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A Case Study of Canadian Seismic Screening Method in Lake Van Basin

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Abstract: *In this study, Canadian Seismic Screening Method for the evaluation of existing buildings was carried out in Ahlat located in Lake Van Basin which is seismically quite active. A fast and simple seismic risk assessment procedure is proposed for vulnerable urban building stocks. 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. There are rapid evaluation methods for this purpose. In this study, thirty-seven buildings have evaluated by Canadian Seismic Screening Method which are in Bitlis, Ahlat. Evaluation calculations have been done by taking examples from each street consisting urban building stocks of Ahlat. 37 RC buildings have been evaluated. %14 of these buildings will be examined in the low priority; %41 in the medium priority, %35 in the high priority and %10 in the very risky priority. This study will be a source for the future studies on the reinforced concrete structures of Ahlat.*

Keywords – *Bitlis, Ahlat, rapid assessment, RC,*

I. Introduction

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 behaviour 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 devastating earthquakes and life and property losses on world have increased importance of earthquake researches and precautions. Main purpose of determining the seismic safety of structures is making necessary investigations and calculations to make right decisions about existing building stock. Increase of building stock overtime makes harder assessment of buildings as number of technician, time and economical aspects. Perscrutation of seismic safety about any building may last for days. Because of these reasons, perscrutation and assessment may not possible for every building. In this case, rapid assessments methods are needed to make right and quick decisions. These methods named as 'first stage assessment methods' generally. Risky buildings may detect before earthquake by using these methods which are make significant decrease in number of perscrutation needed buildings. Canadian Seismic Scanning Method has used in this study as method. The necessary information has given about this method and performance point of existing RC building has calculated by using this method. This study informs, how must apply the first stage assessment methods on buildings and parameters to consider.

Ahlat is a historical town and a district in Turkey's Bitlis Province in Eastern Anatolia Region. Ahlat and its surroundings are known for the large number of historic tombstones left by the Ahlatshah dynasty. The center town of Ahlat is situated on the northwestern coast of the Lake Van. Lake Van is the largest lake (3600 km2) in Turkey and the fourth largest one in the World (Fig.1).

The medieval Muslim cemetery of Ahlat is located nearby the town of Ahlat, Bitlis Province Turkey, and is known for its many Islamic tombs (kümbets) and tombstones dating to the 13th-16th centuries when the area was under control of various Muslim states. . The town eventually declined and depopulated in the 16th century. Today the cemetery is tentatively listed in the List of World Heritage Sites in Turkey [2].

It is basically a sidewalk survey procedure based on observing selected buildings parameters from the street side and calculating a performance score. With this method reinforced concrete structures have been evaluated quickly and the buildings that have damage risk have been determined. Evaluation calculations have been done by taking examples from each street consisting urban building stocks of Ahlat. 37 reinforced concrete buildings have been evaluated with Canadian Seismic Screening Method. The aim of this study is giving information's about this method. The study also gives usability of this rapid assessment method.

Fig.1.1- Location map of Ahlat

II. Methodology

Reinforced concrete structures, which have a significant portion of urban building stock, have different importance of seismic safety determination. The seismic events in turkey show that only a few portion of existing building stock has sufficient seismic performance. At the same time, the buildings, which seem provide seismic performance successfully, cannot provide this performance indeed. It is very important to determine seismic performance of existing buildings in order to make life and property loss as possible as low level in a potential earthquake. However, the structural assessment process cannot be done certainly and detailed as economically and time angle due to number of buildings. Therefore, using fast and accurate evaluation methods on existing building stock is seems as a reasonable solution.

Due to the recent destructive earthquakes in world, those efforts necessary to know earthquake risks of the existing buildings require time and cost. Various methods were developed to pursue such works within the shortest time and at minimum cost. Rapid assessment methods can be used instead of detailed structural analysis because of the buildings stocks amount. These rapid assessment methods can be used for deciding which buildings need further structural analysis and decide to seismic safety level of the buildings. This provides priority of buildings for detailed analysis [3]. The implementation fundamentals of Canadian Seismic Screening Method that used in this study were presented below.

III. Canadian Seismic Scanning Method

Screening entails assessing buildings to ascertain their level of seismic risk following a simplified procedure whose main objective is to determine if the building should or should not be subjected to a more detailed investigation [4]. Buildings can be screened using rapid visual screening methods. One of these methods is “Manual for Screening of Buildings of Buildings for Seismic Investigation” that developed by the National Research Council of Canada (NRC, 1993) [5]. This paper gives also an overview of the Canadian Seismic Screening Method.

The recommended method, according to published principles from Canada National Research Council, has considered as first stage of multi-stage investigation and includes, computationally pre-assessment of every single building. After computationally assessment is done, a more comprehensive study should be performed in order of priority.

Necessary parameters to may use the method have given below.

- Seismicity of area where building is (A)
- Local soil conditions (B)
- Structural system type (C)
- Slab system (D)
- Irregularities of building (E)
- Building importance factor according to number of people (F)
- General condition of building (G)
- Non-structural index (H)

Each parameter named by a letter in this method. The calculations made by using factors given in method for each parameter. At first, structural index has been calculated by digitizing these parameters.
Structural index calculated by expression of;

$$SI = A*B*C*D*E*F \quad (1)$$

Beside, non-structural index (NSI) calculated too. Non-structural index calculated by expression of;

$$NSI = B*F*G*H \quad (2)$$

Seismic priority index calculated by adding structural index with non-structural index as shown below;

$$SPI = SI + NSI \quad (3)$$

Decision of building's priority making by comparing obtained results and boundary values were given in following Table-1.

Table 1. Priority levels for buildings in Canada Seismic Screening Method [6]

Index Points	Boundary Values	Assessment
SI or NSI	1.0 - 2.0	Sufficient Seismic Safety
SPI	<10	Low Priority Buildings
SPI	10- 20	Medium Priority Buildings
SPI	>20	High Priority Buildings
SPI	>30	Very Risky Buildings

IV. Evaluation Results

Information for each building is collected by using parameters that given in NRC. Each parameter has a score. The scores are then used to rank all buildings of the inventory for detailed seismic evaluation. The scoring system is made up of a structural index (SI) and a non-structural index (NSI). Some pictures of investigated buildings are presented in Figure 4.1.

Fig. 4.1. Some pictures of investigated buildings

Results for Canada Seismic Screening method which is used as method in this study were shown on Table 2 .

Table 2. Canada Seismic Scanning Method Results

BUILDING CODE	A	B	C	D	E	F	G	H	SI	NSI	SPI
A1	4	1	1	1	4.3	1.5	1	1	25.8	1.5	27.3
A2	4	1	1	1	2.8	1.5	1	1	16.8	1.5	18.3
A3	4	1	1	1	4.3	1.5	1	1	25.8	1.5	27.3
A4	4	1	1	1	2.8	1.5	1	1	16.8	1.5	18.3
A5	4	1	1.5	1	3.3	1.5	2	1	29.7	3	32.7

A6	4	1	1	1	5.8	1.5	2	1	34.8	3	37.8
A7	4	1	1	1	2.8	1.5	1	1	16.8	1.5	18.3
A8	4	1	1	1	2.8	1.5	1	1	16.8	1.5	18.3
A9	4	1	1	1	2.8	1.5	1	1	16.8	1.5	18.3
A10	4	1	1.5	1	2.8	1.5	1	1	25.2	1.5	26.7
A11	4	1	1.5	1	2.3	1.5	1	1	20.7	1.5	22.2
A12	4	1	1	1	4.3	1.5	1	1	25.8	1.5	27.3
A13	4	1	1	1	1.3	1.5	1	1	7.8	1.5	9.3
A14	4	1	1.5	1	2.6	1.5	2	1	23.4	3	26.4
A15	4	1	1	1	2.3	1.5	1	1	13.8	1.5	15.3
A16	4	1	1.5	1	3.3	1.5	2	1	29.7	3	32.7
A17	4	1	1	1	1.3	1.5	2	1	7.8	3	10.8
A18	4	1	1.5	1	4.6	1.5	2	1	41.4	3	44.4
A19	4	1	1	1	3.2	1.5	1	1	19.2	1.5	20.7
A20	4	1	1	1	1.3	1.5	2	1	7.8	3	10.8
A21	4	1	1	1	2.8	1.5	3	1	16.8	4.5	21.3
A22	4	1	1.5	1	2.3	1.5	1	1	20.7	1.5	22.2
A23	4	1	1	1	1.3	1.5	1	1	7.8	1.5	9.3
A24	4	1	1	1	1.5	1.5	2	1	9	3	12
A25	4	1	1	1	1.5	1.5	2	1	9	3	12
A26	4	1	1	1	1	1.5	2	1	6	3	9
A27	4	1	1	1	2.8	1.5	1	1	16.8	1.5	18.3
A28	4	1	1	1	1	1.5	1	1	6	1.5	7.5
A29	4	1	1	1	4.1	1.5	1	1	24.6	1.5	26.1
A30	4	1	1.5	1	1.3	1.5	2	1	11.7	3	14.7
A31	4	1	1.5	1	2	1.5	2	1	18	3	21
A32	4	1	1.5	1	1.3	1.5	1	1	11.7	1.5	13.2
A33	4	1	1.5	1	2.3	1.5	1	1	20.7	1.5	22.2
A34	4	1	1.5	1	2	1.5	2	1	18	3	21
A35	4	1	1	1	2.8	1.5	2	1	16.8	3	19.8
A36	4	1	1	1	4.1	1.5	2	1	24.6	3	27.6
A37	4	1	1	1	2.6	1.5	2	1	15.6	3	18.6

V. Conclusions

According to seismic regulations, it cannot be certainly said that whether a building is safe, low-risky, mid-risky or high-risky. This is only a first-stage assessment as indicated above. Therefore, certain results can be obtained after application of detailed analyzes methods. Seismic performances of adjacent structures may affect each other so this circumstance should not be ignored. Including the structures in this study and all structures must be utilized; on the other hand, high risky building must be utilized in first place. Structures which are not possible to strengthening economically and unsafe structures must be demolished in terms of reducing seismic risk studies performed. Extricable buildings must be strengthened by doing necessary engineering study. In this study, some of reinforced structures in Bitlis, Ahlat, are subjected to rapid assessment. The purpose of this study is to prove applicability of rapid assessment methods.
The results of evaluation of buildings were given in Table 3.

Table 3. Evaluation results of buildings

Index Points	Boundary Values	Assessment	Number of buildings	Percentage (%)
SPI	<10	Low Priority Buildings	5	14
SPI	10-20	Medium Priority Buildings	15	41
SPI	>20	High Priority Buildings	13	35
SPI	>30	Very Risky Buildings	4	10
TOTAL			37	100

Evaluation calculations have been done by taking examples from each street consisting urban building stocks of Ahlat. 37 RC buildings have been evaluated. %14 of these buildings will be examined in the low priority; %41 in the medium priority, %35 in the high priority and %10 in the very risky priority. This study will be a source for the future studies on the reinforced concrete structures of Ahlat. The reason of large building number of very risky and high risky buildings is high seismicity of the region. The other reason is negative features of the buildings. The size of earthquakes and the negative structural features will be caused an increase in damage amount.

This evaluation is only the first stage evaluation. The purpose of first stage evaluation is determining of the risk priority of the buildings. This provides priority of buildings for detailed analysis. Detailed structural analysis should be performed to give a final decision about the structure.

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