been placed every 30-40 cm in between. The top rail and head binder have been placed upon these posts. Roughcast has been applied in all interior walls. Sometimes the technique of exterior wall has been applied in first level story interior walls of double-story buildings. Timber frames have been filled either with bricks and stone and then plastered or both sides of the construction have been coated with lags strips and plastered instead of being filled.
2. Structural Details of Traditional Timber Frame

Timber frame was always placed upon the base via sole plate (Fig. 7). First floor if exist, second floor head binders of the buildings was single binder, single binder on one side-double binder on other side or double binder on each side like the lower head binder (Fig. 8).

Fig. 7 Detail of sole plate on basement a-c) lap joint b) half lap joint

Fig. 8 The detail of joists and head binder at the corner; a-b) double binder on each side c) single binder on one side-double binder on other side[2] d) double binder on each side

In frame posts were placed on sole plate having space 3 or 4 meters. To create window bay studs were located between posts when windows were to close to corner or each other. All posts in frame always have square section. Top rails were very common on posts. Posts and corner posts were jointed with braces from both sides as Figure 9.

Fig. 9 The placing detail of braces and diagonals on façade [3]
Depending on the adjacency of the windows to the posts that would be placed between the posts, the brace was set against a place close to the middle of the post. In case the windows were close to the corners of the building, the braces were placed in a different way or they weren’t not placed (Fig.9).

If there was a cantilever on the first floor, the floor joists were extended 45-50 cm. A bottom rail was placed on the end of the floor joists that were extended. And then the posts were placed on this bottom rail. Sometimes cantilevers were supported with the angle brace aligning the post and studs (Fig.10). Timber frame was completed with the roof truss that placed at on top rail of wall frame.

![Image of cantilever](image)

**Fig. 10 The detail of cantilever**

The most common roof types were used in traditional buildings was gable or hipped roofs. In the construction of the roof, nails have been used in the joints. The timber-framed roof structure has been set on the main roof girders, which has been placed along the axis of the ridge purlin over the ceiling beams. The posts and studs have been placed along the full length of the ridge purlin, and tied to the ridge purlin. The ridge purlin has been tied to the corners of the structure with the angle rafters determining the slope of the roof, and the opening between the ridge and the rafters has horizontally divided into equal intervals by the purlins. Roof boards of 2.5–3 cm thickness have been placed on the rafters and the over and under type tiles have been laid down on the roof board. The roof has been finished with the timber cladding of the eaves.

The post and beams have usually square, studs, joists, braces and other frame elements have usually rectangle sections. Especially at the rural areas the tree is used without procession only used by shelling. These round cross section elements have used at the frame and roofs.

The timbers were used in creating the frame has always one-piece. Only the sole plate has subjoined (Fig.11). When it has required to make an addition to the sole plate, scarf joint has been used as is seen at Figure 11. In some regions as is seen from the Figure 13a, the notching groove has been applied to assemble the sole plate. Usually the frame elements have been joint together by nails. The wrought nail samples observed in some traditional timber framed constructions have around 9-20 cm of length (Fig. 12). As well as joint of nails, the joining techniques have been also used while bonding the joists to each other, the corner posts to the bottom rail, top rail to the posts and studs, the roof elements to each other and angle brace to the beams.

Especially for the single sole plate constructions that were built by overlapping technique, the groove assembling was used as an addition to nails while assembling the post and studs to the sole plate shown at Figure 13.
In traditional structures, connection of braces to bottom plate and angle brace of cantilever or oriel to beams were made as tonguing or tongued and grooved joint. Tongued and grooved joints were used to connect angle braces to floor.

In Figure 13 b X braces have been connected to each other via double-side notching spider joint method. As it is seen in Figure 14, nail and joint techniques have been used together for connection of headings placed on the post with the post.

This application was made in two ways in structures, where timber framework was covered. First one of them was to coat both interior and exterior surface with lath-work and plaster; second one is to plaster interior surface of the framework with lath-work and coat exterior surface with timber.

The timber structural elements have been used in these buildings usually have a cross-section of 10x10 cm, 5x10 cm. In spaces with larger spans, elements with larger cross-sections (15x20 cm,
20x20 cm) may be used which in any case do not exceed maximum 1 or 2 girders in a building. To join the timber elements, almost always simple nails were used; other more elaborate joints were used in some locations. The certain details such as single overlapping and mortise and tenon have been used on the corners.

On the other hand, such complex joint systems have been widely used in other timber elements such as doors, windows, balustrades, cupboard doors and ceilings. The timber weather boarding of exterior façades became widespread especially after the 19th century in cities like Istanbul and Edirne. In this technique, various infill have been used (lathing or brick) under the cladding in cases where timber lathing has been used under the weather boarding (Fig 15).

![Fig.15 The timber weather boarding of exterior façades [4]](image)

3. Conclusions

The urbanization process in Turkey has caused the abandonment of traditional timber buildings techniques. In this article types and structural properties of traditional timber houses are mainly presented.

The structural properties of the traditional timber houses in Turkey are follows:

- The traditional timber frame houses have been made up of masonry basement and upper floors with timber frame and timber roofs. The masonry has been constructed with stones.
- The timber frame of the houses have been constituted with posts, studs, diagonal or X braces which have especially used for corners, beams and joist which forms the flooring.
- The filling of the frame has with daub, rubble stone, wood and unfired or fire brick.
- Usually cantilevers have been built at first and other floors, and the angle braces have been used in these cantilevers.
- In generally the joint techniques have been used for architectural elements such as doors and windows, and nails for the timber frame sections. Sometimes joint techniques such as mortise and tenon, dovetail joint, have been used at post-beam, post-brace, brace-bottom/top rail.
- The lath and plaster technique has been used in the walls and ceiling.

4. References


