EVOLUTION OF TIMBER CONSTRUCTION IN TURKEY

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Introduction

Wood is known as one of the oldest structural materials used in many parts of the World. But remains of wood from antique period are seldom encountered in archaeological excavations. Turkey, connecting European and Asian continents with Anatolia peninsula, houses many historic structures, mostly of masonry from 12th century BC on. The rock reliefs, drawings, traces of timbers on stone masonry, and written sources show that timber construction was also highly appreciated in ancient Anatolia, especially in the densely wooded regions.

The heritage of timber structures in Anatolia is immense and the oldest examples, still being used date back to 12th century AD, The Seljuk Sultanate coming in 11th century to Anatolia built many mosques, public and military buildings of timber between 12th and 15th centuries (Fig. 1). Some of these buildings are still in good shape and perform their duties.

Fig. 1: Esrefoglu Mosque, 1296 AD

During Ottoman period, as masonry houses have suffered numerous intense and destructive earthquakes, wooden buildings gained importance to be safe especially among rich people. As several fires wiped out thousands of houses and even whole districts, masonry buildings were made obligatory by law in the form of building regulations known as Ebniye Regulations enacted in the early 19th century by the Ottoman government. Later however, due to many casualties and great damage caused by repeated earthquakes, timber for building was once again allowed under the law [1].

The traditional timber construction practice in Turkey can be encountered in east Europe, Egypt, Middle East and west Asia because the Ottoman Empire, which lasted for 650 years, had a broad cultural influence. These structures, depending on the carpenter know-how, were erected using traditional methods and rules-of-thumb passed from one generation to the other with an impressive empirical wisdom that was obtained with experience and great skill,

The timber houses were constructed until approximately 1950s. Afterwards, claiming that timber is expensive and burnable, timber buildings were almost forgotten, their building masters disappeared and these buildings were replaced with reinforced concrete. The ones still in good shape contribute to the visual vitality of historic Turkish towns.

Structural Properties of Timber Dwellings in Turkey

Traditionally, the wood used in timber houses was of the local predominance of species. The hard woods as walnut, oak, elm and juniper or soft woods as pine, beech tree and chestnut was used according to the structural or ornamental function. Generally for columns, studs, beams and joists; oak and yellow pine, for ceiling and floor coverings and windows; yellow or red pine and for balustrades and carved ceilings, red pine, walnut and linden were preferred. However, in the North Anatolia, in Black Sea region, the use of oak and chestnut is predominant for the structural elements in most buildings. In the rest of the country the use of pine predominates.

The foundations of timber walls were of masonry, later of concrete. The timber walls of one or more stories in height were supported on the foundation walls, on timber laced masonry walls of the ground floor or raised on cripple studs or post and beam supports (Fig.2). In the first two cases, the masonry wall top is covered with a layer of lime mortar where timber sill beam is placed forming a level set for the timber wall. The footings of the timber columns are either anchored in concrete or masonry foundations or placed on a big footing stone.

Fig. 2: Timber houses rise on foundation wall, on masonry wall and on columns

Timber houses were erected depending on the carpenter know-how, availability of the material and owner's financial power. In places with lots of wood, totally timber was used. If there were not enough woods, other methods using rough timber pieces or masonry was introduced

Timber Wall Construction

Traditional timber buildings in Anatolia can be classified and named according to the formation of their walls. The timber walls are composed of either block wood or framed structure with totally wood or composite with timber studs and masonry infill (Fig.3).

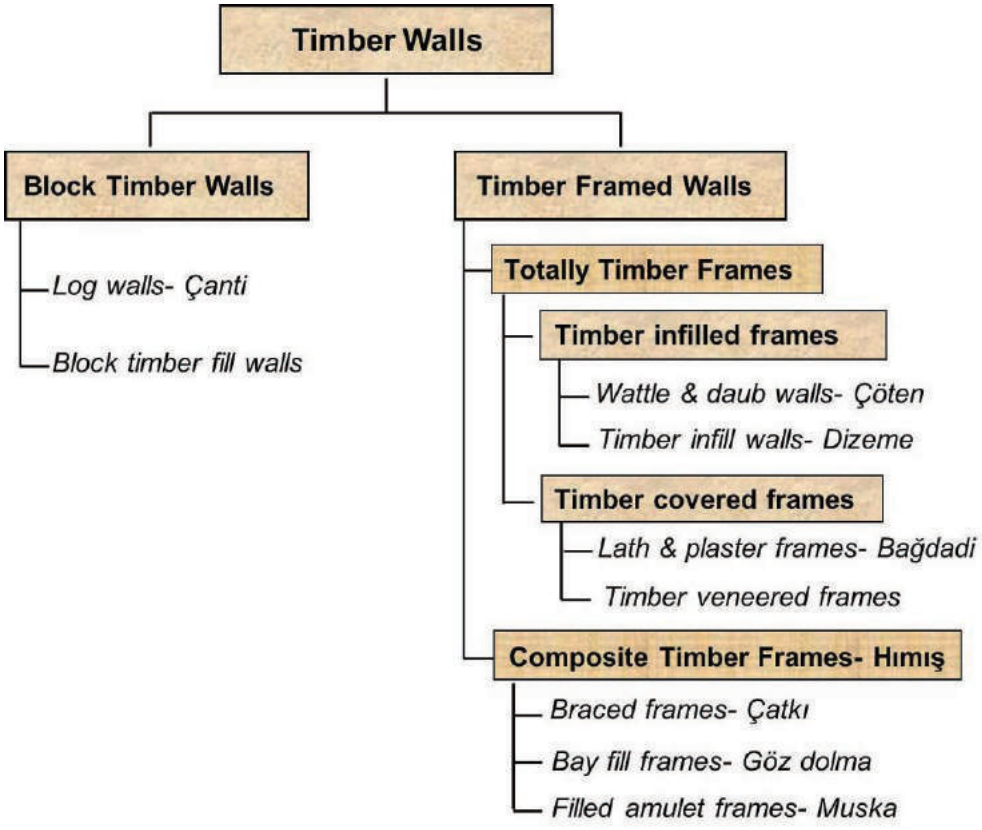

Fig. 3: Traditional Timber Wall Classification

Block timber walls

Block timber walls are constructed in Black Sea area where there are lots of wood. These walls may be classified as log walls and columns/studs with block timber infill.

Log Walls are constructed by piling up of rough round logs or solid sawn lumber laid horizontally and anchored at the ends with simple cross lap. The houses constructed with log walls are called "çanti = chanti" (Fig.2a). *Block Timber Fill Walls* are composed of columns placed at the corners and at the intersection of the partition walls and studs placed in between the columns considering the window and door openings (Fig.9). The space in between the columns/studs is then filled with horizontally laid rough round logs or solid sawn

timber anchored with grove and tongue joint to columns/studs. The horizontal timbers laid one over the other is connected to each other by tongue and grove joint in order to avoid rain water penetrating inside Fig.2b).

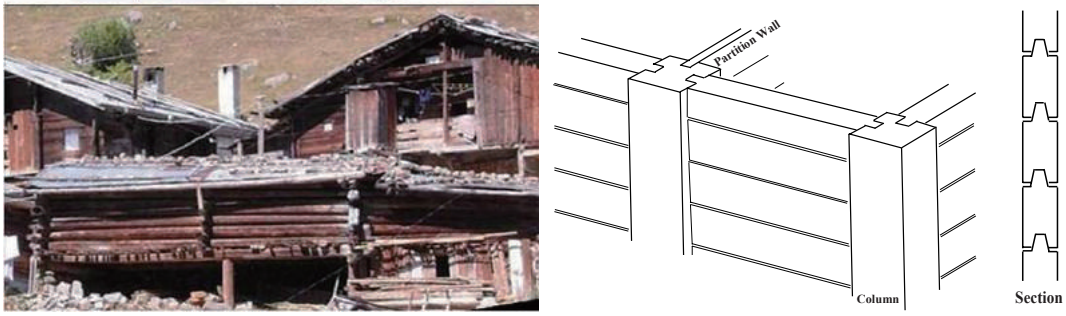

Fig. 8: a) Log house, b) Block timber fill wall formation

Timber Framed Walls

The load bearing framed timber walls are composed of columns or studs placed 0.20 - 1.50m apart resting on the lower chord beam and tied with the upper chord beam at each floor level by mortise and tenon joint. Columns are at the exterior corners and at the intersection of the walls. The rest of the wall is partitioned by studs, considering the window and door openings. The structural composition of the wall between the studs and columns and upper and lower chords are of wide ranging structural typologies depending on the ability of the carpenter and availability of building materials. The framed timber walls can be classified as totally timber framed and composite with masonry infill.

Totally timber framed walls' columns/studs spacing is either 40-150 cm. If the spacing is more than 60cm, the frame is braced horizontally and diagonally. Space between the studs are filled or covered with timber. When the studs are closely spaced, the space is woven with wattle and daub and called "çöten (choten)" walls (Fig.3a). The frame with widely spaced studs are filled with timber and called "dizeme (Fig.3b). If closely spaced laths are nailed on both sides of the frame's columns/studs and then plastered, the wall is called "bağdadi = lath" walls (Fig.4a). In timber veneered frame, the sawn timber planks are nailed on the outer side of the frame (Fig. 4b). The inner face of the wall may be covered by lath and plaster or timber veneered.

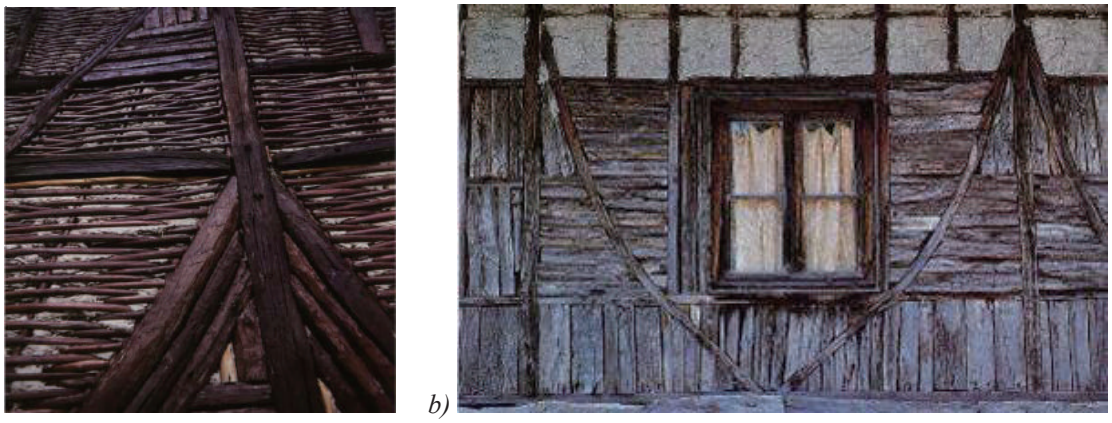

Fig. 3 Timber filled frames

a) b)

Fig. 4: Timber covered frames

Composite timber frames are made of timber frame with stone, adobe or brick infill. The houses constructed with this system are called “hımış” pronounced as humush. Depending on the available material and carpenter’s ability, such composite timber framed walls of wide ranging typology are composed by either 22-60 cm spaced columns / studs or 60-150 cm spaced columns with horizontal and diagonal bracings. Hımış style houses generally rested on a heavy stone first floor wall and named according to their formation as *Göz dolma* (Bay fill), *Muska dolma* (amulet fill) and *Çatkı*.(braced) frames (Fig.5)

Göz dolma (bay fill) Muska dolma (amulet fill) Çatkı (braced)

Fig. 5: Hımış (composite) frames

Timber House Organization

Timber dwellings in Turkey are generally constructed as single houses. However in cities with dense population, it is possible to encounter attached houses aligned side by side. These houses are formed with a floor platform completed at each level, and load bearing exterior walls are erected upon it. The attached buildings contain 50~60 cm thick continuous

masonry walls from foundation to roof in between the houses to prevent fire spreading to neighboring buildings [2]. The first floor framing supported directly on the masonry walled ground floor serves as storage or barn area of the structures.

The traditional multi-storey dwellings in seismic areas are constructed getting progressively lighter both with construction material and the thickness of the wall. These are constructed with a heavy wall as stone masonry at ground floor; timber frame filled with brick or adobe masonry solid then with cavity brick walls at intermediate level and wattle or lathed wall construction at upper floors. The building getting lighter at upper floors make the timber frame at top more ductile and therefore more able to meet the higher seismic demands that occur at upper levels.

Traditional timber building masters, being aware that moisture is a serious non-seismic threat to timber structure, have given high priority to drainage during construction. To control the seasonal and daily raise of underground water, traditional timber structures contained wells in the floor resting on soil, in basement or ground floor. The channels from the wells in underground discharged the water out of the building [3].

Conclusion

Traditional timber constructions with monotonous repetition of wooden joists, studs and rafters have numerous load paths and are considered structurally redundant in providing level of safety in earthquakes without loss of their integrity. Thus, this redundancy of elements with a high level of energy-dissipating capacity leads to the good performance during earthquakes. Masonry infill falling out of the frame and cracks in the plaster are considered a nonstructural damage that dissipates a lot of earthquake induced energy.

Traditional timber constructions with variety of materials and techniques in Turkey have suffered from continuous changes and repair of past works, and abundance during their lifetime. The timber architectural heritage to be preserved today necessitates architects and structural engineers for proper inspection, structural analysis, repair and monitoring and public awareness for maintenance.

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