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# Analysis of Engineering Geology Condition for Qingdao Tongan Area

D. W. Lv, W. F. Ning, B. B. Liu, H. Y. Liu, and J. P. Liang

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## Abstract

As economies develop dramatically fast, more and more engineering projects are being constructed near Qingdao Tongan areas. This issue is written to harmonize engineering activities with geo-environment and avoid occurrence of geological hazards and damages of environment, as well as to provide reliable fundamental data for the exploitation and utilization of Qingdao Tongan areas. This paper is supported by the engineering geological condition of the Qingdao Tongan. Many methods are applied to gain detailed original data, including engineering geological drilling, in situ tests in seabed soil, side sonar measurement, taking superficial soil samples and column soil samples. Many years' engineering reconnaissance data of Qingdao Tongan and research results are also combined in this paper. We study many aspects of this area, such as, regional geology, topography and geomorphy, lithostratigraphy, geological structure, hydrogeologic condition, soil mechanical characteristics and existing major engineering geo-environmental problems. On the basis of the study, we find out the types, regularities distribution, development tendency, hazard level of bad geological process in the study area, and then, offer some advices to manage it. Find out the types, depth, distribution, engineering properties of rock and soil bed in this study area and analyse and evaluate the stability, homogeneity and bearing capacity of ground base. Evaluate the seismic effects of this area. According to characteristics of the proposed building and site engineering geological conditions, select the appropriate foundation bearing stratum, and made a economic, reasonable suggestion.

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## Keywords

Engineering geology • Geological structure • Layer

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## 1 Introduction

Tongan region is significant to the development of Qingdao economic zone, in this region, the construction of engineering structure is urgent to realize the engineering geological environment exactly, so realizing the geological environment and human engineering activities of mutual coordination, avoiding geological disaster.

## 2 Geological Condition Analysis

### 2.1 Lithology

Qingdao region assise is consist of Laiyang Gr. Qingshan Gr. Wangshi Gr. and Quaternary strata (Jia & Tan 1995). Laiyang Gr. is not integrated above Jurassic system, integrated in a set of fluvialite facies and lacustrine facies clasolite which under the Baikui system Qingshan Gr. Lithology varies considerably from place to place. Qingshan Gr. is located in Laiyang Gr., Wangshi Gr. or a set of volcanic series which under the Daqun Gr. The development of this group varies from place to place, Ludong develops more stratigraphic regionalizations, The mafic volcanic rock and acid volcanic alternate with appear. Wangshi Gr. which located above the Kq and Dasheng Gr. and under a set of red tertiary clasolite mainly distribute in Ludong stratigraphic regionalizations, Luxi develops less stratigraphic regionalizations, only in the local area in the distribution. Quaternary system develops along the river, the river and jiaozhou bay on both sides and the surrounding. By the features and the influence of different subsidence of Quaternary, thickness changes greatly, according to the present data, its thickness is commonly 0–30 m.

### 2.2 Geological Structure

According to the regional geological data (Jia & Tan 1995), proposed site which lies in Qingdao–Haiyang fault block heave Grade V tectonic element, since the upper Proterozoic has been in long-term, slow, steady rise the uplift state, in the Mesozoic tectonic activity strongly, with massive invasion of magmatic rocks, to form stable granite batholith. In the long-term weathering, erosion, accumulation and fluvial deposits, granite batholith forms different thickness, and the larger slope rock weathering bed and covered with a certain thickness of the Quaternary overburden.

Survey area is located among the Pishikou–Fushansuo fracture and Wanggezhuang–Shandongtou fracture.

## 3 The Geotechnical Engineering Evaluation

The proposed construction project covers an area of 5600.0 m<sup>2</sup>, total construction area 26040 m, floor area ration 20.6 %. There are 24 floors in proposed 1#building, two floors garage on the bottom of this building, project  $\pm 0.00 = 44.60$  m, underground garage bottom elevation is 33.00 m, embedded depth of foundation is about 11.6 m, this project is used to box shear structure, single footing,

building specific loads and the deformation requirement is unknown; There are 21 floors in proposed 2, 3#building, two floors garage on the bottom of this building project  $\pm 0.00 = 44.60$  m, underground garage bottom elevation is 33.00 m, embedded depth Of foundation is about 13.1 m, the actual completion of the workload: exploratory hole: 25, geologic section: 13, Fig. 1.

### 3.1 Aquifers with Engineering Analysis and Evaluation

According to field drilling data, Within the scope of proposed site survey depth, the main geotechnical layer are Quaternary plain filling and strong, middle weathering bedrock, aquifers with engineering analysis and evaluation as follow :

#### 1. Quaternary

The first level miscellaneous fill soil backfill in the short time, belong to consolidation of soil, the thickness of the stratum is larger, the structure is loose, uniformity is poor, low intensity, and permeable layer is strong. After the foundation pit excavation the most is excavated. Combined with experience in comprehensive analysis, Natural severe  $\gamma$  take 18.0 KN/m<sup>3</sup>, stick together force  $c$  take 0.0 kPa, be like internal friction Angle  $\varphi$  take 20 °C.

#### 2. Bed rock

The 16th strong weathered granite: by the strong weathering or structure effect, rock broken—very broken, joints and fissures development, rock loose, the mineral links between power is low, close-grained loose medium body, with the compressibility and weak rock foundation engineering characteristics, treat water to soften, is not stable grade V of rock mass, the slope rock mass easy to have the local instability collapse when excavating. On the basis of “Standard for classification of engineering rock masses” GB 50218—94 of relevant provisions, combining with the drilling situation, Qualitative discrimination: rock belong to soft rock, very broken-broken, the basic quality level of the rock is grade V.

Combined with experience in comprehensive analysis, the natural severe  $\gamma$  take 23.0 KN/m<sup>3</sup>, stick together force  $c$  take 0.0 kPa, equivalent internal friction Angle  $\varphi$  take 45 degrees, the characteristic value of subgrade bearing capacity  $f_{ak}$  take 800 kPa, deformation modulus  $E_0$  take 45.0 MPa.

The 17th weathered granite: This layer is difficult to drill, the most of the core are fragments form, the exposing period of rock mass index averaged 0.68, BQ for 397.97. This layer of rock mass elasto-plastic material with characteristics, structure surface mainly for structural joints, followed by weathering fracture, joint plane micro opened. Rock have high bearing capacity, good stability, which is

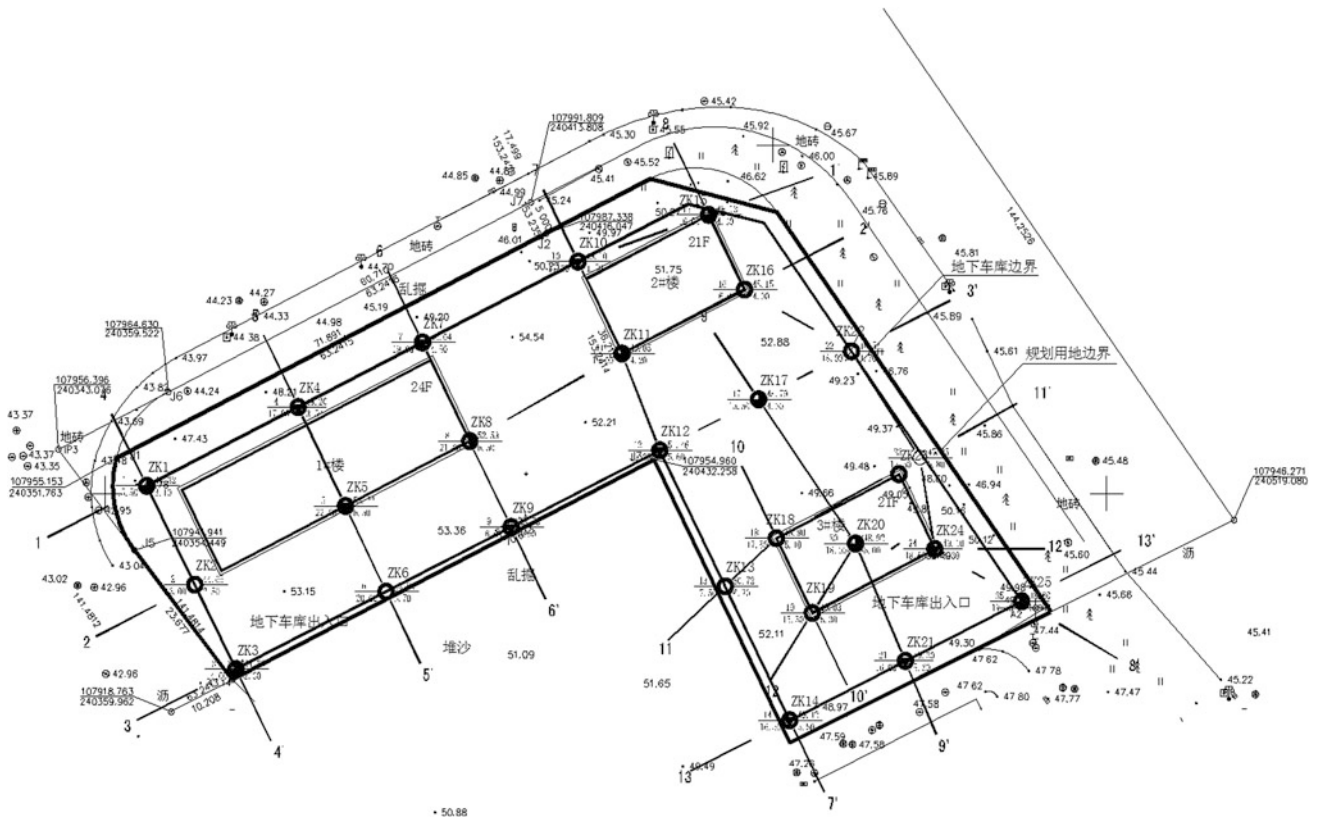


Fig. 1 Site workload schemes

good natural foundation and good building foundation next lie layer, but during the foundation pit excavation rock mass easy collapse or caving along the joints surfaces, which belong to III level of rock mass. On the basis of Tables 3 and 4 in chapter “Large Deformation Analysis for Costal Geo-Disasters Using Continuum and Discrete Modeling” shows statistical result and “Standard for classification of engineering rockmasses” GB 50218-94 of relevant provisions, calculation and analysis and judgement: the rock is more stronger, rock mass is more complete, the basic quality level of rock mass is III.

Combined with experience in comprehensive analysis, the natural severe  $\gamma$  take  $25.0 \text{ KN/m}^3$ , stick together force  $c$  take  $0.0 \text{ kPa}$ , equivalent internal friction Angle  $\varphi$  take  $55$  degrees, characteristic value of subgrade bearing capacity  $f_{ak}$  take  $2000 \text{ kPa}$ , elastic modulus  $E$  take  $5 \times 10^3 \text{ MPa}$ .

The 18th low weathered granite: This layer of diamond drilling tools must be adopted to drilling, most of cores are cylindrical, the period of exposing rock mass integrity index averaged  $0.74 \text{ kV}$ , BQ for  $501.23$ . Joints development—agensis, Joint surface closed, breakthrough sex of fracture is poorer, Core is short column shape, groundwater activities weak. The whole strength of the rock mass is high, good

integrity, present elastic material characteristic, in certain vertical load can be regarded as incompressible body, the stability of rock mass is good natural foundation and foundation of the lie. On the basis of Tables 3 and 5 in chapter “Large Deformation Analysis for Costal Geo-Disasters Using Continuum and Discrete Modeling” shows statistical result and “Standard for classification of engineering rock masses” GB 50218-94 of relevant provisions, calculation and analysis and judgement: the rock is more stronger, rock mass is more complete, the basic quality level of rock mass is II.

Combined with experience in comprehensive analysis, the natural severe  $\gamma$  take  $26.7 \text{ KN/m}^3$ , stick together force  $c$  take  $0.0 \text{ kPa}$ , equivalent internal friction Angle  $\varphi$  take  $65$  degrees, characteristic value of subgrade bearing capacity  $f_{ak}$  take  $5000$ , elastic modulus  $E$  take  $25 \times 10^3 \text{ MPa}$ .

3. Each layer (body) geotechnical engineering property index

According to the above the layer of geotechnical engineering evaluation, concluding the engineering characteristics above data induction together, drawing up the engineering properties list. Then each layer (body) geotechnical engineering property index suggested value see Table 1 (the geotechnical engineering parameters of list).

**Table 1** The geotechnical engineering parameters of the list

Tiernumber	Solum	Base of bed level (m)		Thick degree(m)		$q_{sik}$ (kPa)	Severe $\gamma$ (kN/m <sup>3</sup> )	Cohesion C (kPa)	Internal friction angle $\varphi$	Modulus (MPa)	Load bearing $f_{ak}$ (kPa)
		Min	Max	Min	Max						
①	Plain fill	43.3	49.3	0.4	4.9	20	18.0	0.0	20.0	–	–
(16)	High weathering granite	37.8	45.5	3.7	7.4	150	23.0	0.0	45.0	45/E0	800
(17)	Middle weathering granite	32.7	42.8	1.8	5.4	250	25.0	0.0	55.0	$5 \times 10^3/E$	2000
(18)	Low weathering granite	Not penetrate				550	26.7	0.0	65.0	$25 \times 10^3/E$	5000

$f_{ak}$  characteristic value of subgrade bearing capacity,  $E_0$  modulus of deformation,  $E$  modulus of elasticity,  $q_{sik}$  soil and the anchor solid limit friction standard values,  $\gamma$  natural severe,  $C$  cohesion,  $\varphi$  internal friction angle

## 4 Conclusion

1. In the proposed site, the geomorphy is simple and the stratal configuration is clear. Moreover, the regional tectonic background is steady so it's not easy to develop bad geological process.
2. In Qingdao, the seismic fortification intensity is 6 and this area is in the design earthquake group 2. The buildingyard category of the proposed site is I, and its eigen period is 0.30 s, which means that it is seismic favorable area.
3. There are no hidden riverway, channel, grave, air-raided shelter or boulder found in the reconnaissance process of the site.
4. The underground water of this area can erode the concrete structure. To reinforcement in the reinforced

concrete structures, it has no effect in long-term water environment and slight effect in alternating wet and dry environment (Cheng & Hao 2002; Dong 2009). Furthermore, there's fine-grained granite dike in the proposed site.

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