A STUDY ON ECONOMIC LOSSES CAUSED BY EARTHQUAKE

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Abstract

Buildings have been repaired or strengthened for many different reasons throughout of their service life. It can be decided to demolition of buildings when strengthening or repairing is unsuitable. There can be many reasons for repairing, strengthening or demolition buildings. Earthquake is one of these reasons. In this study, firstly performance calculations were made for a RC building according to Turkish Earthquake Code 2007 (TEC'2007) which has been damaged after an earthquake. The results of performance based assessment show that performance level of building is not desired level. The building is not safe and not economical to strengthen so it needs to be demolished. The institution has decided to demolish the building after detailed analysis of building. In this study demolition cost and re-construction cost have been separately calculated. The results have been compared and suggestions have been made. The construction cost of the building has been calculated according to the unit production method using the unit prices of 2014.

Keywords: *Demolition Cost, Re-Construction Costs, Economic Loss, Earthquake*

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1. INTRODUCTION

The importance of studies, researches and prevention about earthquake have risen after destructive earthquakes in the world especially in recent years. Earthquake damages will increase according to vulnerability of urban and rural building stocks. The size of earthquakes and the negative structural features will be caused an increase in damage amount. Knowing the properties of buildings that have been negatively influenced to the seismic behavior of buildings under earthquakes will be put forward to ensure more serious approaches to reduce the level of damage risk after earthquakes. In order to reduce the damages of the earthquakes firstly the performance of buildings needs to be determined [1]. The main objective in the determination of building's earthquake safety is to enable giving the correct decisions on the existing building stock by conducting the necessary inspections and calculations on existing buildings in advance of a possible earthquake.

In order to reduce the damages of the earthquakes, which are likely to affect residential areas, firstly the performance of existing buildings needs to be determined. The most affective damage reduction method of the earthquake is to strengthen the buildings, which are under the risk of being collapsed or being damaged. If strengthening is not efficient, then the building needs to be demolished and rebuilt [2]. In recent years, with the affect of a developing consciousness about the earthquakes, the society started to think more rationally and they want to learn the performance of their buildings against a possible earthquake. This consciousness is coming both from individuals and companies. Turkish Earthquake Code 2007 (TEC'2007), Section 7 has the characteristics of responding to this need [3].

In order to be able to evaluate an existing building, firstly every kind of data needs to be collected about the building. These data are provided from the element detail and dimensions that will be used in in calculating existing buildings' capacity for structural system elements and in evaluating their strength against the earthquake, from the information about the structural system geometry and materials' properties, from the projects and reports of the buildings, from the observations and measurements made with the buildings, from the experiments that are applied to the material samples taken from the building [3].

Lake Van basin is located in Eastern Turkey that has suffered very severe tectonic deformation [4,5,6]. Destructive earthquakes that will be occurred in Lake Van Basin will affect also the city of Bitlis as it happened during the 2011 Van earthquakes (Fig.1).

Fig. -1. The study area to the epicenter of Van earthquake

The maximum structural losses observed in Van and Erciş District. Erciş district was the most heavily damaged area in this earthquake. Maximum structural losses observed in Bitlis after Van and Erciş District (Fig. 2.)

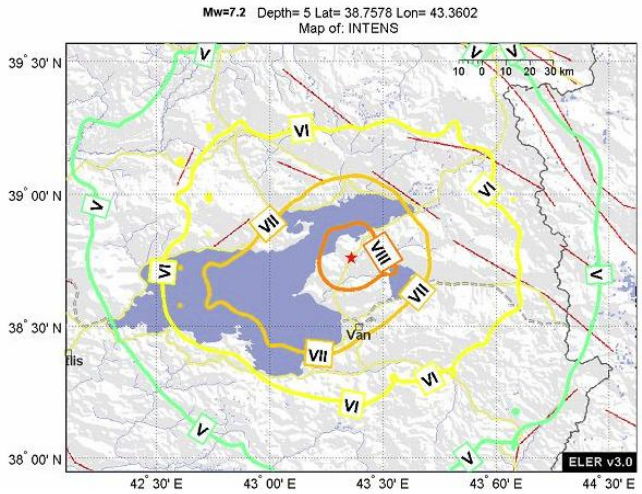

Fig.-2. Instrumental intensities associated with the main shock [7]

In this study, the building that used as Tatvan Vocational High School has been affected seriously after the earthquake. The building is not safe and not economical to strengthen so it needs to be demolished. The institution has decided to demolish the building after detailed analysis of building. In this study demolition cost and re-construction cost have been separately calculated. The results have been compared and suggestions have been made.

2. BUILDINGS PROPERTIES

Tatvan Vocational High School was investigated in this study which was located in Tatvan province in Bitlis. The building was built in 1993. Building was formed one basement, one ground an done normal storey. It is totally 3 stories. The dimensions of the building are 76.55m x 48.45m. Building was formed RC frame and RC walls. Total height of building is 10.80m. The blueprint of ground story was given in Figure 3.

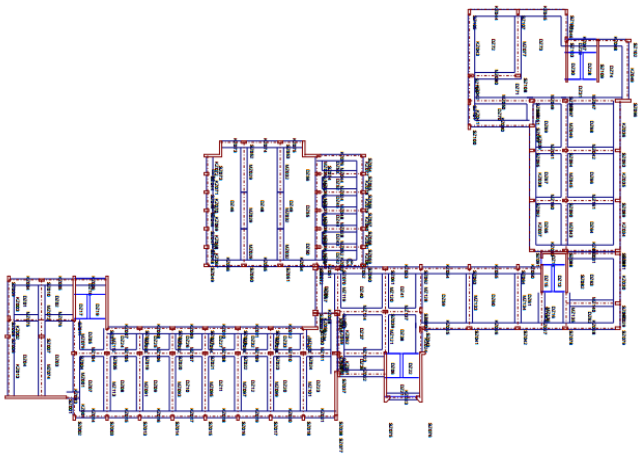

Fig.-3. The blueprint of ground story

3. MATERIAL AND METHOD

Required experiments for performance analysis were carried out of the building, which is designed as an educational institution. Determine the existing concrete strength is one of these. The concrete strength was calculated by taking the required number of core samples in the studied building. The concrete class is determined as C3.5 from experiment results [8]. In experiments conducted at the construction site, corrosion measurement and reinforcement mat is scraped visual control of diameter and made of corrosion was observed in this case the equipment. It also has been found to be specified in regulations stirrup densification process (Fig. 4).

Fig.-4. Status of the columns

Basic concepts and assumptions used to structure performance are as follows:
* TEC 2007 criteria were used.
* Concrete quality class has been accepted as C 3,5.
* Reinforcement was St I and corrosion have been adopted.
* Spectrum analyze was used according to the TEC 2007
* Second degree earthquake zone.
* Ground safety tension has been taken as 13.5 t / m2.
.* Local soil type has been taken as Z2-D
* Periods for the building has been taken as Ta = 0,20 ; Tb = 0,90.

The structure is modelled as three stories for performance based assessment. Bearing capacity of the beams and the columns were observed to be minimal. There is a certain need to strengthen the structure as to the windings in columns. This plurality of columns (at least 90%) will need to be strengthened. This information is made within the framework of the strengthening of the columns and beams of 90%, the concrete in the basement curtains and strengthening the basic structure of the basement because of poor pitch will make it necessary to be strengthened [8]. This calculation probability of exceedance 10% in 50 years, which now use of the seismic forces and the possibility of exceeding 2% in 50 years were found to be not provided the level of safety performance. So strengthening of building is unsuitable.

Construction, mechanical and electrical installations have been described separately when calculating the cost of demolition of the structures. The amount and costs of demolish construction was given in Table 1.

Table -1. The amount and cost of demolition (2014 Unit Prices) Turkish Lira (TL)

No	Item No	Type	Unit	Amount	Unit price	Price
1	18.198./10	Removing roofing as galvanized steel, aluminium, glass fibbers and etc.	m²	1.870,84	3,59	6.716,32
2	3165	Removal of wooden doors, windows or safe	m²	177,10	5,45	965,20
3	KGM/18.183	Demolition of Construction with Cement Mortar without Using Explosives	m³	2.692,78	11,88	31.990,23
4	KGM/18.185	Demolition of concrete structures without using explosives	m³	2.594,92	23,41	60.747,08
5	MSB.133/A	Removal of Iron rafters, profile or sheet metal column and beams	ton	4,32	700,48	3.028,88
6	P-1	Transplant of rubble	m³	5.287,70	7,00	37.013,90
7	P-033/A	Removal of aluminium and PVC	m²	622,98	5,31	3.308,02
8	P-034/A	Removal of suspended ceiling	m²	248,28	2,96	734,91
9	V.0333	Removal of the classic and simple iron fence, iron doors, glazing and window	m²	19,04	27,63	526,08
10	V.0339	Removal of each type wood coating	m²	96,34	5,81	559,74
11	V.0342	Removal of wood roof	m²	1.561,61	19,26	30.076,61
TOTAL						**175.666,95**

Demolition costs have an important place in order to determine the economic losses after the destructive earthquakes. Cost demolition is an important economic scale for earthquake losses. Cost of demolition calculated such as three main groups. These main groups are construction, mechanical and electrical groups. In this study, detailed data for construction was given in Table 1. All main groups were calculated separately. Then the result cost of demolition calculated for selected school building which was damaged after Van earthquake.

The total cost demolition of building was given in Table 2.

Table -2. Cost of demolition

Part of Production	Price (TL)
Main Group	
1 Construction	175.666,95
2 Mechanical	2.933,07
3 Electrical	29.486,64
Total	208.086,66

Re- construction cost of studied building was calculated in Table 3.

Table -3. Re-construction cost of the building

Number of story	**Basement story area** (m^2)	**Normal stories area** (m^2)	**Total area of building** (m^2)	**Unit production cost** (TL/m^2)	**Total Cost** (TL)
B+G+ Normal Story	3.708,85	7.417,70	11.126,55	1.150,00	12.795.532,50

4. CONCLUSIONS

The size of earthquakes and the negative structural features have been caused an increase in damage amount. Knowing the properties of buildings that have negatively effect to the seismic behavior of buildings under earthquakes will be put forward to ensure more serious approaches for reduce the level of damage risk after earthquakes. It unfolds the necessity of earthquake effects to be kept in mind during constructing. Due to seismic risks, the reality of earthquake should not be forgotten.

Knowing the reasons of earthquakes damages are very important in terms of minimizing the possible economic and life losses and taking necessary precautions for before, during and after the earthquakes. Recently modern disaster management was emphasized disaster preparedness but also importance of disaster prevention.

Life and economic losses caused is very high by the earthquake. The damage in buildings according to earthquake was investigated economically in this study.

The construction costs of the Tatvan Vocational High School building has been calculated according to the unit production method using the unit prices of 2014. As a result, the re-construction costs of this building with the prices of 2014 has been found to be 12.795.532,50TL and the cost of demolition is 208.086, 66TL. The total economic loss was calculated as 13.003.619,16TL. This calculated value is belongs to only one of the buildings.

Many factors must be considered in strengthening the damaged structures. The strengthening of the non-rational to be immediately demolished, it will be more economical.

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