



Workshop Study on Impact of 2011 Van Earthquake on Rural Settlement Houses

2011 Van Depremi'nin Kırsal Yerleşmelerin Evleri Üzerindeki Etkisi Hakkında Bir Atölye Çalışması

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ABSTRACT

The impact of economic policy and industrialization has led to considerable urban migration, with negative effects on rural and urban settlements. The consequences of this migration have been felt in Turkey, particularly since the mid-1970s. Unplanned large-scale migration has caused the population of cities to approach 80% of the total population, negatively affecting the economies of rural settlements, as well as agricultural production. Villagers experiencing financial difficulty construct homes at minimum requirements, with inadequate material and structural detail. The rural houses built with earthquakes. Statistical data indicate that the rural population living in areas surrounding Van constitutes 50% of the total population of the province, in spite of large-scale migration and negative effects of the 2011 Van earthquake. Taking this data into consideration, the present study elected to address these rural settlements, and a pilot region was chosen. Two surveys – social and structural – were conducted in the region, and their results led to critical analyses. Shedding light on the settlements' infrastructures and problems experienced by their population, theses analyses also provided comprehensive information concerning the village houses and their structures in the settlements.

Keywords: Analysis; earthquake; rural settlement; structural detail; sustainability.

ÖZ

Sanayileşmenin etkisi ve izlenen ekonomik politikalar, köyden kente büyük bir göçün yaşanmasına, köy ve kent yerleşmelerinin de olumsuz olarak etkilenmesine neden oldu. Göçün etkisi Türkiye'de özellikle 1970 yılların ortasından itibaren hissedilmeye başlandı. Plansız büyük göç, şehirlerde yaşayan insanların sayısını toplam nüfusun %80'ine yaklaşmasına, kırsal yerleşmelerin tarım üretimi ve ekonomisi de olumsuz olarak etkilenmesine neden oldu. Geliri azalan köylü, evini asgari koşullarda yanlış malzeme ve yapısal detaylar ile yapmaya başladı. Hatalı yapısal detaylarla ortaya çıkan deprem bölgesindeki köy evleri de, depremlerden sonra büyük hasar tabloların ortaya çıkmasına neden oldu. İstatistiksel veriler, yaşanan büyük göç ve 2011 Van Depreminin olumsuz etkilerine rağmen, Van'ın kırsal yerleşmelerinde yaşayan nüfus, toplam il nüfusun %50'sini oluşturduğunu göstermektedir. Bu önemli veriyi dikkate alan çalışma, araştırmalarını Van'ın kırsal yerleşmelerinde yapmaya karar vererek bir pilot bölge seçimi yapılmıştır. Araştırmalar sırasında pilot bölgede sosyal ve yapısal anket olmak üzere, 2 anket uygulanmıştır. Anketlerin ortaya çıkardığı sonuçlar, önemli analizlerin gelişmesine neden olmuştur. Analizler, bir taraftan yerleşmenin altyapısı ve sorunlarına ışık tutarken diğer taraftan da, yerleşmelerde bulunan köy evleri ve yapıları hakkında çok kapsamlı bilgilerin elde edilmesini sağlamıştır.

Anahtar sözcükler: Analiz; deprem; kırsal yerleşme; yapısal detay; sürdürülebilirlik.

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Introduction

Following the years after the World War II, the effect of new economic programs followed by Turkey and some developing countries obtaining a large portion of their revenues from agriculture has been important in transforming into an industrial society. Turning its goal towards industrialization, Turkey has gradually moved away from agriculture, and its revenues from agriculture have increasingly decreased. Lacking necessary training and education in developing farming, the peasants have been unable to profit from the products they harvested. "The research we did in rural areas of Turkey steers us to the opinion that the villagers look like a peasant rather than a farmer as they reflect maybe not all but most of what is expected from them towards change, education and lifestyles of city dwellers, and they adjusted their lives to a subsistence economy rather than a trading economy."¹ The difficulties of rural life, inadequate income obtained from agriculture and suchlike adverse conditions have caused villagers to move from rural areas to cities swiftly. Table 1 shows the population changes taking place in rural and urban settlements of Turkey between 1927 and 2009.

Some policies implemented in the process have aimed to eliminate the village-city dichotomy, make the village gain true benefits of city and, lessen the difference between the two social structures. However, the texture of rural settlement shaped based on socio-economic developments and scattered, and consisting of a lot of number units has negatively affected the policies and efforts put forward to develop villages. The scattered rural settlements have:

- Expanded the scope and limits,
- Increased the cost, and

- It has inhibited the evenly distribution of the services and facilities provided by the central governments to the population living in the region.

"Such concepts as Village-City or Central Village have been put forward by some politicians and intellectuals for resolving the problem and these terms have been debated for a long time. However, the efforts made towards developing the villages have been ineffective due to the mentioned problems and the wrong economic policies implemented."³ The implementations in relation with restructuring by public administration especially after natural disasters affected the conditions of residents in rural settlements in a negative way in the long run. "For example, the first question raised by the long and straight roads and houses lined up at equal distances instead of the texture developed by people over centuries is to what extent this order is appropriate for the habits and way of life of people" (Figure 1).⁴ Figure 2 shows the apartment blocks built by "Housing Development Administration" in place of village houses following the March 2010 Elazığ earthquake. As can be understood from the figures, the residential applications developing independently of socio-cultural and climatic conditions, though they may initially be approved by the villagers, will be abandoned soon or misused as they are not appropriate for the life conditions of the villagers.

After 23 October and 11 November 2013 Van earthquakes, the high level of damage in Van countryside on the one hand and 50 % of Van population still living in the rural settlements despite the migration on the other hand caused the important issue to come into question. The major damage table caused by earthquake in rural settlements pointed out that new steps based on

Table 1. 1927–2009 Censuses, 2009 Address-Based Census 2²

The year of counting	Total of the population (%)	Population of the city (%)	Population of rural (%)
1927	13.648.270	3.305.879	10.342.391
	100%	24.22%	75.78%
1960	27.754.820	8.859.731	18.895.089
	100%	31.92%	68.08%
1965	31.391.421	10.805.817	20.585.604
	100%	34.42%	65.58%
2000	67.803.927	44.006.274	23.797.653
	100%	64.90%	35.10%
2009	72.561.321	54.807.219	17.754.093
	100%	75.54%	24.46%

¹ Tütengil, 1983, p.68.

² Tüik, 2010.

³ Parsa, 1993, p. 4-221.

⁴ Berköz, 1975, p.10.

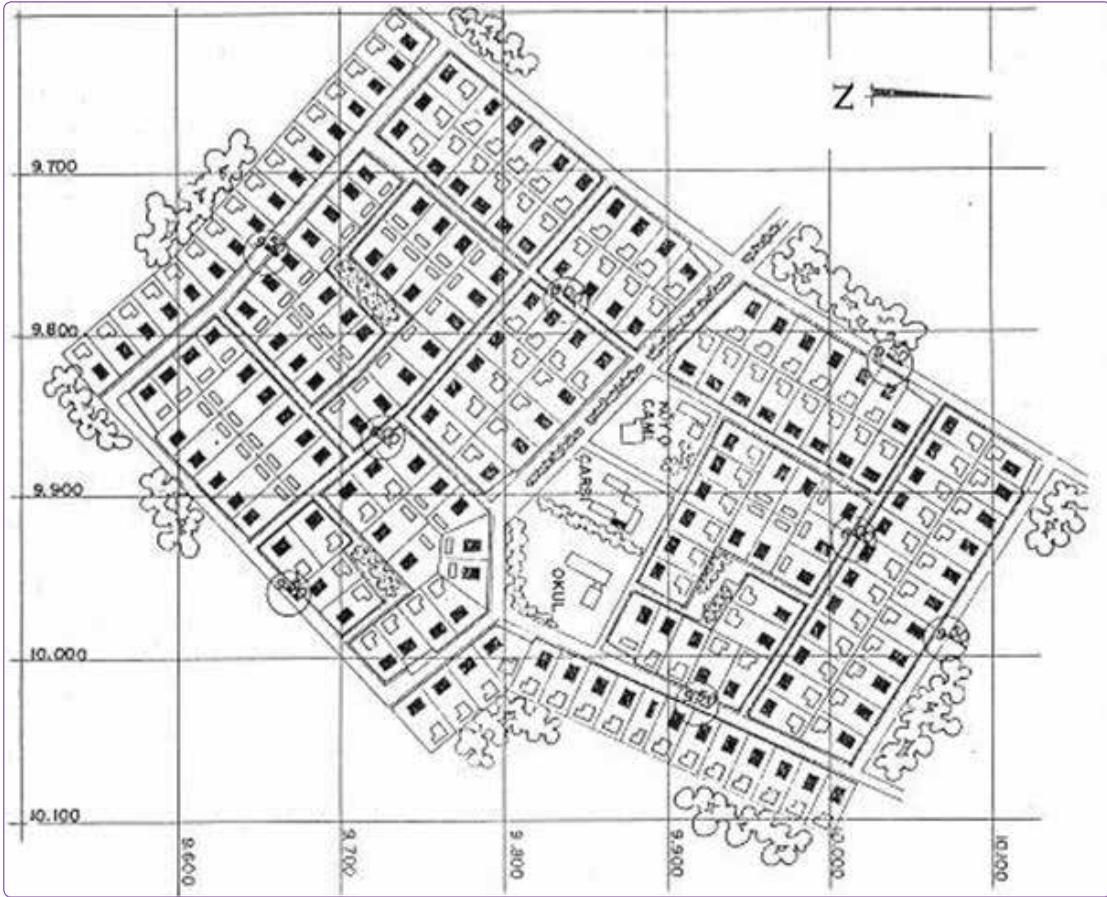


Figure 1. (Berkoz, 1975, p.10).



Figure 2. Rural houses which made by 'Housing Development Administration' after 2010 Elazig Earthquake (Parsa, A.R. Archive, 2011).

Table 2. Population Information of the Pilot Region (TÜİK, 2010)

Year	Male	Female	Total
1935	96	104	200
1960	134	162	269
1990	86	93	179
2010	150	138	288

realistic data and scientific research should be taken in order not to cause a new wave of migration. In accordance with the aforementioned major titles, it has been decided to establish a workshop in the department of architecture at Yildiz Technical University in order to conduct this study.

The Selection of a Pilot Region

To relate the findings of the study to concrete values, a pilot region was intended to be chosen. The area was planned to have the following features:

- It represents Eastern Anatolian rural settlements in terms of architectural texture and socio-cultural characteristics,
- It represents Eastern Anatolian villages in terms of its architecture and structural features, and
- It should have structures affected by earthquake.

Based on the features mentioned above, Gülsünler Village of Van Central County was selected as the pilot region of the research, and the study started in this rural settlement. The study also intended to do necessary research aiming at making use of the village workforce appropriately and preventing possible migration to reveal a village settlement that is safe, comfortable,

sustainable and ecological, and contributes to the economy of the country. Therefore, while examining the climate, economy, education level, population, history and structures of the pilot region, the study also carried out 2 separate questionnaires focusing on social and structural aspects were conducted in the pilot region for the determination of the details in relation with the subjects as stated above.

Demography and Climate Features of the Pilot Region

Van, whose written history dates back to the beginnings of 3000 BC, has a total of 576 large and small rural settlements. The pilot region, which is situated within the borders of the city centre, is one of the rural settlements of Van not affected much by immigration. The family ties are strong in the pilot region and the population of female and male citizens is nearly the same. Table 2 shows the population structure of the pilot region.

Researches indicate that the temperature difference between day and night in the pilot region is extremely high. In addition, it has continental climate feature like other settlements of Eastern Anatolia. It is also one of the arid zone of Eastern Anatolia. Table 3 presents climatic values of pilot region.

Damaged Houses of the Pilot Region

The study on all of the houses in the pilot region revealed that 88% of the structures in the settlement were masonry structures made of stone and adobe material by the villagers. In addition, the technical analyses determined that a most of the houses in pilot area are damaged by the earthquake in 2011 and the causes of the damage that had occurred in the houses of the pilot region were as follows:

Table 3. Change in the Precipitation Amounts by Month (Kalecioğlu, 2010)

Months	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Precipitation amount (mm)	41.9	35.4	46.2	57.5	40.5	16.8	5.5	2.9	12.1	44.2	48.5	32.5	384
Relative humidity (%)	70	71	69	64	57	50	44	41	43	58	67	70	59
Number of rainy days	9.7	9.3	10.9	11.2	9.2	4.3	1.7	1.1	3.2	7.6	8.6	8.9	84.8
Number of snowy days	7.8	8.4	8.3	1.8	0.2					0.2	1.4	6.6	31.7
Highest snow cover thickness (cm)	106	95	80	42	2					10	30	44	106
Number of foggy days	0.4	0.5	1	0.5	0.4						0.2	0.5	3.5
Number of sunny days	3.9	3.7	3.2	4.1	6.3	14.8	18.9	20.9	20.4	11.1	7.1	6.2	120.8
Number of cloudy days	7.8	6.8	7.3	5.1	2.9	0.4	0.1	0.1	0.2	2.7	4.4	6.7	44.6

- Inappropriate material use,
- Inappropriate architectural design,
- The walls are not connected in the corners and remain unsupported
- Voids in the masonry walls with inappropriate proportions,
- The use of heavy ceiling,
- Inappropriate subsequent interventions to the structure and
- Lack of use of beam in the walls.

Inappropriate Material Use

Adobe structures have been used for centuries all around the world as they are easy to construct and provides energy saving and a healthy life. Nevertheless, as a result of the fact that the soil used in the adobe structures in the pilot region is not appropriate for adobe structures and that no additives are included in the soil, the adobe structures were damaged by the earthquake. The correct choice of adobe soil ensures a durable adobe block. Furthermore, adobe is extremely durable against water. Additive agents are required for ensuring that adobe structures are affected less by water. “Generally speaking, gravelly soil is not appropriate for adobe constructions. The most appropriate types of soils for adobe constructions are sandy clay and or clayey sand.

The addition of cement or lime, or both if possible, to adobe grout to prevent dissolution when it gets wet or cracking and disintegration when it dries is crucial. As a result of several experiments carried out, it was found out that an addition of 5% cement or 10% lime to adobe grout to ensure soundness and to prevent disintegration when it gets wet, cracking when it dries and freezing”⁵ (Figure 3).

Some of the masonry structure with stone walls in the pilot region, as a result of the use of undressed stone and the low quality mortar, were damaged by earthquake (Figure 4).

Inappropriate Architectural Design

The architectural design of the structures to be built in earthquake zone must be developed in a way which prevents the impact of earthquake load. The forms in the shape of T and L, which are developed without implementation of dilatation joint cause the structures to be twisted and damaged during an earthquake (Figure 5).



Figure 3. An adobe structure damaged by earthquake as a result of inappropriate material choice (Parsa, A.R. Archive, 2011).



Figure 4. A structure with stone walls, broken down as a result of use of undressed stone and low quality mortar (Parsa, A.R. Archive, 2011).

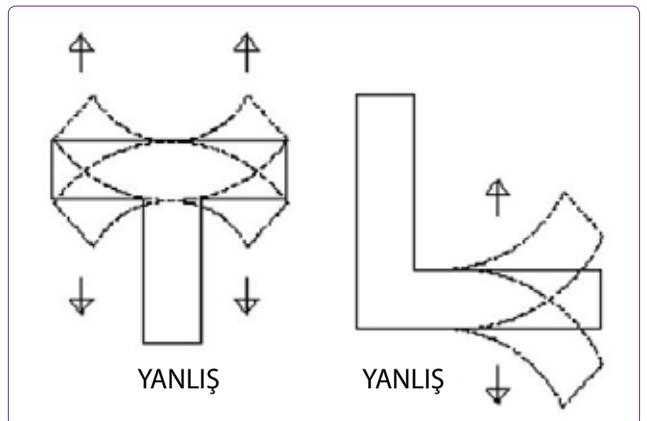


Figure 5. The behaviour of T- and L- planned structures in the event of earthquake (Prepared by Author, 2012).

A part of the houses in the pilot region was damaged during the earthquake as they were not formed suitable for earthquake zones. Figure 6 shows a damaged structure with a form in the shape of T.

⁵ Ergünay, 1978, p. 102-114.



Figure 6. T-Planned structure damaged during the earthquake (Parsa, A.R. Archive, 2011).

Another problem is the load-bearing walls which are not placed on the plan symmetrically. Non-symmetric voids opened for doors and windows in walls are also an important issue for damage in masonry buildings.

In non-symmetric applications, torsion occurs during the earthquake since the heaviness center and the rigidity center don't overlap. The torsion of the structure causes the occurrence of significant damages.

The Walls Are Not Connected in the Corners and Remain Unsupported

Additionally, the researchers pointed out that one of the most important damage reasons that had occurred in the rural masonry structures stemmed from weak vertices. Therefore various measures are needed to support the vertices. "The main reason of the collapse in masonry structures is that walls separate and they collapse with the roof. To prevent the structures from collapsing, support walls with props can be built at the connection and corner points of the walls".⁶ Technical analyses which investigated in pilot area determined that the problem of walls in the corners is one the most important causes of damage for the structures of pilot area. Figure 7 presents the details of props to be used in the structures.

As shown in Figure 8, supporting the structure damaged in 2011 Van earthquake temporarily with wooden props proves how important Adeli's and Author's suggestions were years ago.

Voids in the Masonry Walls With Inappropriate Proportions

The voids in masonry walls and their proportions are highly important in the performance of the wall against earthquake. But the voids in masonry walls and their proportion of the pilot area are not suit-

⁶ Adeli, 1983, p. 33.

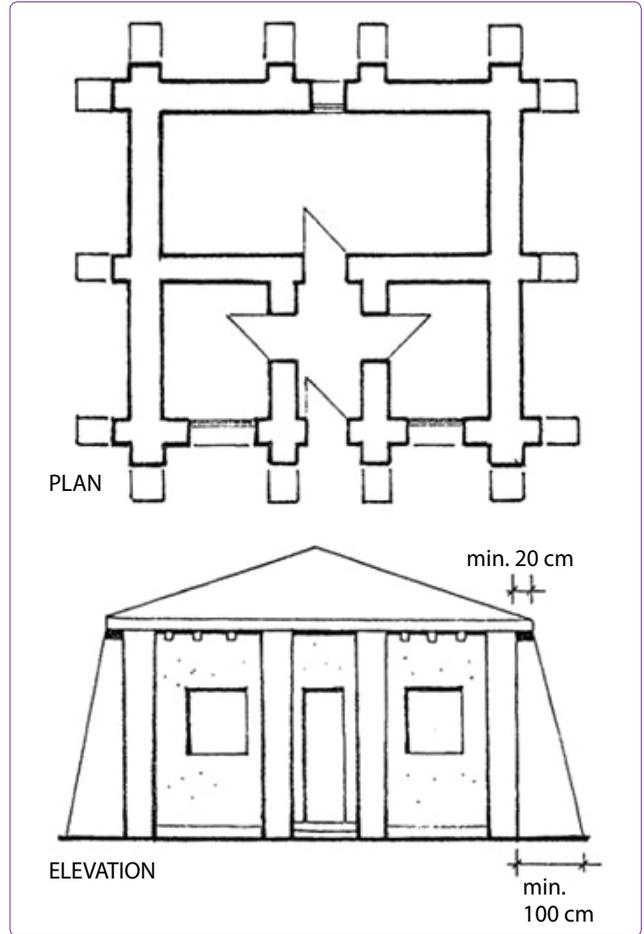


Figure 7. Detail of props (Prepared by Author, 1993).



Figure 8. Building which was supported by props after 2011 Van Earthquake (Parsa, A.R. Archive, 2011).

able for the rules specified for walls and proportions in Earthquake Regulation 2007. Figure 9 presents the rules of the Earthquake Regulation 2007 specified for the proportion of voids and their locations in the walls.

$Lb1 \geq 150 \text{ cm.}$ $Lb5 \geq 50 \text{ cm.}$ $Lb2 \text{ ve } Lb4 \leq 300 \text{ cm.}$
 $(Lb2+Lb4) \leq 0.40 L_n$

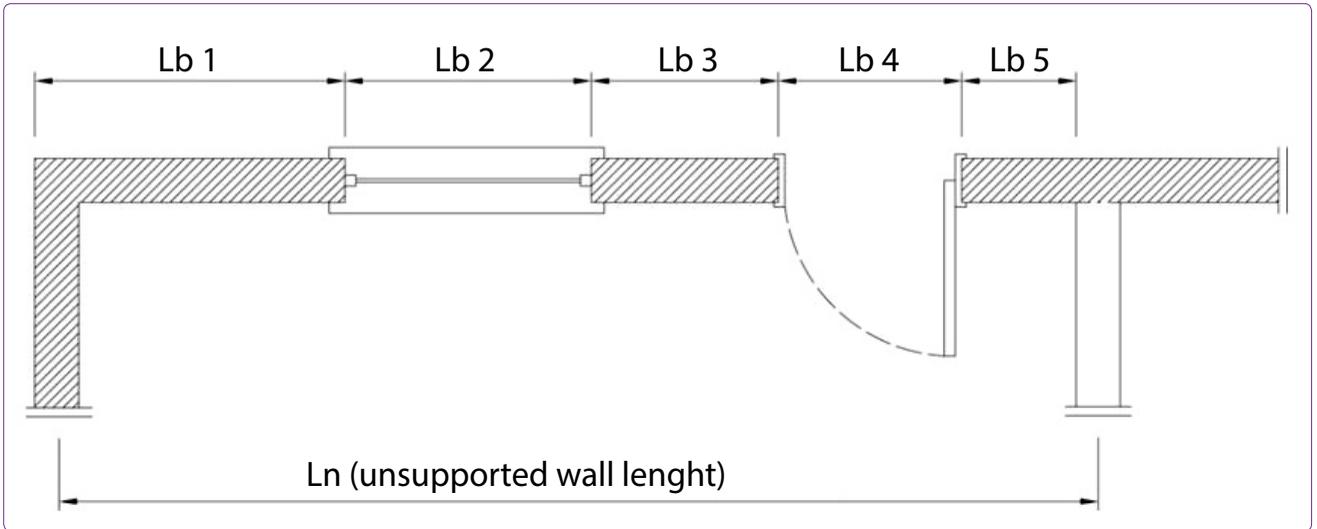


Figure 9. The rules of the earthquake regulation specified for the proportion of voids and their locations in walls (Earthquake Regulation, 2007, p. 93).

The Use of Heavy Ceiling

Mud coated heavy ceiling coverings are built on walls independent of the walls. Heavy tiles on the one hand and their operation during earthquake independent of walls on the other hand emerge as important damage causes. “The ceilings of rural structures with mud-brick and stone walls are generally covered with mud. One meter square weight of the wooden bearer and mud covering of the ceiling is about 750-1000 kg. Therefore a huge ceiling load presses on the walls. The walls are already under difficult conditions during an earthquake due to their construction, so it is inevitable that they will be damaged during earthquake because of heavy ceiling”.⁷ Figure 10 shows a heavily damaged building with mud ceiling in the pilot region.

Naturally a heavy structure alone cannot be the cause of damage. If appropriate measures are taken, no damage will occur on the structure. “Each structure is calculated based on its own weight. Each well-designed and well-built structure, light or heavy, has to be safe.”⁸

Inappropriate Subsequent Interventions to the Structures

Figure 11 presents earthquake-damaged houses in the pilot region. As can be seen in the figure, a lot of incorrect structural details emerged in the buildings. The fact that the parts annexed to the structure depending on the increase of population within the family are not built in accordance with earthquake load is yet another significant cause of damage.

The damages in Figure 11 indicate that the villagers have also been moving away gradually from the construction culture that has formed for ages.

Lack of Beam Usage in the Walls

Beams used in the walls are an important detail observed in masonry structures. Beams significantly contribute to the behaviour of the walls which constitute



Figure 10. A heavily damaged building with mud ceiling (Parsa, A.R. Archive, 2011).



Figure 11. Damaged buildings in the pilot region (Parsa, A.R. Archive, 2011).

⁷ Ergünay, 1978, p. 102-114.

⁸ Aka, 2001, p.9-16.

the most important elements of the masonry structures against earthquake loads. The beams:

- Prevents the crack in the wall from growing bigger,
- Decreases the fineness of the walls H/L and
- Splits the wall mass and ensures less damage resulting from earthquake.

During the research carried out, it was found out that beams were not used in the majority of the houses. Figure 12 gives information about damage percentage of the beamless masonry buildings with mud-wall and Figure 13 presents the damage percentage of the masonry buildings with stone walls and beams.

As understood from Figure 12 and 13, the damage level between buildings with beams and those built beamless is significantly different. Figure 13 indicates that the use of horizontal beams as structural detail affects the behaviors of the structures against

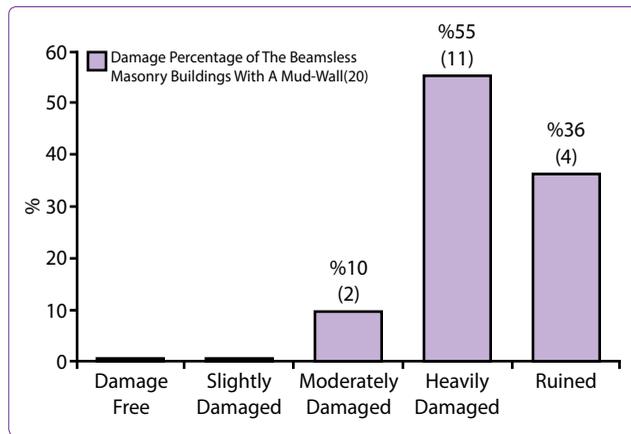


Figure 12. Damage percentage of the beamless masonry buildings with mud-walls (Prepared by Author, 2012).

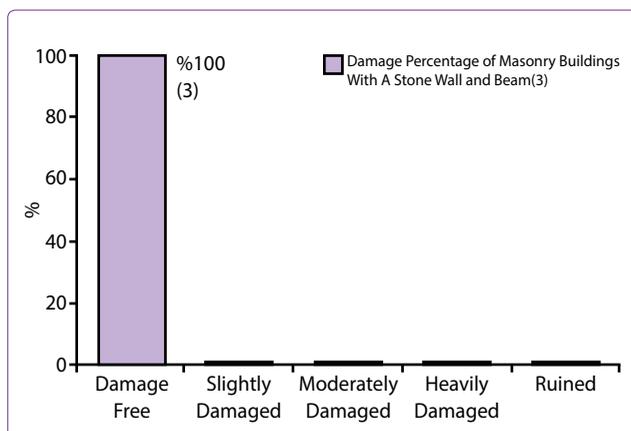


Figure 13. Damage percentage of the masonry buildings with stone walls and beams (Prepared by Author, 2012).

earthquake positively. The results obtained from experiments on shaking tables of the masonry structures point out the same issue.

“In these experiments on shaking table, three earth-roofed structures with mud mortar and rubble stone walls were tested. The plans of the buildings were the same. The only difference between them was that the first structure was beamless and the others had wooden or reinforced-concrete beams on window frames and at the top of the walls.

Each structure was exposed to 3 times 20 mm and 3 times 30 mm shakings with initial shifts respectively. Then each structure was exposed to 45 mm shakings with initial shifts as much as they could resist. As a result, the permanent deformation obtained in structure No 1 at the 6th shaking formed only at the 8th or 10th shakings in structures with beams. In addition, the acceleration of 8th and 10th shakings was applied much more powerfully than that of 6th.⁹

“Reinforced-concrete beams will be as wide as the walls and at least 15 cm high. Wooden beams, on the other hand, will be located in such a manner that the outer surfaces of two 10 cm x 10 cm tarred framework coincide with the inner and outer wall surfaces.”¹⁰

The Structural Questionnaire

During the study, a structural questionnaire was implemented for a total of 55 civil and public buildings found in the pilot region after October and November 2011 Van earthquakes. The structural questionnaires helped reveal important analyses about the structures of the pilot region. Structural questionnaire provided insight with regard to:

- The intended use of the structures,
- The causes of damages occurred on the structures,
- The different load bearing systems used in the structures,
- The level of damages occurred on the structures compared to their load bearing system,
- The type of materials used in the structures,
- The structural details of the structures and many other aspects.

For example, Table 4 shows the number and percentage of the buildings according to load bearing systems and Table 5 presents the general damage state of the buildings.

⁹ Bayülke, 1988, p. 16.

¹⁰ Çamlıbel, 2000, p 213.

Table 4. The Number and Percentage of the Buildings According to Load Bearing Systems (Prepared by Author, 2012)

Load-bearing system	The number of buildings	Percentage (%)
Beamless masonry with amud-wall	20	36
Beamless masonry with a briquette wall	21	38
Masonry with a briquette wall and a beam	3	5
Masonry with a stone wall and a beam	3	5
Hybrid-stone at the bottom briquette at the top	2	4
Reinforced concrete frame system	6	12
Total	55	100

Table 5. The Number of Buildings According to the Damage State in the Pilot Region (Prepared by Author, 2012)

Damage state	The number of buildings	Percentage (%)
Undamaged	9	16
Slightly damaged	8	15
Moderately damaged	10	18
Heavily damaged	20	36
Ruinous	80	15
Total	55	100

The Social Questionnaire

The family structure in Turkey undergoes a process in which nuclear family first turns into extended family then again nuclear family and finally missing family. The social questionnaire applied to 90 % of the people living in the pilot region contained items such as family structure, economic level, their habits, their homes and environments. The results of the survey provided important information about the new village architecture and settlements to be built. For example, 87% of the social questionnaire participants stated that they

were satisfied with the plan of the house where they lived. The village houses shaped by the villagers devoid of architectural service also function as a workshop for them. They process the products they obtain from agriculture and animal husbandry at home. Of the many results revealed by the social questionnaire, Figure 14 and 15 present two results only about the kitchen as an example.

The results revealed by the social and structural questionnaires and the observations during the study helped obtain various important syntheses match-

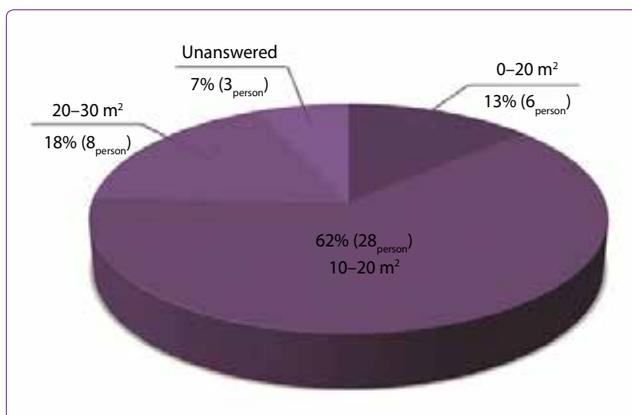


Figure 14. What are the dimensions of the kitchen? (Prepared by Author, 2012).

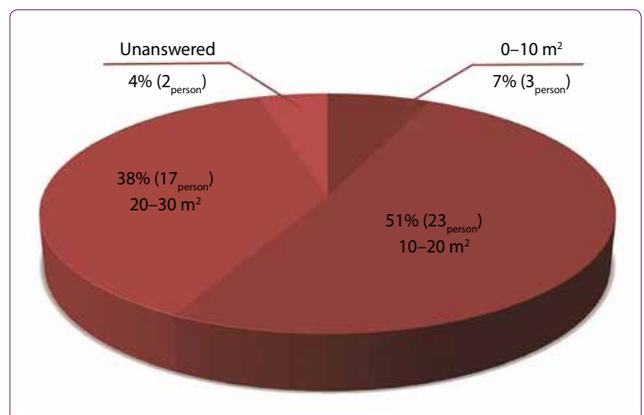


Figure 15. What should be the dimension of an ideal kitchen? (Prepared by Author, 2012).

ing the objectives of the study. These syntheses were taken into consideration for new home designs in the pilot region. One of the important outcomes indicated that the village houses were gradually developing. As mentioned earlier, the villagers need more space during transformation from nuclear family to extended family. The village house affected by this process constantly faces structural interventions. The additions

emerging in inappropriate structural details in different periods make the structures insecure.

Suggestions

Following up the important research, observation and diagnoses, the study put forward 4 different improvable, sustainable, comfortable, safe and ecological house proposals, taking the recommendations of the

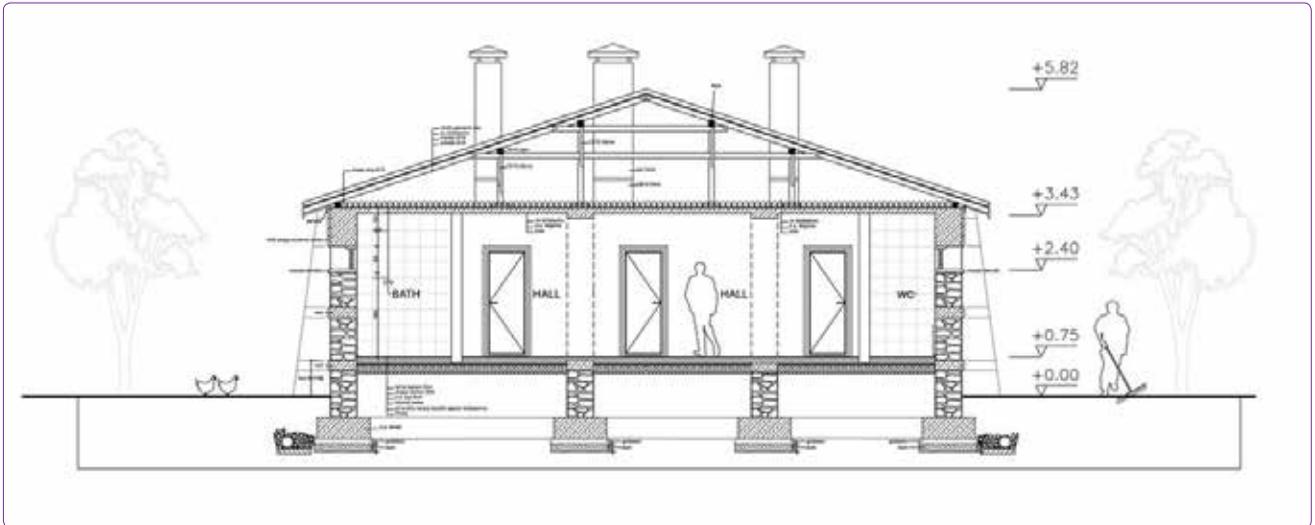


Figure 16. A section of suggested masonry house of pilot region with props and reinforced-concrete beams (Prepared by Author and members of Workshop, 2012).



Figure 17. Suggested masonry house of pilot region with props and reinforced-concrete beams (Prepared by Author and members of Workshop, 2012).



Figure 18. Suggested site plan of pilot region's square and social center (Prepared by Author and members of Workshop, 2012).



Figure 19. Suggested plan of the social center (Prepared by Author and members of Workshop, 2012).

villagers as well. The main material of the proposed houses designed with traditional masonry system was planned to be stone and adobe. The structural details of the houses proposed by the study were prepared

taking the seismic factor into account. In addition, while the details included recommendations for minimum energy use, they also involved important solutions for using the rain and snow water coming from



Figure 20. Section A-A of the social center (Prepared by Author and members of Workshop, 2012).



Figure 21. East elevation of the social center (Prepared by Author and members of Workshop, 2012).



Figure 22. North elevation of the social center (Prepared by Author and members of Workshop, 2012).

the roof in farming. Figure 16 and 17 shows the section and a view of a masonry house which belongs to the pilot region with props and reinforced-concrete beams which has been improved during the study.

One of the most difficult sections of rural life was determined to start after sunset. As there are no facilities for social activities in villages, the period of the day after sunset becomes unbearable especially for women and children. To resolve this important problem, the study proposed a village square which is to form the identity of the pilot region and designed a social center building in the square. The most important feature of the social center is that it can amortize itself during utilization without any charge to public budget. A further feature of the social center is that it is a training and production center for the villagers. Figures 18, 19, 20, 21 and 22 present the plans, sections and appearances of the proposed social center building.

Conclusion

The most important reason why rural settlements and urban areas have lost identity is the migration problem emerging due to economic policies pursued during transformation from an agricultural community to an industrial society. Turkey is a country of earthquakes and a large part of the rural settlements are located in active seismic zones. The development of the abandoned villages due to poverty and earthquakes has been the problem of all times. However, incorrect and superficial approaches for the solution of the problems have prevented successful outcomes. Re-emergence of comfortable and safe life in rural settlements will help use a large part of the unused lands of Turkey again and provide economic growth. The study and the research it developed for the solution of the problem focused on the problems of Eastern Anatolian rural settlements in seismic zone and made important observations. The study suggesting solutions in line with its findings argues that rural settlements and buildings might be safe and comfortable despite undesirable conditions today. In addition, it suggests that the traditional masonry structures can be designed and applied as earthquake resistant.

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