

PRELIMINARY SEISMIC MICROZONATION AND SEISMIC VULNERABILITY ASSESSMENT OF EXISTING BUILDINGS AT THE CITY OF NIGDE, TURKEY

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ABSTRACT :

Preliminary seismic microzonation studies, local site characterization and investigation of seismic vulnerability of existing buildings provide a basis for the current Earthquake Engineering research. In this study, a site investigation is conducted in order to maintain Earthquake Risk Mitigation in the City of Nigde, Turkey. The City of Nigde is close to the region where devastating Adana-Ceyhan Earthquake occurred in June 1998. Site investigation mainly concentrated in Selcuk and Yenice districts which are two of the most residential and heavily populated districts of the City. Building construction practice in the City is evaluated and; general information about seismicity of Nigde Region is provided. Nondestructive testing methods are applied and computational structural analysis techniques are used for the evaluation of seismic vulnerability of selected buildings. During the investigation substantial amount of undesired structural irregularities are observed within the existing building stock in the City. This research provided valuable information about the current local construction practice at the City of Nigde. An essential basis for future seismic microzonation research and site investigation in the Region is established.

KEYWORDS: Seismic Microzonation, Seismic Vulnerability, Site Investigation, Earthquake Risk

1. INTRODUCTION

Seismic microzonation and seismic vulnerability assessment of building stock at a certain location is of importance in order to reduce the potential damage from future earthquakes. Seismic microzonation is considered as an important tool for earthquake mitigation which provides a basis for site-specific hazard analysis. It provides information regarding the use of different areas of a city in an order such that structural, geological, seismologic and geotechnical factors can be considered. In the recent years microzonation is becoming more popular and has been started to be applied in different areas of the world.

There has been intensive urbanization in Turkey since 1950's even though it does not occur within respect to an organized construction practice considering the earthquake effects. There have been continuous recent seismic microzonation studies in Turkey since 1999 Marmara and Duzce earthquakes (Ansal et al. 2003; Ansal et al. 2007; Yagci and Ansal 2007). Seismic drift response and behavior of building structures at seismically active regions has been investigated (Ozturk 2003). There has been extensive research work in Europe and other parts of the World regarding prediction of ground motion and loss scenarios (Faccioli 2007; Tuladhar et al. 2004a, 2004b). Additionally, seismic risk assessment of buildings in urban areas is also being investigated in Turkey (i.e. Inel et al. 2008).

There has been an important progress within respect to understanding and application of microzonation. In that respect, a research in preliminary seismic microzonation and seismic vulnerability assessment of building stock in Nigde has been conducted. The building stock located at two residential districts of Nigde namely Yenice and Selcuk districts are counted and classified. Structural properties and seismic resistance of sample buildings are investigated. Soil properties of these two districts have been examined and evaluated and seismicity of Nigde is briefly explained. An essential basis for future seismic microzonation research and site investigation in the region is established.

2. SEISMICITY OF NIGDE

Seismic zone map of Nigde county is provided in Figure 1. Most of Nigde province is located in seismic Zone 4 ($0.10g < PGA < 0.20g$) while town of Altunhisar is in seismic Zone 5 ($PGA < 0.10g$) and Çamardı town in seismic Zone 3 ($0.20g < PGA < 0.30g$).

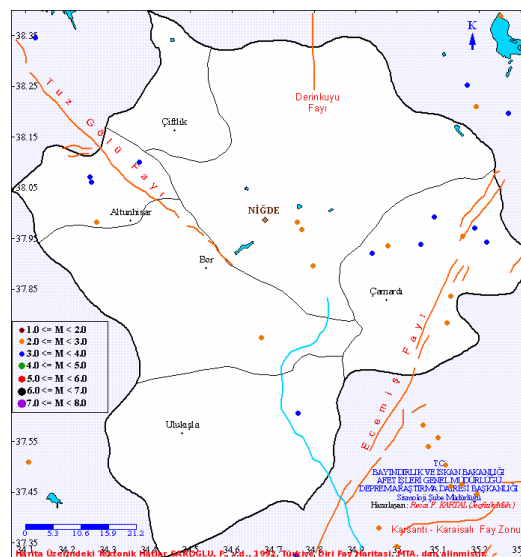


Figure 1 Seismic map of Nigde county (Kartal 2008)

Figure 1 includes information regarding the fault line system of the area, Ecemiş fault line is located close to Nigde city and located in the south east of Tuz lake (Kartal 2008). Seismicity of Nigde region and seismic activity for the one year period of May 2007–May 2008 is also shown in Figure 1.

Topographic map of Nigde city centre and its vicinity is provided in Figure 2. Mainly the area consists of old alluvium in the city center, Melendiz agglomerate in the north, old alluvium in both south and west, new alluvium and melendiz andesite in the northwest and hillside rubble in the southeast of the city center (Baykan 2002).

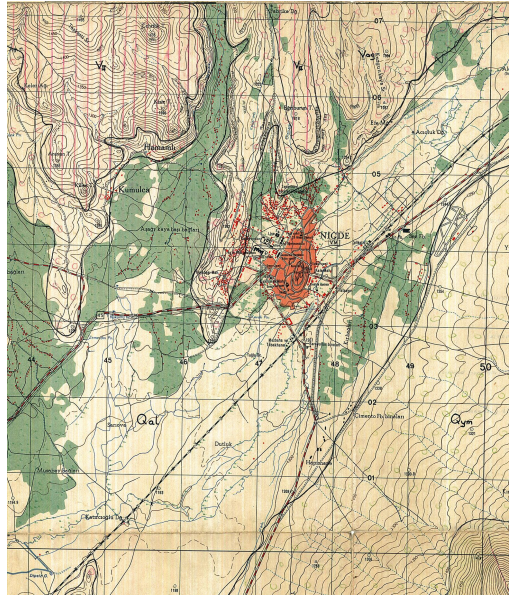


Figure 2 Topographic map of Nigde City central area (Kozan Map section)
(General Directorate of Mineral Research & Exploration 2008)

3. SITE INVESTIGATION AND SEISMIC MICROZONATION OF SELCUK AND YENICE DISTRICTS

Recently, there has been studies regarding seismic vulnerability assessment of the existing building stock (Tanyildiz 2004; Turunc et al. 2004) and application of seismic zonation in Selcuk and Yenice districts of the City (Sahin and Guzel 2008).

Selcuk district is the largest residential district of Nigde city and is located at the southwestern part of the city centre while Yenice district is at the center of the city including financial center and high-rise residential buildings. The plans of these two districts are provided in Figure 3 given below.

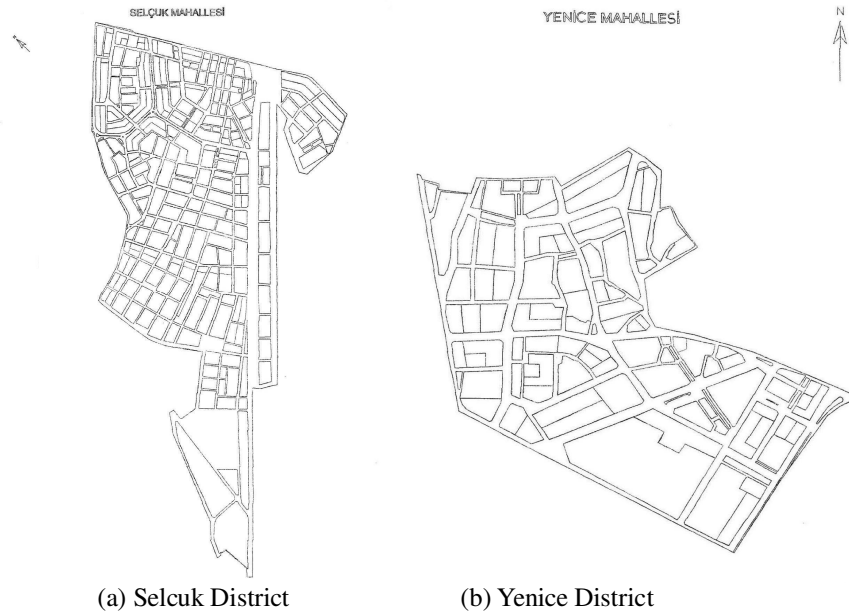


Figure 3 Municipal plans of Selcuk and Yenice districts (Municipality of Nigde 2008)

A site survey for investigation of characteristics of building stock in the districts named above has been conducted (Sahin and Guzel 2008). The investigation provided information regarding the number of buildings, their number of stories, location and construction type. Part of this survey is provided in Tables 1 & 2 given below.

A total number of 919 buildings have been counted and considered in the currently evaluated building stock in Nigde. There are 607 buildings counted in Selcuk district while there are 312 in Yenice district. Their locations, number of stories, their being single or side-by-side, their being reinforced concrete or masonry have been considered. The buildings are mainly mid-rise reinforced concrete buildings.

The experimental results of soil samples are provided for both Selçuk district and Yenice district. The soil type at Selcuk district is found to be composed of sandy clay and silty clay while at Yenice district the soil type is silty clay. As a result of the preliminary results of soil tests for Selcuk district, soil group is determined to be Z2 type with design spectrum periods $T_A= 0.15$ sec and $T_B= 0.40$ sec. Meanwhile, as a result of the preliminary results of soil tests for Yenice district the soil type is found to be Z1 type with design spectrum periods $T_A= 0.10$ sec and $T_B= 0.30$ sec.

Table 1 Number of buildings and their stories in Selcuk district (Sahin and Guzel 2008)

Number of Stories	Number of Buildings	Total Number of Stories	Overall number of Buildings
1	98	98	607
2	54	108	
3	35	105	
4	172	688	
5	147	735	
6	55	330	Overall number of Stories 2405
7	29	203	
8	15	120	
9	2	18	

Table 2 Number of buildings and their stories in Yenice district (Sahin and Guzel 2008)

Number of Stories	Number of Buildings	Total Number of Stories	Overall number of Buildings
1	42	42	312
2	56	112	
3	43	129	
4	46	184	
5	61	305	
6	33	198	Overall number of Stories
7	19	133	1213
8	4	32	
9	4	36	
10	2	20	
11	2	22	

4. SEISMIC VULNERABILITY ASSESSMENT OF SELECTED BUILDINGS

General building stock in Nigde is being investigated in means of seismic vulnerability of the existing buildings and quality of construction. It is observed that there are structural irregularities in some of the existing buildings. In means of construction and quality of material used, buildings constructed after 1999 Turkish earthquakes are in better condition compared to buildings which were built before these events. There is an increase in concrete quality and detailing of reinforcement and steel in the new buildings.

Structural irregularities can be easily observed at buildings located in Selcuk district informing us that the buildings will not behave well during a future seismic excitation. Structural analyses and nondestructive testing methods such as ultra sound test and Schmidt hammer concrete test have been applied for the investigation of buildings. There has been research regarding the seismic vulnerability assessment of three selected buildings. Two of these buildings are located at Selcuk district which are Fatih high school and Safir condominium. The third building is the building of Faculty of Engineering & Architecture. Information about investigation of seismic behavior of three sample buildings is explained below.

4.1 Fatih High School Building

It is a reinforced concrete school building located at Selcuk district of Nigde. It has a total of four stories: basement, entrance story and two upper stories. It is located on soil type Z3 with design spectrum periods $T_A=0.15$ sec and $T_B=0.6$ sec. The entrance story has a height of 4.20 m while the other two upper stories have a height of 3.20 m each so that the total building height is 10.60 m. Structural periods of its first three modes are 0.65 sec, 0.60 sec and 0.56 sec, respectively. It was built before 1998 Adana Ceyhan Earthquake and after the event cracks were observed in its beams and columns. Upon application of nondestructive testing methods such as Schmidt hammer concrete test and ultra sound test, the concrete quality is determined to be of low quality with a compressive strength around 12 MPa.

4.2 Faculty of Engineering and Architecture Building

It is a new building located at the campus area of Nigde University. It is a four story reinforced concrete building composed of basement and three stories above ground level. It is constructed on Z4 soil type with design spectrum periods $T_A=0.20$ sec and $T_B=0.90$ sec. It has a total height of 9.6 m above ground level. Its fundamental period is calculated to be 0.27 sec. The building has extensive slab discontinuities and structural irregularities. The results of nondestructive testing methods refer to a concrete compressive strength around 25 MPa.

4.3 Safir Condominium

It is located at Selcuk district of Nigde. It is a reinforced concrete building constituted of basement and five upper stories. It has a total height of 16 m above ground level. It was built after 1999 Turkish earthquakes. It is of higher construction and material quality such that the results of nondestructive testing methods refer to a concrete compressive strength around 28 MPa.

5. RESULTS

In this study, Selcuk and Yenice districts of City of Nigde, Turkey are investigated in order to apply preliminary seismic microzonation and to assess seismic vulnerability of the current building stock. Selcuk and Yenice districts are two of the most residential districts of the city. 919 buildings are counted and classified according to their number of stories, locations, soil properties and structural characteristics. Soil samples from both of these districts are examined and preliminary results are obtained. In addition, seismicity of Nigde is briefly explained.

Initial findings from the presented study which is currently in progress refer to an increase in both the construction quality and building material quality for buildings which were built after 1999 Turkish earthquakes. Meanwhile, structural irregularities and discontinuities which may negatively affect the seismic behavior of structures are still being observed in some of the structures. Investigation results of seismic behavior of three buildings are provided. This study will be extended with further data regarding soil properties obtained from different parts of the City and inclusion of evaluation of buildings located at other districts of the City.

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