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Tugas	: Sebagai Pemakalah dalam International Conference on Landslides and Slope Stability - SLOPE 2019
Waktu	: 26 September 2019 s.d 27 September 2019
Tempat	: Kartika Plaza Hotel - Bali

Harap melaksanakan tugas dengan sebaik-baiknya dan penuh tanggungjawab.

Semarang, 05 September 2019
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Bali - Indonesia, September 25 - 27, 2019

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Conference Chairman

Assoc. Prof. Hisham Mohamad
Conference Co-Chairman

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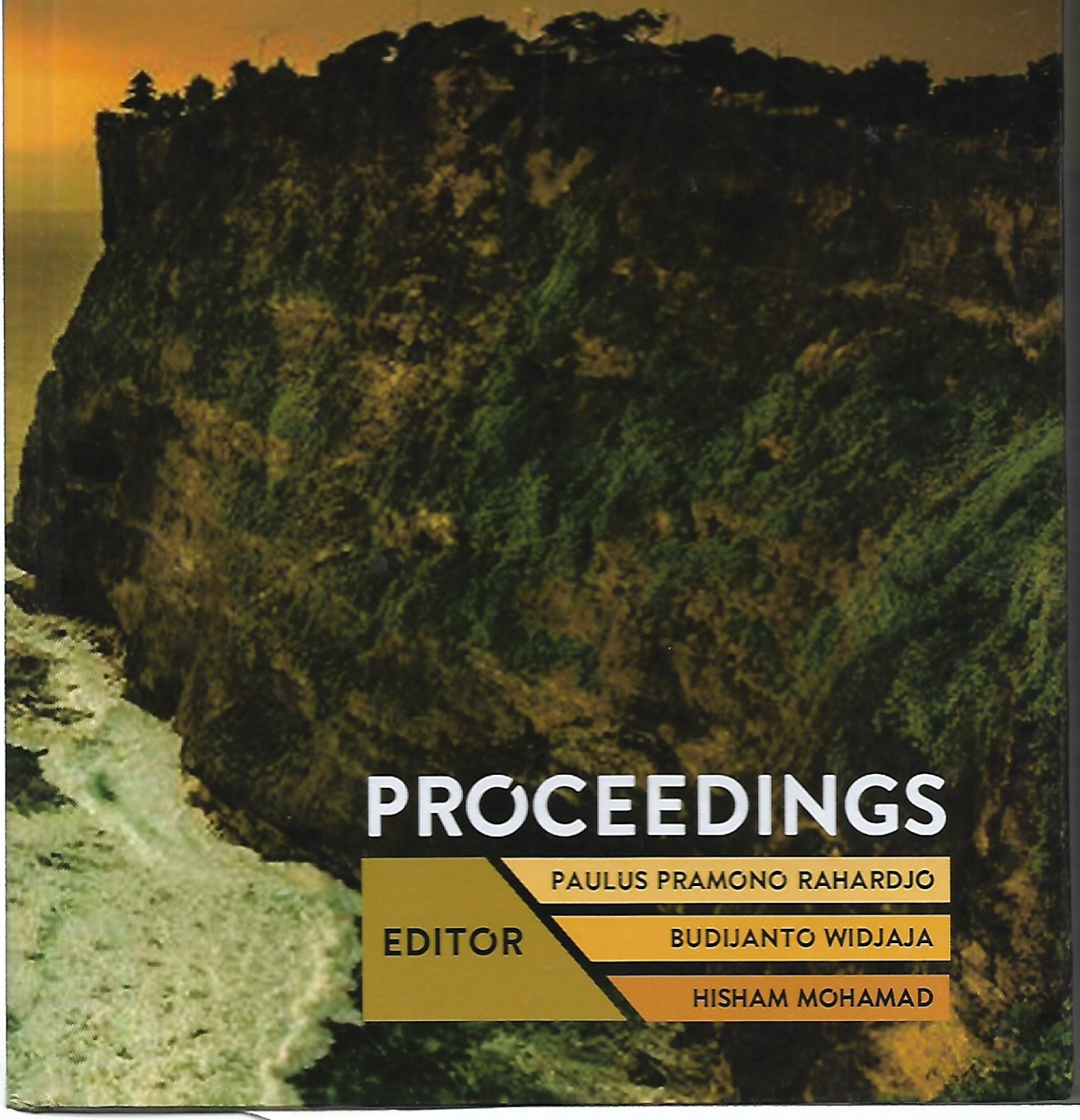

PROCEEDINGS

EDITOR

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CAUSED AND DIRECTION OF SOIL MOVEMENT GOMBEL LAMA – PAWIYATAN LUHUR STREET SEMARANG CENTRAL JAVA

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ABSTRACT: Soil movements that often occur in many sloping areas cause damage to the infrastructure around the location. Likewise, the soil movement that occurred in the area of Semarang Pawiyatan Luhur street has caused continuous damage to the main street and building facilities as campuses and houses. Joint research conducted by several Universities in Semarang showed that the main cause of soil movement occured in the region was caused by infiltration in the top area and erosion at south-west of kaligarang riverbanks. The direction of movement based on the results of the research shows that it leads to the Kaligarang river in Semarang. This is evidenced by the results of mapping the crack direction and the geological search that has been carried out. Some of the geo-electric test results as well as deep drill tests accompanied by SPT data show the depth of soil shift shows up to a depth of 60.00 meters from the existing land surface. Some proposed short-term and long-term countermeasures need to be done to minimize the soil movements that occur are regulation of sewerage, soil improvement using grouting, soldier piles, lowering the surface of steep road bodies, and setting the edge of the Kaligarang river flow.

Keywords: Soil movement, slope, infrastructure, facilities, lecturers, university, soil improvement

INTRODUCTION

The movement of land in Gombel Lama street to the Bendan Dhuwur area of Semarang is not new to the citizens of Semarang who live in the area. Many residents' houses were damaged by soil movements that occurred in this area. Infrastructure facilities in this area such as Gombel Lama street access and Pawiyatan Luhur street often damaged too. This is of course very disturbing the flow of traffic that passes through the road.

Especially in Bendan Dhuwur area at Pawiyatan Luhur street is a very dense current that is traversed by traffic that will lead towards Sampangan street - Gunungpati street or towards Jatingaleh street - Karangrejo street. Positioned as a rstreet dividing between the campus of Soegijapranata Catholic University and the campus of the University of Tujuh-Belas Agustus 1945 (UNTAG Semarang), soil movement has often caused the street to be repeatedly repaired but continues to suffer damage due to continuous ground movements.

The location of the research in this paper can be seen on the following map.

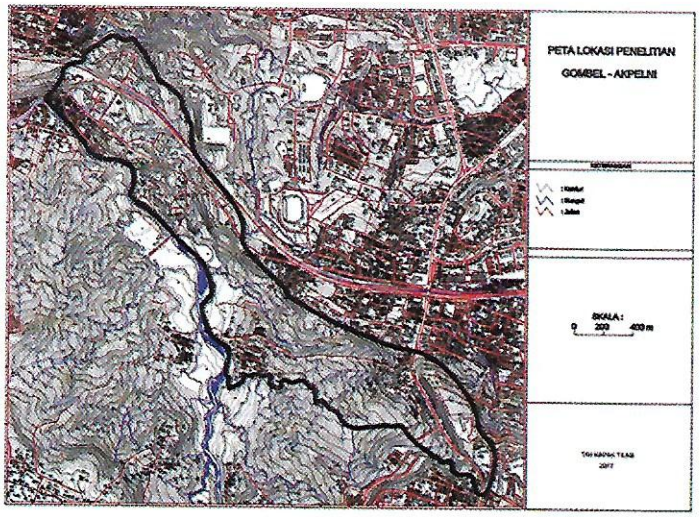

Figure 1. Research Location

LITERATURE REVIEW

Geological Conditions

To find out the caused of soil movement, first it is necessary to know the geological conditions in the location / region. Generally, the geological conditions in the research area are Gombel Lama street to Pawiyatan Luhur Semarang street based on general geological map conditions can be seen in the following figure.

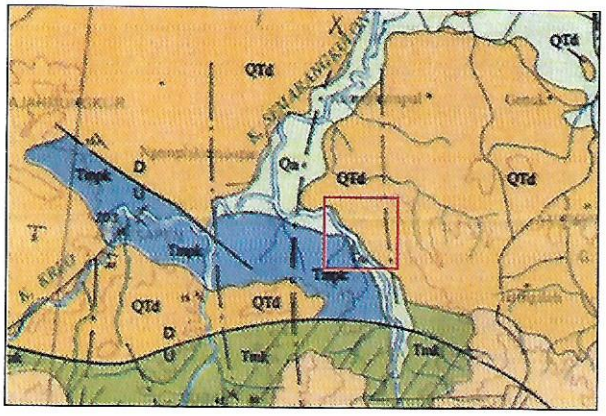

Figure 2. Gombel Lama - Bendan Dhuwur Regional Geological Map **(Source: RE. Thaden, et al. 1996)**

From the geological map, the red box is the location of the study. This location consisting of rocks and soil as a result of volcanic activity in the form of breccias and brown tuffs that are strong, rock layers or soil are located on the surface. The rotational landslide can be seen from minor scarp

Under the breccia and tuff there is a claystone (green colour at below) which was the result of deep sea deposit activities. In the river cliffs to the north of the research location, we can found some claystone in the form of green clay with soft to firm consistency and flowing landslides characteristics form.

Previous Researc

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a. **Geoelectric**
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Figure 3

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Figure 4a.
Citra Goog

Previous Research

The following are the results of previous studies that have been carried out.

a. **Geoelectric Test Results at Unika (2011)**

In 2011 before the construction of the Sport Hall of Unika Soegijapranata building, the Geoelectric test was first carried out. The geoelectric test results can be seen in the following figure.

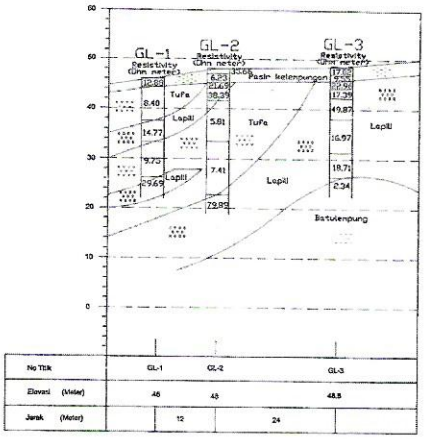


Figure 3a. Section A - A Geoelectric Test Results (Report 2011)

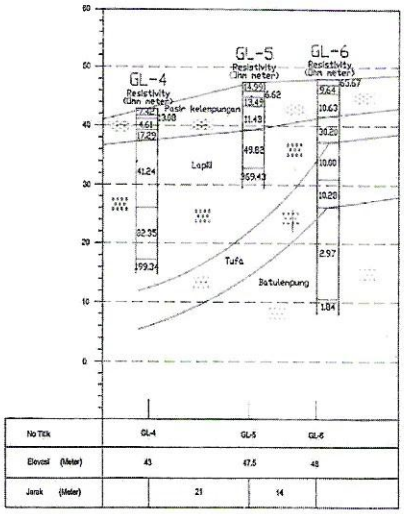


Figure 3b. Section B – B Geoelectric Test Results (Selimut Bumi Report 2011)

Based on the results of the geoelectric test section A – A and B - B can be seen the type of soil layer that is below the surface of the soil. One of the most important types of soil is known as the presence of clay stones in the geoelectric test results. Clay stones are very important because if there is a flow of water in this layer, it will cause the soil to slip.

b. Direction of Soil Movement at Pawiyatan Luhur Street

Based on the results of previous research conducted by a team from Gajahmada University (UGM, 2012), it is known that the direction of movement can be described as follows (Figure 4a and Figure 4b) from the fractures. It can be seen that the direction of the soil movement is southwest.

Figure 4a. Fracture of Bendan Dhuwur From Citra Google Earth Unika (UGM Report 2012)

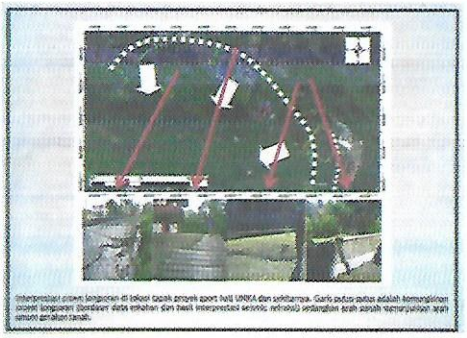


Figure 4b. Crown Interpretation of Land Movement (UGM Report 2012)

c. Field Condition

Following are some references of the conditions that are in the field after repaired are carried out especially in Sport Hall Building of Unika Soegijapranata Semarang which still continues to suffer damage due to land movements that occur in Bendan Dhuwur. There were 8 bored piles as soldier piles had been installed in 30 m depth and 60 cm diameter to increase the soil strength and to retain the soil movement (plaxis modelling). Unfortunately it can't stop the soil movement.

Monitoring from inclinometer's instrumentation showed the depth of landslide at 18.00 – 20.00 m from the ground surface (Figure 5a).

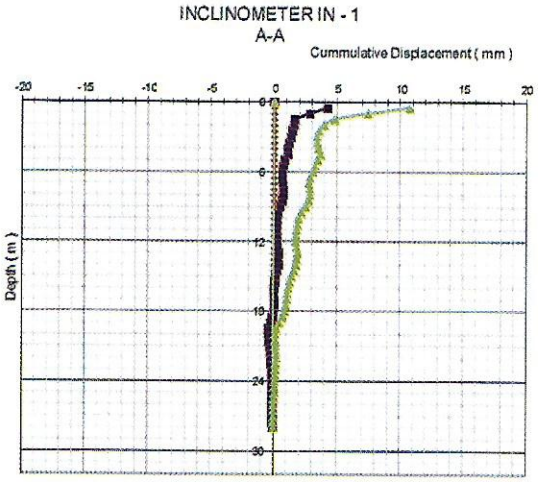


Figure 5a. Inclinometer reading results (source: GEC report, 2014)

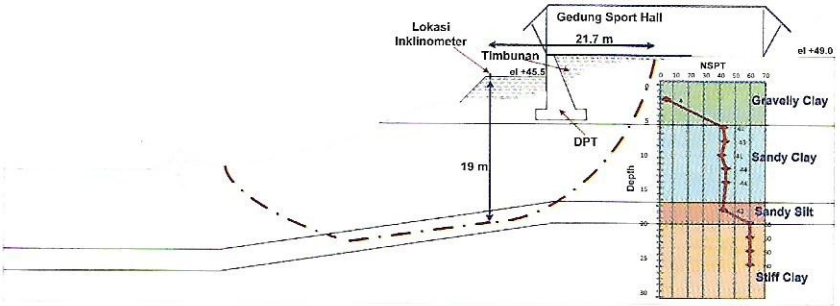


Figure 5b. Simulation of Landslide Conditions (source: GEC Report, 2014)

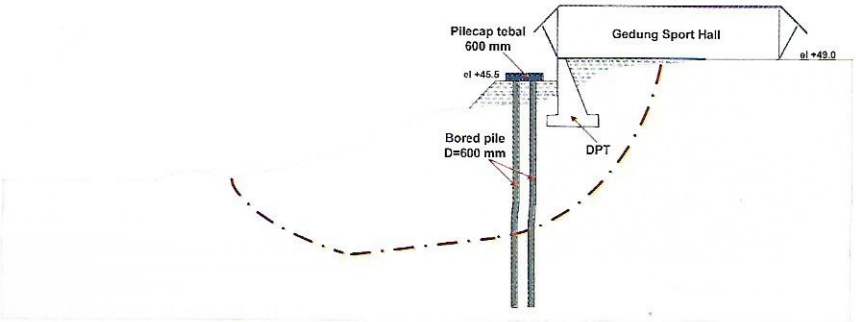
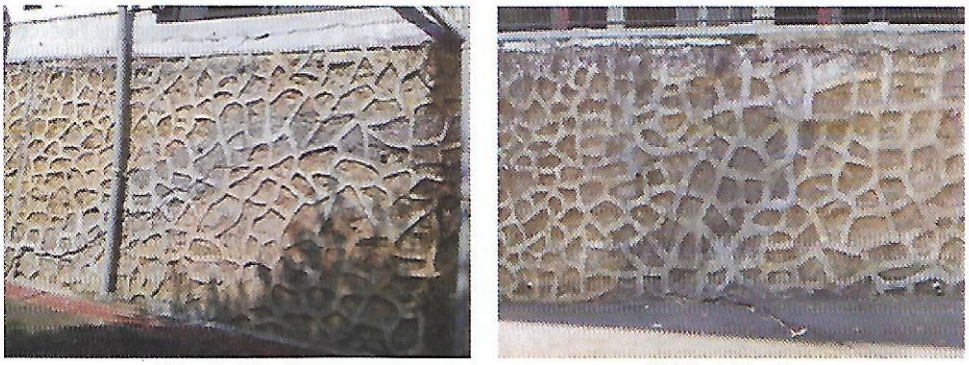


Figure 5c. Soldier Piles at Sport Hall Building (GEC Report, 2014)

Based on soil repairs using Soldier Pile in front of the retaining wall structures of Sport Hall Building, today the cracks at the retaining walls still occur. The condition of the crack can be seen in the following documentation.



(i) South Direction (ii) West Direction

Figure 5d. Cracks at The Retaining Wall

Figure 5e. Cracks at The Path of Sport Hall Building (West Direction)

Besides damage at Sport Hall building, many damages has occured in many houses and retaining walls at Pawiyatan Luhur street as figures below.

(i) Crack at the Wall of House (ii) Crack of the Retaining Wall

Figure 5g. Cracks On The Wall and The Retaining Wall at Pwiyatan Luhur Street

depth between 1.50 - 5.00 m is throught to be hollow due to granules eroded by underground water flow during the rainy season.

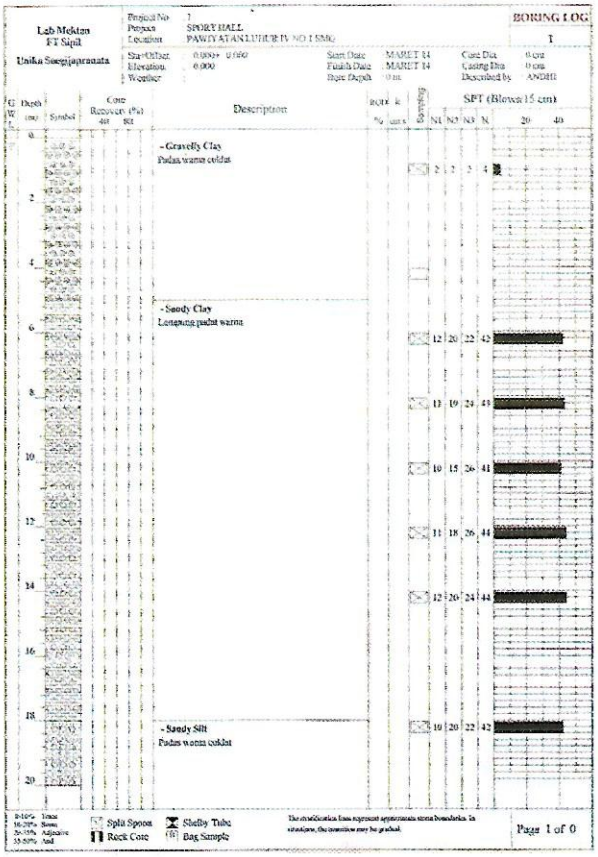


Figure 7. Sport Hall Borlog (Unika Soil Investigation Report, 2014)

The Direction of Soil Movement

The direction of ground movement is illustrated in the form of a ground movement map as shown in the following figure. The map can be illustrated based on the results of a field survey of the direction of land movement that occurs in the field. Measuring the direction of soil movement was carried out with the help of a geological compass tool to describe the deep-strike of cracks that appeared at the study site.

It can be seen on the map that the direction of soil movement occurs towards the same point, the riverbank of the Kaligarang river, that has been eroded by river current at southwest direction. This condition illustrates that if the Kaligarang riverbank continues to be eroded, the soil material around it will move towards the bank. Carrying soil material is thought to originate from the surrounding soil, including soil materials from Pawiyatan Luhur street. The flow of water from the rain carrying material also leads to the banks of the Kaligarang river.

There are some consequences:

a. cavities form due to eroded soil material
b. when heavy traffic passes the road, it can cause a decrease due to the hollow soil layer
c. if continuous handling is not carried out on the banks of the Kaligarang river, then the movement of land on Jl. This Pawiyanan Luhur in particular will not stop moving

ANALYSIS RESULT

Surface Mapping Results

Based on the mapping of the land surface that has been carried out, it can be known the types of soil in this area. The following picture shows the results of the research that has been done.

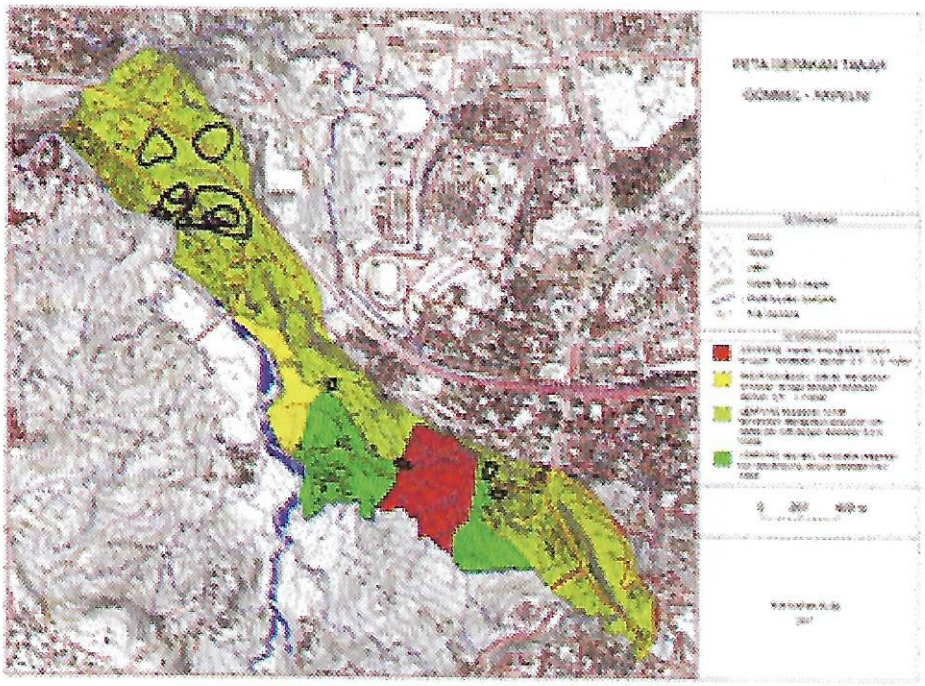


Figure 6. Map of Surface Soil Types (source: 2013)

Based on visual investigation results, the types of soil mapping as land surface maps are drawn from the map above. Generally, it can be described as follows:

a. Light green color that leads from Gombel Lama street to Pawiyatan Luhur street is a result of weathering of breccias and tuffs. The type of soil at this location is brownish-red clay
b. Dark green color shows the results of weathering of clay stones. The type of soil is gray clay
c. Yellow color is the sediment from the river. This type of soil is brown gravelly sand
d. The red color is a red clay fill.

Borlog Results (2013)

Besides geoelectric testing and visual mapping of soil types in the field, deep drilling and SPT have been carried out at the Soegijapranata Unika campus. Drilling is carried out closed to the Sport Hall building which has cracks due to the impact of ground movements. Borlog results can be seen in the following figure.

It can be seen that the soil investigation result from borlog are dominated by sandy clay and sandy silt soil types. The SPT number after the depth of 5.00 is relatively high (> 40 blows). This shows very hard soil consistency. Unfortunately, at drilling below the depth of 1.50 m to 5.00 m, the soil sample is not taken at all (empty / lost). This condition indicates that the soil below the

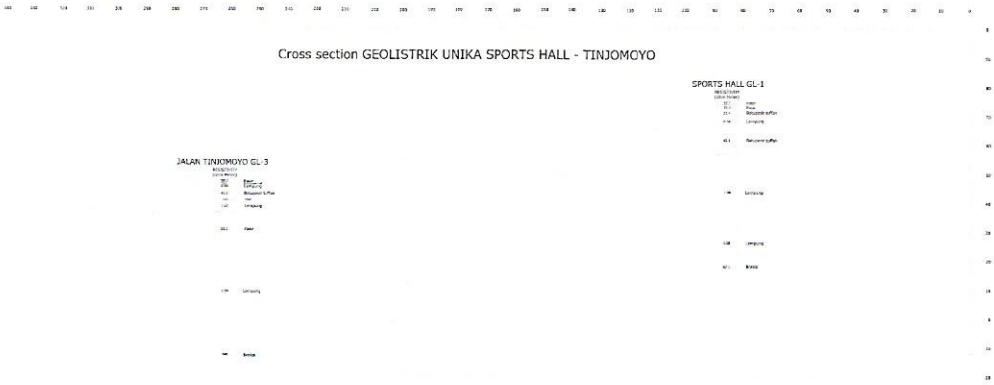


Figure 9c. Sport Hall - Tinjomoyo Geoelectric Test Results

Based on the results of the geoelectric test and the assumption of the slip circle which is correlated with the results of the geoelectric test, an analysis is then carried out to determine the stability of the slopes in the Bendan Dhuwur area, especially on the section of Pawiyatan Luhur street at Soegijapranata Unika campus to UNTAG Semarang campus.

Table 1 shows the depth of landslides interpreted from Geo-electric result. It can be seen the depth of landslides between 12.00 m – 60.00 m.

Due to the limited data available in the field and in the laboratory, it has been analysed by back analysis to obtain the initial parameters. Soil improvement at this location was modelled using grouting for a short term to minimize the soil movement. Figure 10a – Figure 10b shows the results obtained from the analysis.

Table 1. Depth of Landslides

No.	Location of Geo-electric	Depth of Landslides (m)
1	Untag – Kaligarang river	12.00 – 35.0
2	Unika – Tinjomoyo street	20.00 – 40.00
3	Sport hall - Tinjomoyo	20.00 – 60.00

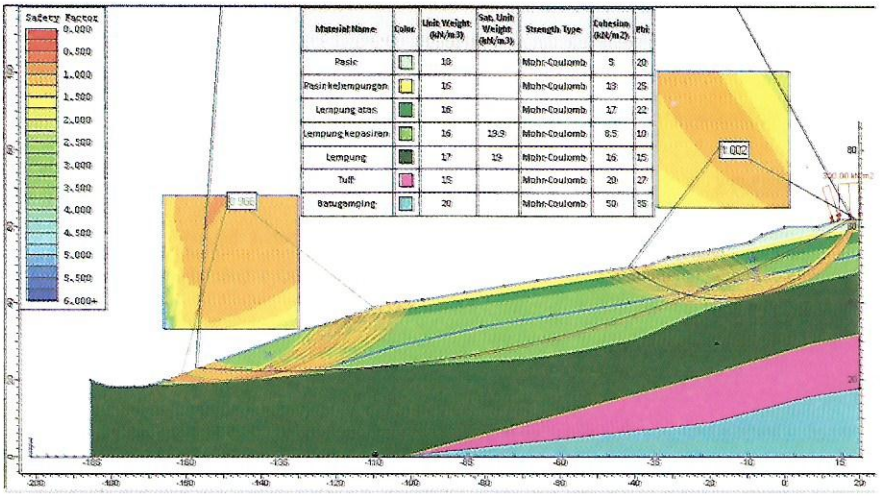


Figure 10a. Slope Stability Without Grouting

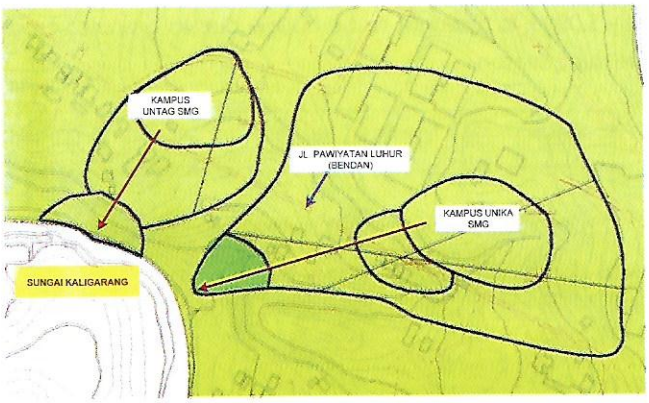


Figure 8. Direction of Soil Movement Maps (Source: 2016 Napak Tilas)

Analysis Using Slide 6.0 Rocscience

Slope stability analysis was carried out using Slide 6.0 from Rocscience. Descriptions of slip circles are obtained based on the Geoelectric test results carried out in several direction pieces. The following are the Geoelectric test results that have been carried out to assump the slip circle of landslide.

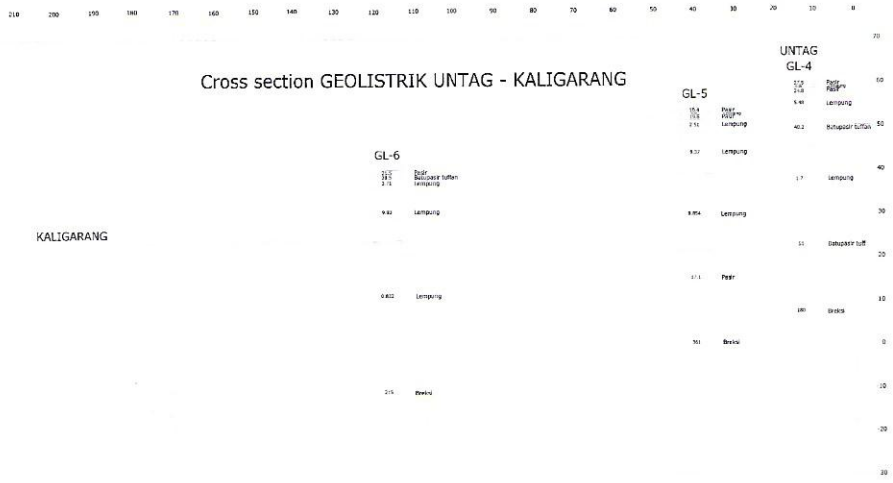


Figure 9a. Untag - Kaligarang Geoelectric Test Results

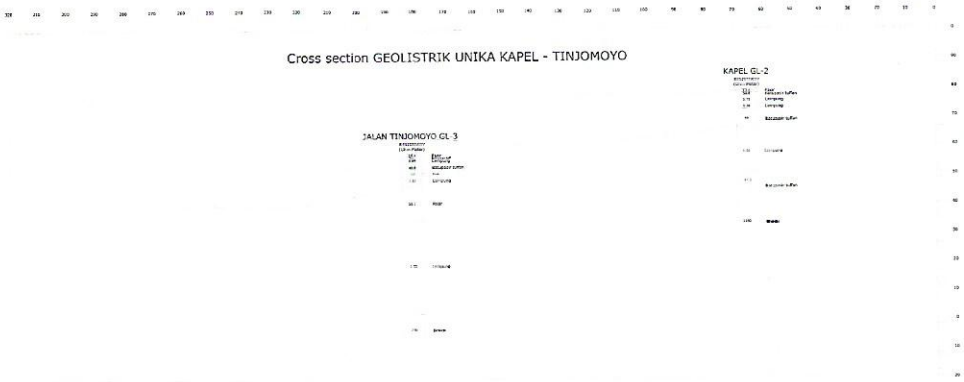
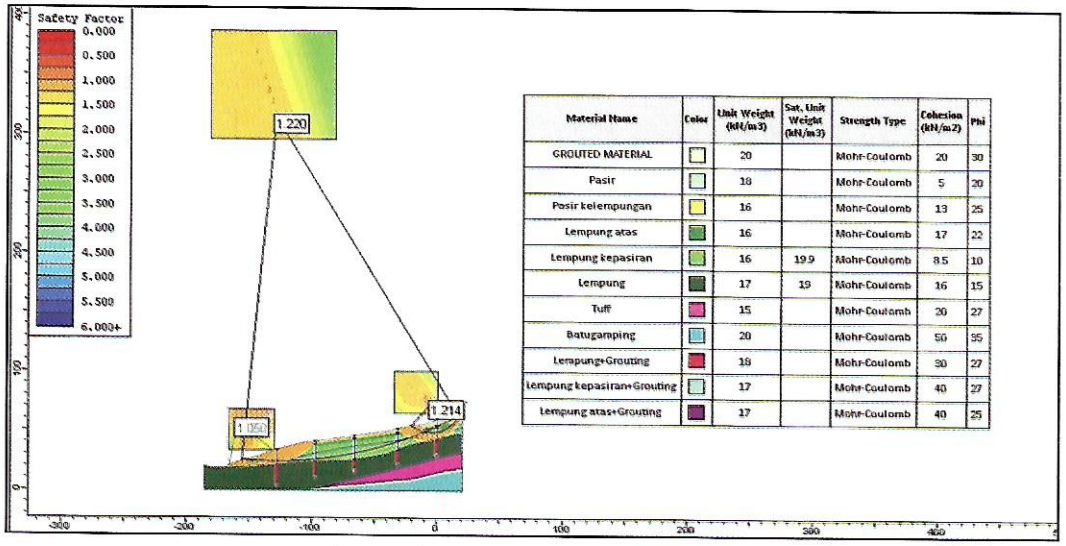


Figure 9b. Unika Chapel - Tinjomoyo Geo-electric Test Results



Material Name	Color	Unit Weight (kN/m3)	Sat. Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi
GROUTED MATERIAL		20		Mohr-Coulomb	20	30
Pasir		18		Mohr-Coulomb	5	20
Pasir kelempungan		16		Mohr-Coulomb	13	25
Lempung atas		16		Mohr-Coulomb	17	22
Lempung kepasiran		16	19.9	Mohr-Coulomb	8.5	10
Lempung		17	19	Mohr-Coulomb	16	15
Tuff		15		Mohr-Coulomb	20	27
Batugamping		20		Mohr-Coulomb	50	35
Lempung+Grouting		18		Mohr-Coulomb	30	27
Lempung kepasiran+Grouting		17		Mohr-Coulomb	40	27
Lempung atas+Grouting		17		Mohr-Coulomb	40	25

Figure 10b. Slope Stability with Grouting

It can be seen from the picture, that when there was no soil improvement, the safety factor of the slope was 1.002. Meanwhile, after using grouting to improve the strength of the soil properties, safety factors increased until 1.2.

CONCLUSION AND SUGGESTION

Some conclusions that can be drawn from this study are:

a. Factors in the movement of landslide in Gombel Lama street to Pawiyatan Luhur street are triggered by many factors, but mainly due to the riverbank of the Kaligarang river which is eroded by continuous water flow
b. Grouting method in this case only for a short term solution
c. Handling locally at the location of the movement will not have the effect of stopping movement because the movement that occurs is "Global" movement area
d. Reading the inclinometer at Pawiyatan Luhur street needs to be continued again to find-out the direction of soil movement
e. Further soil investigation need to be continued to find the effective solution methods of soil improvement
f. Collaboration with stakeholders is needed to discuss the solution.

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Acknowledgments are conveyed to the entire Soil Movement Study Team in Gombel Lama Street to the Akpelni Campus which involved both lecturers and students of PTN - PTS in the city of Semarang.

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