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Geotechnical examination of Ermenek District in the province of Karaman

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ABSTRACT

In recent years, as a result of the increasing interest in construction in our country, the demand for construction areas has also increased. Regarding the buildings we plan to build, we should examine whether the ground being the surface on which the structure will sit or be adjacent, can respond to us positively in terms of strength. As a result, if the soil strength is poor, either the ground must be improved or the property of the structure to be built must be changed. Hence, the building and the ground cannot be considered separately. They need to be considered as a whole. In our country, there are not many geotechnical studies which deal with the structure-soil relationship and explain the ground infrastructure of the region, especially in settlements with medium and small populations. Due to this reason, in this study, it is aimed to address the Ermenek district of Karaman from this respect and to eliminate this deficiency of the district. In accordance with this, ground structure of district, various ground survey reports and geophysical reports prepared in recent years were examined. Furthermore, structure class of building planned to be made on that parcel, as well as ground settlement area, number and height of floors, approximate building and foundation loads were calculated with respect to architectural aspects and static and dynamic loads that were formed were brought together and their suitability for the structure, amount of seating that may occur on the ground, and liquefaction situations were examined with respect to bearing capacity of ground. In this way, an infrastructure information bank was created with regards to geotechnical aspects of district.

Introduction

Natural disasters occur almost every year in our country and in different parts of the world. These disasters cause situations of loss of life and property. Earthquake, which is one of these disasters, is the most damaging ground movement. About 500,000 earthquakes occur annually in the world whereas 80% of these earthquakes are palpable, and nearly 100 of them are destructive. Unfortunately, earthquakes in urban areas cause physical and socio-economic losses. As an example of this, we are a country that experienced earthquakes in 1999 in Gölcük and Düzce, in 2003 in Bingöl, in 2011 in Van, and in 2020 in Elazığ and İzmir. As a result of these earthquakes, tens of thousands of our citizens lost their lives and were injured, and thousands of families were left homeless and unemployed.

Besides, incidents such as “Building-Soil Incompatibility”, that is, the construction of a structure on a ground with unsuitable strength for the structure, are often confronted with. This event does not only cause settlement or swelling in the buildings built over time, but also damages and even collapses the structures situated on the adjacent parcels.

Even though it is not possible to prevent the occurrence of earthquakes or to determine when they will occur with today's technology, it is possible to minimize the damage they will cause, and it is possible to prevent the dangers and damages that will occur by improving the soils with unsuitable strength and by choosing the appropriate construction/manufacturing method.

Ermenek District of Karaman Province, which has been examined regarding this issue, is one of the safest regions in our country in terms of seismicity. No large earthquakes occurred in the mentioned region. Considering the earthquake events of the last 15 years in the region, it is seen that the largest earthquake had a Magnitude of 3. Maybe due to these reasons, no geotechnical studies and investigations covering Ermenek and its surroundings that can be taken as a reference in general terms have been carried out. However, the recent major construction attack in the district, in addition to this, the Ermenek Dam with a crest height of 274 meters that is built on the Ermenek Stream, which passes through the south of the district and feeds the Göksu River, the presence of many regulators on the same brook and the construction of Tekeçatı Regulator on Tekeçatı Stream, which passes through the north of the district constitute the evidence that more interest must be shown on the region with regards to geotechnical aspects.

In this study, geological and geophysical reports previously prepared in province of Ermenek were evaluated, and structures built or planned to be built as per zoning plan were evaluated and required numerical values were calculated and accordingly, bearing capacity of ground, amount of floor seating, liquefaction situation were examined parcel by parcel with certain geotechnical programs. By means of this study, ground status of province has been revealed.

To give examples of some studies similar to this study, we can mention about study conducted by [1] in the Sakarya region, study conducted by [2] in Bursa province and its surroundings, study conducted by [3] in the Çayırhan District of Ankara, study conducted by [4] around Batman Province, study conducted by [5] in Osmaniye, study conducted by [6] in Kaynaşlı District, study conducted by [7] in the northeastern region of Şanlıurfa in 2008, study conducted by [8] in the south of the Bosphorus and the Golden Horn region in 1992, and study conducted in Denizli city center by [9].

As a result of this study, it is aimed to examine whether the structures suitable for the ground are built in this district, where almost no geotechnical studies have been carried out, whether any soil Improvement is needed for the ground of the structures to be built, and to shed light on the future studies.

Material and Method

If we would mention about the district being examined, Ermenek District is located in Karaman province and it is 67 kilometers southeast of Karaman. There is Mut district in the east of the district, Anamur in the south and Balkusan Village in the west, 15.75 km north of the Antalya provincial border. While the land structure of the district varies from north to south, that is, from Tekeçatı Region to Ermenek Dam, between an altitude of 1400 and 700, there is no great difference in elevation from east to west. Geologically, the region is a structure that generally contains limestone, clay, marl, fossiliferous sandstone and even coal. At a distance of 40 km from the district, there are many small faults that are distributed within a zone of 17 km length and 3 km width. This region is named as Mut Fault Zone. The researchers state that the fault is strike-slip with vertical component and possibly alive due to the river valleys and parallel ridges following the faults.

The study was started by obtaining the Geological and Geophysical Report, which was prepared as a result of the Field and Laboratory Test results obtained from the Ermenek Municipality, from more than 40 parcels and more than 100 boreholes built by both state institutions and private companies, and by examining these reports in detail.

Experiments and results of the Geological Surveys on the land, the results of the laboratory experiments made on the samples taken, as well as the results obtained as a result of the Geophysical Surveys and seismic refraction tests carried out on the same plot, were presented in plots. Then, all data were transferred to a Geotechnical Analysis program known as Geotransportation, again separately. In the meantime, the building classes, number of floors, residence areas, estimated foundation models, foundation depths, Groundwater Levels and total building load of the structures built or planned to be built on the parcels were calculated and processed in the same analysis program. As seen below, 5 parcels selected from different regions and neighborhoods are presented in Table 1.

Geotechnical analysis results

After all the data were entered into the Geotransport Soil Analysis Program separately, the Controls for the Transport Forces, Settlement Amounts and Soil Liquefaction of all processed parcels were made as a result. Here again, the results of the 5 plots I mentioned above are presented in Table 2.

Conclusion and Suggestions

The soil class determined in the district is mainly ZC class and has a structure mainly composed of limestones. In the analysis made in the examined parcels, it was seen that it has sufficient and suitable properties in terms of Bearing Power, Elastic and Consolidated Settlement Amounts and Liquefaction potential. It has been concluded that there is no need for any ground improvement for these structures planned to be built on the said parcels. In addition, the results of these geotechnical analyzes in higher building loads and multi-storey structures, can be examined and even examination can be made about how far the endpoints can be.

Table 1. Data relating with 5 parcels presented as example among examined parcels

Quarter Plot Parcel	Underground Water Level Df Form type	Vp speed Vs speed Vs30 and To	Ss-Fs-SDS S1-F1-SD1 PGA-PGV	TA-TB-TL TAD-TBD-TLD	Building details Foundation form Building weight
Seyran	None	483-2495	0,280-1,30-0,364	0,063-0,313-6,000	BKS=1 I=1,5
112	-2,00m	274-809	0,076-1,50-0,114	0,021-0,104-3,000	DTS=3a BYS=6
33	Raft	564-0,24	0,127-6,142		1097m² 104586 kN
Taşbaşı	None	316-1172	0,283-1,30-0,368	0,062-0,310-6,000	BKS=1 I=1,5
761	-5,30m	192-723	0,076-1,50-0,114	0,021-0,103-3,000	DTS=3a BYS=6
5	Raft	434-0,30	0,128-6,179		2950m² 103826 kN
Meydan	None	719-1190	0,286-1,30-0,372	0,062-0,311-6,000	BKS=3 I=1
460	-2,00m	440-568	0,077-1,50-0,116	0,021-0,104-3,000	DTS=3a BYS=5
36	Continuous	558-0,38	0,130-6,223		175m² 34030 kN
Güllük	None	556-1228	0,282-1,30-0,367	0,062-0,311-6,000	BKS=3 I=1
701	-3,50m	223-558	0,076-1,50-0,114	0,021-0,104-3,000	DTS=3a BYS=6
1	Continuous	401-0,38	0,128-6,173		1580m² 32282 kN
Değirmenlik	-3,00m	616-884	0,282-1,57-0,444	0,082-0,411-6,000	BKS=3 I=1
174	-2,00m	223-354	0,076-2,40-0,182	0,027-0,137-3,000	DTS=3a BYS=5
36	Raft	334-0,59	0,128-6,167		280m² 29049 kN

Table 2. Geotechnical Analysis Results of examined parcels

Quarter Plot-Parcel	**Bearing capacity analysis as per TBDY**	**Elastic fit amount Consolidated fit amount.**	**Liquefaction Analysis**
Seyran	238,578>166	E.F.A. s=0,010m Suitable	Layer 1: 4,49>1,1 Suitable
112-33	Sufficient	C.F.A. s=0,088m Suitable	Layer 2: 3,177>1,1 Suitable
Taşbaşı	1252,286>200	E.F.A. s=0,063m Suitable	Layer 1: 0,335<1,1 Suitable
761-5	Sufficient	C.F.A. s=0,027m Suitable	(Layer is above UWL)
			Layer 2: 2,799>1,1 Suitable
Meydan	2005,714>184	E.F.A. s=0,000m Suitable	Layer 1: 0,331<1,1 Suitable
460-36	Sufficient	C.F.A. s=0,007m Suitable	(Layer is above UWL)
			Layer 2: 2,769>1,1 Suitable
Güllük	788,67>302	E.F.A. s=0,000m Suitable	Layer 1: 4,459>1,1 Suitable
701-1	Sufficient	C.F.A. s=0,001m Suitable	Layer 2: 4,49>1,1 Suitable
Değirmenlik	2331,429>151	E.F.A. s=0,003m Suitable	Layer 1: 0,278<1,1 Suitable
174-36	Sufficient	C.F.A. s=0,004m Suitable	(Layer is above UWL)
			Layer 2: 1,441>1,1 Suitable

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