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Van Earthquake's Effects on Mud-Brick Houses in Van and the Last Survived Buildings

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Abstract: The city of Van is located to the Eastern Region of Turkey and has experienced two large earthquakes recently. Van earthquakes have caused big damages and demolitions in the city center, districts and in villages. As a result of precautions works have been realized to remove its effects shortly. However, it can be seen that the either urban or rural areas of the city carry the earthquake's traces. Damages that the eartquake left on the buildings formed the most apparent and standing ones of the traces. Mud-brick buildings are the primary of those damaged buildings both in the centre of Van and in villages. Especially roofs' collapsing and then walls' demolition for mud-brick houses which were abandoned, and therefore were not maintained properly for a long time, are quite familiar situations after the earthquake. However, inhabited and maintained houses have been survived sturdily by contrast of other houses with modern materials and they helpt life to continue after the earthquake. In this study, mud-brick houses which were survived after earthquakes in Van and in the villages will be discussed. Reasons for demolition of those demolished and the qualities of those surviving ones will be scrutinized. It is going to be discussed how the mud-brick material which is distinguishing and struggling to gain it deserves as an ecological material today to resist against natural disasters sturdily when it is applied in decent way in scope with examples in the city of Van. Purpose of this study is to document right and wrong usage of the mud-brick materials with examples.

Key words: Mud-brick houses at Van, effects of the earthquake on mud-brick houses, villages houses of Van, traditional Van houses.

1. Introduction

The city of Van located to the Eastern Region of Turkey is a favourable residential center where the Lake Van can be found which is Anatolia's largest river basin with productive rivers on its shore, besides its cultural wealth which has been cradled by many civilizations for centuries. Van city has experienced two large earthquakes recently, which are called as the Van earthquakes in media.

Van Earthquake has contributed us to remember the reality that our country is an earthquake zone and many of our provinces, districts and villages are facing destroying risk of the earthquake. The earthquakes occurring in Van measuring 7.2 on 23 October 2013 and then measuring 5.6 on the Richter scale on 9 November 2011 have caused hundreds of people's death and thousands of people to be injured on one hand, and thousands of buildings to be damaged in various degrees on the other hand. Either multi-storey, ferro-concrete, or masonry work, mud-brick, many buildings were demolished or damaged after this earthquake. However as happens after every earthquake, the mud-brick was found guilty for loss of lives and properties. And local people turned out to be demanding ferro-concrete buildings, not to bother with the others.

Purpose of this study is to document mud-brick buildings' situations after the earthquake in Van and suburbs. Thus starting point is, the usage of construction techniques and the material is presupposed for earthquake-resistant buildings more than the used material such as mud-brick or stone.

2. Material and Method

This study is limited with the study of mud-brick houses in Van's suburbs and a couple of them in Van's centre. Twenty-four (24) village have been searched in

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the scope of this study. Also some quarters where mud-brick buildings are located in Van's centre have been researched. As a result of these searches, mud-brick usage in Van and suburbs is scrutinized separately.

2.1 Mud-Brick Usage in Van and Villages

It is possible to see historical buildings in Van and surroundings with its deep-rooted history dated to Urartians. Many usages of various construction materials are seen in these buildings such as stone, soil, tile and wood. Especially soil material has been used as brick and mud-brick. We see mud-brick material in Van Castle as the most apparent. Some places and most of the buildings inside of the castle which were settled on a rock ground are made out of mud-brick, even including Süleyman Han Mosque that had been built in Ottoman period and re-storated recently [1].

It is discovered during the excavations that mud-brick has been used in most of the castles which Urartians had built because of the security purposes [2]. It is known that houses that formed Urartian civil architecture have been structured out of mud-brick over rubble foundation. As general building structure of the houses, pitch-faced stone wall has been laid continuously over rubble foundation until sub-basement elevation and surface of this wall has been graded by bonding timbers. Then the buildings have been continued with mud-brick and finished with flat roof cover. There is not any change observed at foundation, wall and surface cover systems because of the material qualities; furthermore, it has fallen behind the historical process in some applications [3].

2.2 Features of the Van Traditional Houses

It is known that buildings inside the castle had been made out of mud-brick and in the style of attached buildings and after 1918, houses outside of the castle also have been built out of mud-brick in the centre of Van [4]. Only a couple among these houses have been resisting against the time today while 19 of them were standing in 1990 (Fig. 1). However, it can be still seen that one-storey mud-brick houses do not have historical qualities, which people built with their own means in the suburban neigbourhoods like Haçort, Hacıbekir (Fig. 2). Although some of these houses were destroyed in the Van earthquakes, some of them have been still inhabited.

All of the old Van houses which had been built outside of the castle and whose lesser example remained, have been built as independent buildings and with yards around because of the wideness of the land (Fig. 3). The furnice house, an indispensable part of the every house is located separately from the house and barn in the yard while having been built in attached to the house sometimes. There have been anteroom and living rooms near anteroom and primary service units of the anteroom [5]. There is passage from the service unit to the garden and the yard. Service units that are one-storey in general are made out of storage room, toilet, kitchen, oven, furnice houses and the bathrooms which are called "çal" in local tongue and this unit might be opening to the yard and the garden directly.

Fig. 1 An example of old Van houses: Abdulalim Arvas House.

Fig. 2 A mud-brick house at the Haçort neighbourhood.

Fig. 3 An old Van house with a front of yard.

A stair with one flight goes up to the upper storey in general. There has been an anteroom with a wood cantilever in the center of the room, towards street direction, which is called "köşk" locally (Fig. 4). Guest rooms have been located in this storey, at two sides of the anteroom as well. Thicknesses of the walls are between 60-70 cm on these storeys and for upper storeys they are between 40-50 cm. For floor coverings, rubble has been used in the ground storey's anteroom and service unit, jammed soil in the furnice house and wood in the rooms while interior walls have been coated with clay, plaster and fat lime and then painted with whitewash.

The mentality of sitting separately for men and women has been existing institutionally but not locationally. It differs from traditional Turkish architecture with this quality that this case can be explained with Turks being affected by Armenian culture (Fig. 5) [5].

The main material used for walls, roof, floors of some spaces and coatings in the old Van houses is mud-brick. Stone foundations are paved until frost line in the dug ground in Van. Then, quarry or cut stone sub-basement is built until approximately 85 cm from the ground. Over the sub-basement, a 15 cm thick bonding timber has been settled. Over the bonding timber, two rows of 0.50 × 1.20 m sized regular cut stone block plinths have been put on two sides of the door and corners of the building. Later, a wall is laid as thickness of 2 whole and 1 half mud-brick size for lower storeys and 2 half and 1 whole mud-brick size for upper storeys. Whole mud-bricks are of 30 × 30 × 8 cm, and half mud-bricks

Fig. 4 Corbelled anteroom which is called Köşk in the old Van house.

Fig. 5 Van house service units and furnice house.

are of 10 × 30 × 8cm dimensions. When mud-brick walls are laid, rubbles are settled under and over the penceres. Previously used elms as bonding timber later replaced by pine and poplar trees. Poplar tree is used for the coverings of door, pencere, cupboard, ceiling and floor because of being ample in the region [4].

Roofing system in Van is flat covering like many regions of Anatolia. Deck girders are settled between 40 and 50 cm gaps and 3-4 cm thick rafters are settled over those girders on the mud-brick walls (Fig. 7). Surface of the rafter is covered by 5 cm thick sedgy plants like reed. And over the reed, a semi-dry soil which baked with less water called Püşürük (=baked, in local tongue) is spreading as approximately 20-30 cm thickness. And then an approximately 10-15 cm mud-brick with clay plaster salt added, is laid with a small slope and two times a day it is burnished with a stone called "loğ". The salt which was added to clay prevents both plant to get green and provides water isolation functioning as a binding material (Fig. 6).

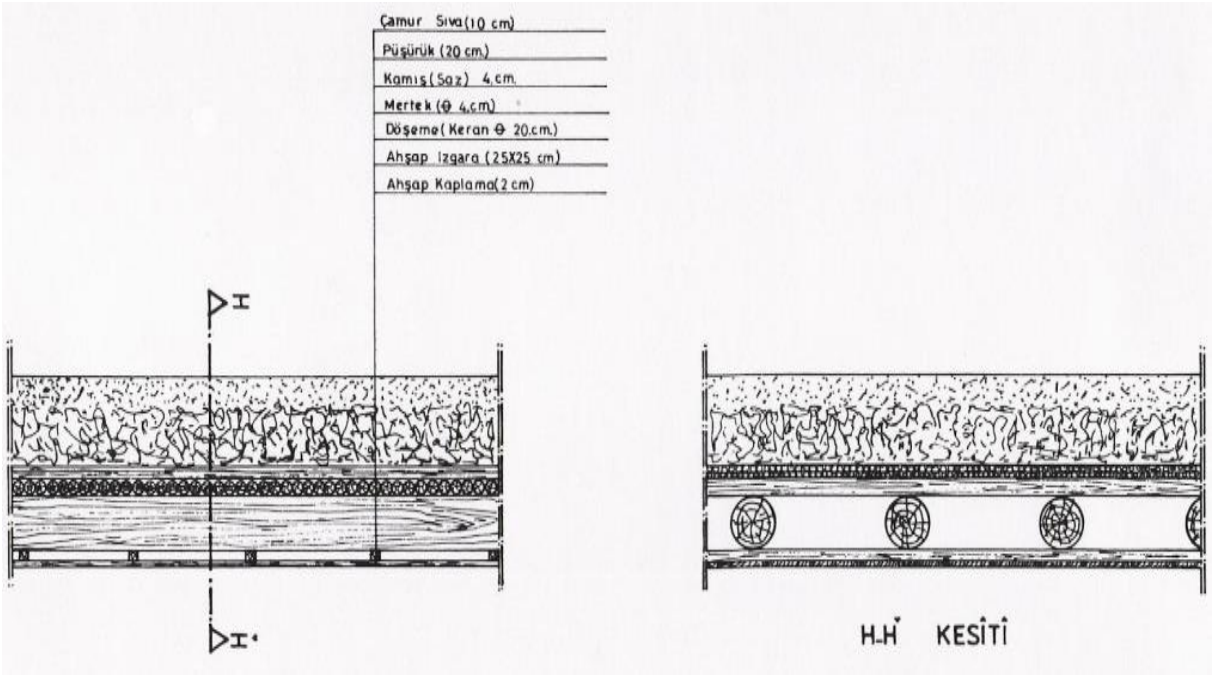

Fig. 6 Soil roof covering on old Van house detail drawing [4].

Fig. 7 Soil roof covering on old Van house (Esenpınar Village).

The direction of the slop is usually towards gargoyles (şoratan) which were put on the yard and street side. On the construction that macrostructure is finished, again the mixture out of clay, straws and salt is used as the plaster [4].

2.3 Van Villages Houses and Use of Mud-Brick

Monotonous and big roofing systems covering as much as wide area are seen on villages of the Van region that this view looks similar with hill town settlement. Furthermore frequently seen straw and turd piles bring first unsound roof and pavilion structures [3].

Once-living effectively in the region, Urartians' principles and apparent application techniques can be traced in the village architecture as well. Primary of this is reflection of the topographic structure to the construction. Furthermore, Van region's village architecture quite has been made out of mud-brick over rubble foundation like Urartu residential buildings. Mud-brick is the most basic traditional building material from the earliest periods when inhabiting had started while being modified in time. Other building materials such as stone and wood are included in the concept of village architecture. However, quite a few stone buildings are seen in the region's villages while there is not any wood building. These are mostly annex buildings that were added later. Houses are continued with pitch-faced stone until sub-basement elevation over rubble foundation as general building structure and surface of these stone walls are graded with bonding timber. And the buildings are continued with mud-brick and finished with flat roof cover [3].

Van region's village houses are all flat roof covered. Layers of the cover do not differ from other regions' mud-brick buildings. Wet spaces like bathroom and

toilet are added later in most cases. Washing corners called "çal" in local tongue were used as bathroom function.

Houses are planned as one-storey usually. Some or all of the annex buildings like kitchen-furnace house, hayloft, barn, bathroom and toilet are either built as extensions of the main building and opened to the same yard or garden. Plans of the one-storey houses are quite basic and they are made up of one or two rooms opened to the anteroom in most cases. This plan schedule looks similar to Urartian house plans in a large scale. Anterooms in one-storey Van village houses are covered by porches with either overhanging roofs or half-embedded interior terrace and are covered by roof porches [3].

Duplex houses which are seen rarely in the village architecture function as a particular mission in the village. These houses which are owned by elite families mostly have a construction structure in order to meet accommodations for men on upper storeys. These kinds of houses are entirely the same from the aspect of planning no matter what village they are placed. Their storey plans do not differ in both storeys. Their plans are made out of a wellhole where stairs to upper storey are placed and a room whose entrance is here. There are one-storey service units rowed connecting to the houses in the same yard or corridor and under the same roofs. These service units may differ according to the planning, numbers and functioning aspects. Duplex houses are designed as introverted as planning which is compromising traditional Ottoman architecture and almost any window is not placed in the street front of ground floors. In obligatory cases, window sizes are kept in minimum. The building and the annexes have only one door towards outside. Circulation is provided with yard or wide interior corridors [3].

3. Effect of the Van Earthquake on the Mud-Brick Houses

Damages in the mud-brick houses have been scrutinized during researches in rural areas after Van Earthquake. Twenty-four (24) villages have been scrutinized with this purpose, however eight of these villages are seen that do not have mud-brick buildings. Other 18 villages have mud-brick buildings and some of them are used for services such as being barn, depot while some of them still are used as houses and some others are kept empty.

A list of the villages where mud-brick houses are located as below: Adıgüzel Village; Aktaş Village; Bağdaşan Village; Çalımlı Village; Değirmen Village; Dibekli Village; Dilimli Village; Esenpınar Village; Güvençli Village; Hıdır Village; Ilıkaynak Village; Irgat Village; Karagündüz Village; Kaymaklı Village; Pirgarip Village; Yukarı Gölalan Village; Yeşilsu Village; Yabali District of Yeşilsu Village.

3.1 Data Provided from Scrutinizing These Villages

Data provided from scrutinizing these villages are listed below.

(1) During the conversations with local people at researches in these villages it is stated that most of the people do not want mud-brick house with the reasons of the mud-brick's being not sturdy with the aspect of earthquake, its production's being challenging and hard, and even non-existing of mud-brick contractors anymore.

(2) It is watched that people prefer to use brick which is easier to supply rather than mud-brick in most of the villages (Fig. 8).

(3) It is considered that all of the demolitions or heavy damages were caused by basic masonry work construction mentality without precautions against the earthquake.

(4) With damages on the mud-brick structures after the earthquake, it is seen that most of the buildings are not used for a long time or used as barn or depot, without sub-basement and again, did not undergo maintenance for a long time (Fig. 9).

(5) Another reason of damages on the mud-brick structures has been the heavy and neglected roof covering (Fig. 10).

(6) Splits are seen in mud-brick buildings, especially in the edges and corners of doors and windows. These damages existed in the buildings whose horizontal joists are seen either non-existing or irregular (Fig. 11).

(7) Another reason of the damages is those caused by differing in the way of shrinking at mud-bricks and bricks when two materials were used together (Fig. 12).

3.2 Survived and Undamaged or with Minimum Damaged Mud-Brick Buildings

When survived and undamaged or with minimum damaged mud-brick buildings are researched, it is obtained that:

(1) Which has a sub-basement (Fig. 13);

(2) Where horizontal joists were used in decently (Fig. 14);

(3) Continuously maintained (Fig. 15);

(4) Whose wall and roof covers were in decent thickness;

(5) Buildings whose materials for mud-brick have been used in right proportions and methods, with right workmanship.

Fig. 8 Usage of bricks instead of mud-bricks (Bağdaşan Village).

Fig. 9 Mud-brick buildings whose sub-basement elevation is not enough (Adıgüzel Village).

Fig. 10 The damages caused by the heavy and neglected roof covering (Dibekli village).

Fig. 11 Damages on the mud-brick buildings whose horizontal joists are non-existing (Ilıkaynak Village).

Fig. 12 Damages caused by usage of mud-bricks and bricks' being used together (Yeşilsu Village).

Fig. 13 A mud-brick building whose sub-basement elevation is sufficient (Kaymaklı Village).

Fig. 14 A mud-brick building where horizontal joists were used in decently (Çalımlı Village).

Fig. 15 Inhabited and maintained mud-brick building which is approximately 100 years-old (Esenpınar Village).

4. Conclusions

None of the construction material (ferro-concrete, wood, stone, brick, mud-brick, etc.) is a sole reason for demolitions in the earthquake. Safety of the buildings depends on design, projectioning, application, surveillance, capacity of ground bearing, distance to the fault line, weight and many factors in the same vein.

When the qualities of the mud-brick material are known and buildings are constructed with this knowledge, many of them will resist the earthquake as undamaged or minimum damaged and will not demolish.

Mud-brick buildings are demolished because of sub-basement mistakes, structural bearings' not fitting good, walls are not being in enough thickness, lack of the heights of the crossing wall bins flat roofs with heavy soil coverings, joists' not being settled and wide space openings, etc. those caused by lack of knowledge on the qualities of the mud-brick and by workmanship mistakes.

All buildings which were not designed according to the earthquake and were not built with a qualified workmanship can be demolished and damaged in the earthquake whatever material to be used in it.

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