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Engineering Geologic Mapping Around The Newly Built Higher Education Complex In Jatinangor, West Java, Indonesia

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ABSTRACT

The government of Indonesia had developed new campuses for several higher education institutions in the mountainous Jatinangor area, West Java, Indonesia. Major earthquake in this region due to active faulting was recorded about 2000 years ago with magnitude of 6.77 Mw scale, which has potential to have major earthquake in the future. Several infrastructures of facilities and high rise buildings are newly built, including apartments, malls, highway, etc. This means to support the life of more than 75,000 students and local populations. This research is aimed to uncover the engineering geological condition of this area as a basis to analyse the potential of disaster occurrence in the future.

The methodology of engineering geologic mapping consists of morphometric analyses using geomorphic indices, disturbed and undisturbed soil samplings, shallow trenching and laboratory analyses of phisical and mechanical soil properties.

Result of this study shows that this region is configured by subdendritic to parallel drainage pattern. The surface materials composed of mainly fine size and high plasticity soils such as clay (CH), silt/mud (MH) and organic (OH) types based on the USCS classification. These types of soil are weathering product of Quaternary volcanic materials, which may contain swelling & shrinking type of clay minerals. This can cause failures of foundation of buildings and slope instability due to excessive pore water pressure in the rainy season combined with earthquake event. Earthquake amplification values belong to middle to very high zone, which is potential to become disaster in the future when a major earthquake occur combined with heavy rainfall.

***Keywords**: Engineering geology, earthquake, soil classification, Jatinangor*

I. INTRODUCTION

Background

The government of Indonesia had developed new campuses for several higher education institutions in the mountainous Jatinangor area, West Java, Indonesia. The western part of Java Island is part of active margin of Eurasian Continental Plate due to its geological location closed to subduction zone beneath the Indian Ocean. This region is categorized as active tectonic area and resulted in high occurrence of active faults. Soehaimi (2011) explained that within this area there are several major active faults in E-W and N-S directions.

Bandung highland is the capital of West Java Province, inhabited by more than 3 million people with a number of modern infrastructures such as skyscrappers, toll road, etc. As part of regional development, the government has relocated several higher education institutions from central Bandung City to Jatinangor area of Sumedang Regency within about 21 km distance to the east.

Jatinangor used to be a rural area located in Cikeruh District of Sumedang Regency. Decision to develop this area into an education city had been started since 1980s suitable with the development program of greater Bandung. This decision had change the status of this area from rural type dominated by agricukture and

plantation into urban type dominated by infrastructures and increasing population. (Anonymous, 2009)

Major physical development was seen from the end of 1980s to 1990s by widening the activities related to trading, industry, government and education. 4 major campuses of higher education institutions were built and relocated in this area, namely IKOPIN, UNPAD, STPDN and UNWIM (which then to be acquired by ITB).

Since then, the physical environment of Jatinangor is drastically change and undergoing quality degradation. This might be due to incomprehensive plan of area development from the beginning. This condition can be seen from irregularity and highly dense of residence and building development, traffic jam and garbage problems. Unsuitable land development had caused Jatinangor area to become uncomfortable to reside and vulnerable to geological hazards such as landslide, flood, earthquake, etc. (Anonymous, 2009).

Jatinangor as an education city currently has more than 100,000 inhabitants with only 26 km^2 wide. It has several skyscrapers served as apartment for students, shopping mall, supermarket, residential area as well as buildings of faculties and departments in the university premises. With the increasing population along with limited developable area it seems that geological resources including land resource in this area need to be managed well, to avoid any problems in the future. Land resource is classified as non-renewable therefore it is necessary to develop a good and manageable plan to support the space for living in the future.

1.2. Objective

Due to rapid development of Jatinangor area as explained above, this research is aimed to uncover the engineering geological condition of this area as a basis to analyse the potential of disaster occurrence in the future.

II. LITERATURE REVIEW

2.1. Geological Setting

Silitonga (2003) in his Bandung regional geological map reported that the study area is composed of undifferentiated Quaternary volcanic rock unit (Qyu). This young rock unit consists of tuffaceous sand, lapilli, lava, breccia and agglomerate, which was the product of Tangkubanparahu or Tampomas volcanoes nearby.

Geomorphologically the study area consists of hilly to mountainous landform, with medium to relatively steep slope. As part of southeastern toe of Manglayang Mountain, Jatinangor area is located on the NW-SE directions of elongated hills and valleys. Several buildings and skyscrapers (even up to 40 floors of apartment) are built on the top or toe of hills.

2.2. Active Fault

Based on the catalogue of destructive earthquake in Indonesia, Supartoyo and Surono (2008) mentioned that there was a destructive earthquake in Cihideung area of Lembang on July 11, 2003. It tremors was felt until the eastern part of Bandung. The epicenter was suspected on the Lembang Fault.

Syahbana *et al.* (2010) in their earthquake vulnerability map of West Java explained that Jatinangor and surrounding area belongs to highly vulnerable zone. There had been major earthquake epicentered in Tanjungsari area in 1972 and Cicalengka area in 2000. The study area is also closed to the well-known Lembang Fault on its eastern edge near Manglayang Mt. Several surface lineaments are also easily recognized trending NW-SE, which probably representing faults in this area. These lineaments are thought as part of Lembang Fault.

Yulianto (2011) based on his research on sagpond sediment and trenching analysis in Lembang explained that major earthquake in the north Bandung region due to active faulting was recorded since 2000 years ago with predicted maximum magnitude of 6.77 Mw scale. There had

been recorded 4 events of major earthquake, which their hypocenter taking place along the fault line. It is concluded that Lembang Fault is categorized as active fault and has potential to have major earthquake in the future.

Sulaeman and Hidayati (2011) explained that on July 2, 2011 at 05.45 AM there was an earthquake on the eastern part of Bandung City with magnitude of 3.4 Richter scale and intensity II-III of MMI scale. Based on data from 6 seismic stations run by the Meteorological Agency (BMKG), it was concluded that the epicenter was located at coordinate 107.72° E and 6.84°S at 6 km depth. This epicenter was measured about 12.5 km east of Lembang and about 16 km northeast of Bandung. This location is on the track of Lembang Fault line and shows focal mechanism of normal faulting.

Eventhough the recent earthquakes (events of 1972, 2000, 2003, 2011) affecting the study area are not categorized as major and destructive but there is potential to happen again in the future due to its relation with faulting mechanism of Lembang Fault. In the study area, several infrastructures of facilities and high rise buildings are newly built, including apartments, malls, highway, etc. This means to support the life of more than 100,000 students and local populations. It is deeply concern that when an earthquake happens in the future, there could be more destructed buildings or facilities are reported due to physical rapid development.

Syahbana *et al.* (2010) explained that the study area, which is in the high vulnerable earthquake zone, has potential to undergo soil cracks, liquefaction, landslide on steep slope, subsidence, *etc.*, when an earthquake happens. Theoritically these geological hazards are possible to occur on certain surface deposit. Jatinangor and surrounding area is covered by semi-consolidated young volcanic product, alluvium, loose coarse soils of volcanic weathered. These materials are predicted to amplify the effect of tremor when an earthquake occur. Therefore it could be seen that geohazards potential in the study area is classified as high.

III. METHODOLOGY

In this study, methodology of engineering geologic mapping is carried based on Dearman (1991). It will map the surface materials mainly as weathering product of the young volcanic rocks appeared on the outcrops. Field description and shallow trenching were conducted to unearth soil horison. Disturbed as well as undisturbed soil samplings sampling were carried out for physical and mechanical analysis of soils in the laboratory. Geomorphological analysis was carried out to map the morphometry of rivers and their tributaries in the study area. Drainage pattern analysis is used to approach the indication of structural geology.

Secondary data and results from previous researchers were utilized to analyze the distribution of earthquake epicenter around the study area. These data, mainly from USGS and Geological Agency of Indonesia (Center for Volacnology and Geological Hazard Mitigation, CVGHM), were used as basis for early disaster planning to implement mitigation effort in the study area. It is necessary to implement this effort in order to avoid major destruction and large victims when certain disaster happens in the future.

IV. RESULT AND DISCUSSION

Result of this study shows that this region is spatially located on the south - southeastern flank of Manglayang Mountain, which is closed to the eastern end of Lembang Fault (see Figure 1). 3D configuration of the study area shows elongated hills and valleys with altitude from 700 to 1000 masl to the north (see Figure 2).

Geomorphologically the study area is configured by subdendritic to parallel drainage pattern, especially from Cileles River and its tributaries. The occurrence of parallel drainage pattern combined with several surface lineaments indicate the possibility of faulting or joints. Direction of lineaments and river segments is

generally within N-S to NW-SE (see Figure 3). It is necessary to carry out geophysical measurement to analyse subsurface condition, especially to trace the occurrence of fault that possibly relate to the active Lembang Fault on the north of study area.

The surface materials composed of mainly fine size and high plasticity soils such as clay (CH), silt/mud (MH) and organic (OH) types based on the USCS classification. There are also sand soils ywith medium to poor graded size (SM-SP). These types of soil are weathering product of Quaternary volcanic materials, which may contain swelling & shrinking type of clay minerals. This content of "problem clay minerals" could impact to the stability of land (see Figure 4).

The combination of clayey and sandy soils can cause failures of foundation of buildings and slope instability due to excessive pore water pressure in the rainy season combined with earthquake event. According to Syahbana *et al.* (2010) earthquake amplification values of Jatinangor area belong to middle to very high zone, which is potential to become disaster in the future when a major earthquake.

Due to the explanation above, it is understandable that the physical and mechanical conditions of soils as weathered materials from young volcanic product in the study area bear critical condition when earthquake happens. The development of high rise building without proper analysis of foundation could impact to its failure followed by catastrophic situation because of amplification of tremor and other geological hazards. More over when it happens in the heavy rainfall, which is common in the rainy season.

Mitigation could also be carried out to communities in terms of preparedness and disaster awareness (Muslim *et al.*, 2015). This low cost effort seems to be yet conducted in the study area, despite rapid growth of population and infrastructure development in the study area.

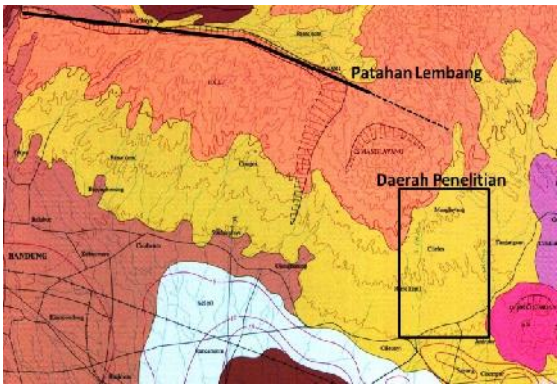

Figure 1. Location of the study area and its relationship to Lembang Fault.

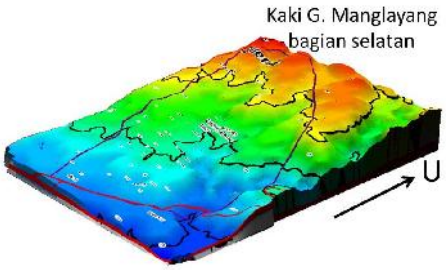

Figure 2. 3D configuration of morphology in the south flank of Manglayang Mt.

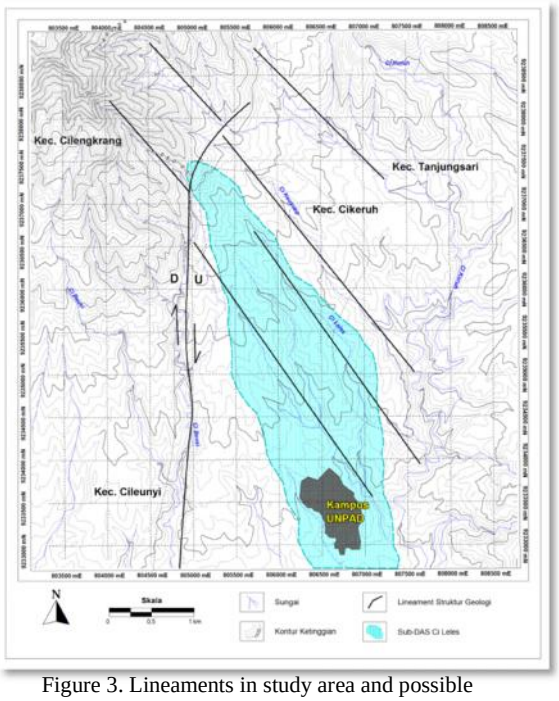

Figure 3. Lineaments in study area and possible occurrence of fault.

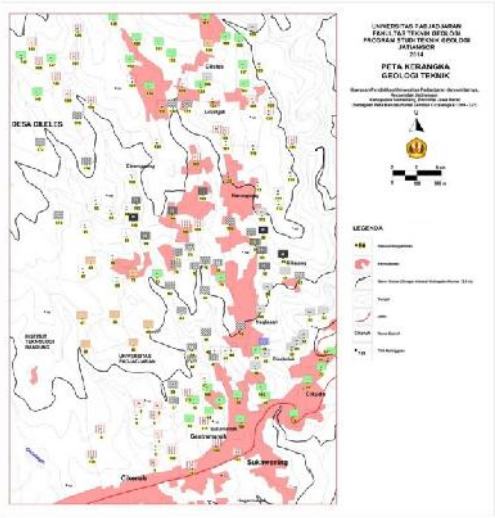

Figure 4. Skeletal engineering geologic map and sampling locations in Jatinangor

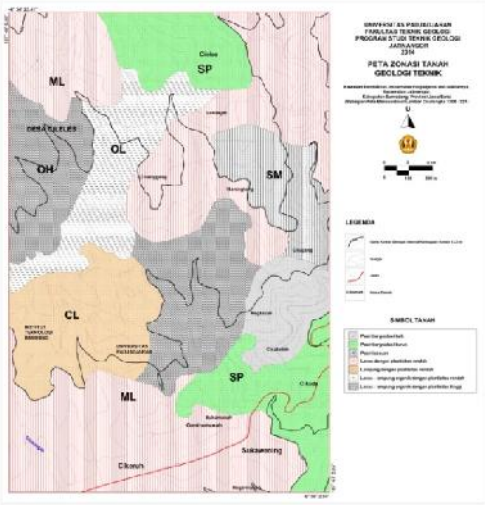

Figure 5. Engineering geologic map of the study area

V. CONCLUSION

From this study, it can be concluded that proper investigation of soil behavior for the construction of foundation is necessary. Engineering geological properties of soils and Quaternary volcanic rocks are the main supporting materials for any infrastructures in the study area. They have certain mineral contents that could behave improperly when a major earthquake happens combined with heavy rainfall.

Low cost mitigation effort such as disaster awareness education and preparedness for the communities are necessary to avoid major disaster in the future. This is in line with the eco-campus program of the Universitas Padjadjaran.

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