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The Potential of Seawater Intrusion Based on the Physical Rock Measurement in the International Airport Planing, Kulonprogo DIY

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Abstract: The research area located in Temon, Kulon Progo. Stratigraphy of the research area is divided into four units of rock namely, Breksi Kaligesing (Oligocene-early Miocene) unit, sandstones Kaligesing (Oligocene-early Miocene) unit, Sentolo limestone (N17-N19) unit (Late Miocene-Early Pliocene) and sandstones unit (Holocene). The airport plan contsrucution planning have a quarter material deposits which make up roughly 80% of the area of research, on the other hand, alluvial beaches and rivers deposit, composed by gravel, sand, silt and clay. The morphology of the terrain and the depth of it is a relatively shallow ground water which is being supported by the physical properties of the soil grain size relatively an uncompact condition and then on the alluvial deposition of research area, there is the potential for intrusion of sea water. The prevention of the intrusion of sea water occurrence can be done, by means of taking of shallow ground water in order to not overdo it, if it is possible to look for the location of the raw water supply for the activities purposes of the airport from another location.

Key words: Alluvial, uncompact, seawater intrusion, soil grain, Sentolo limestone, late Miocene-early Pliocene

INTRODUCTION

The development of air transports to fulfil demand for the current conditions, to support economic activity and to grow up tourism in Yogyakarta which has a global perspective, thus, it arises a plan to build a new international airport that located in Kulon Progo (Purwanto *et al*., 2015). Adisucipto Airport is considered to be inadequate to serve the domestic and non-domestic flights. Kulon Progo was accounted as a location which has quite wide and strategic to be developed into an international airport (Purwanto *et al*., 2015). The polling locations are along the South coast of Java which has some problems related to the hazard.

The problem from the Southern region of Java Island is earthquakes because of the plate interaction for instance, subduction between Eurasia and Indo-Australia Plates (Song *et al*., 2013). The lithology in this field consists of uncompacted alluvial deposits, thus, it is necessary to improve the foundation related to the soil compaction tobeing able to bear the weight of the building above it and to be able to prop the burden of landing and take-off aircraft (Pratama *et al*., 2016; Honda *et al*., 2014; Leynaud and Sultan, 2010). In addition, the hydrogeological conditions in the coastal areas which have shallow water depth, it will allow the potential of seawater intrusion.

MATERIALS AND METHODS

The research area located in Temon, Temon Regency, Kulon Progo, Daerah Istimewa Yogyakarta. The research methodology that was used were field observation, geological collection data, rocks and soil sediment sampling and groundwater, outcrop and soil sediment photographs, data analysis and the interpretation method and the resume of research results.

This is divided into several stages. The initial observation was processed with the studio observation through a topographical map and a research reference, thus, it should be proven during mapping in the field. The geological data were taken with the observation of morphological condition, the measurement of strike-dip of layers, the description of rock in the field, furthermore, the rocks were analysis with megascrophy and petrography, also, it was analysis the geological structure. Related to the intrusion of seawater potential were observed and supported by geological and hydrogeological condition with Geo-electricity data. The secondary data were collected to support the research. The data that obtained was analysed, thus, it can be determined the geological conditions, hydrogeological conditions which resulted in the zone of seawater potential.

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RESULTS AND DISCUSSION

The geomorphological unit from the location of airports planning to compose with alluvial plain, coastal alluvial plain and sand dunes. Geomorphic unit area of research areas, in the sequence from the largest alluvial plains of 64 and 28% coastal alluvial plains and sand dunes around 8% (Fig. 1). Those units have a flat slope with rate (0-2%) and have a weak resistance. Those units are consisted of loose material due to erosion and weathering and deposition until right now. The difference of those geomorphic units is the controlling factor of erosion, weathering and deposition. In the alluvial plain, the main factor is the fluvial process while in the coastal alluvial plain is the fluvial system the wind (Purwanto *et al*., 2015; Thompson *et al*., 2010; Vavro and Soucek, 2013). While on the sand dunes, it is controlled by the wind and influenced certain conditions, for example, the barrier that caused the formation of a sand dune.

Stratigraphy: According to the geomorphic units and the field observations, it have already known that the airport construction site is composed d in the loose material sediment unit or called by not compact sediment (Fig. 2). Based on the observation of material, the materials consist of medium sand-clay (Mu, *et al*., 2015). Generally, the liquefaction occurred on the geological conditions for youngest rock with the physical properties for instance loose material, it has unconsolidated and water saturated.

In the study area, it was processed the profiling on the leeve of Serang to know the variation of material deposition.

Based on the profile, it had known that the dominant material in the research area is medium to fine sand. Regarding the observation field either in the megascopic or in the profile cross-section, the dominant material that consisted is extremely well sorted. The Geo-electricity data had shown the thickness of alluvial deposits in the research area. The results of the analysis produced two-dimensional cross sections. Making cross-section based on the value resistivity that was obtained from the analysis using Software IP2Win. It is clearly seen that in the depth of 100 m is composed of loose sediment which has sized around clay to sand.

Analysis the physical properties of soil the analysis of technical geological engineering related with the physical properties of soil was tested in a laboratory to support this research about liquefaction potential study. The number of 4 samples was taken, either disturb or undisturbed that has elected to be further analysed based on the properties, the grain size analysis, the compaction test standard and the limits of Atterberg test.

Basic properties: This test is processed to obtain soil bulk density which is one of the ratio between the weight of the wet soil with volume in g/cm^3 bulk density soil either wet or dry soil bulk density, besides, it is processed to acquire the moisture content value. From the tests, it was conducted on four samples, namely samples A-D that obtained the results as explained in Table 1.

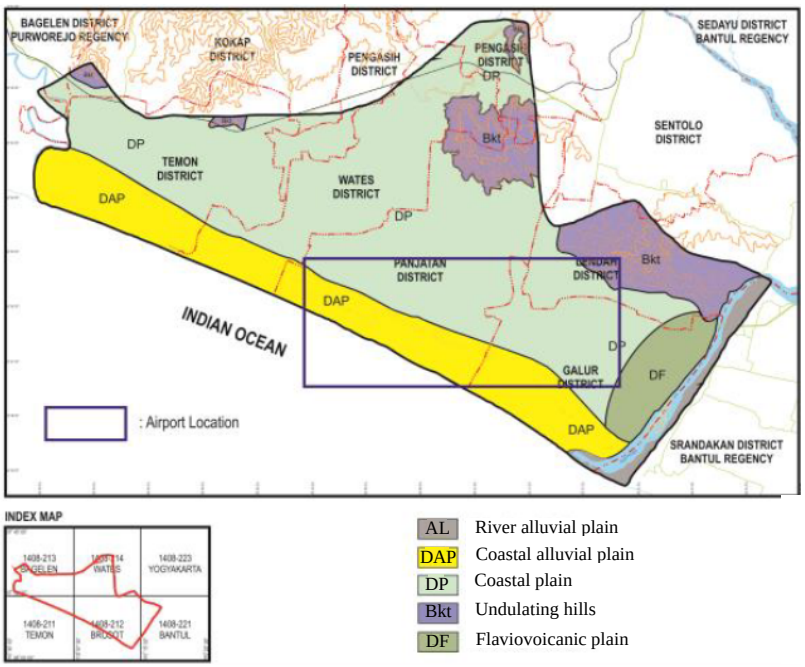

Fig. 1: Geomorphology airport site map and surrounding area

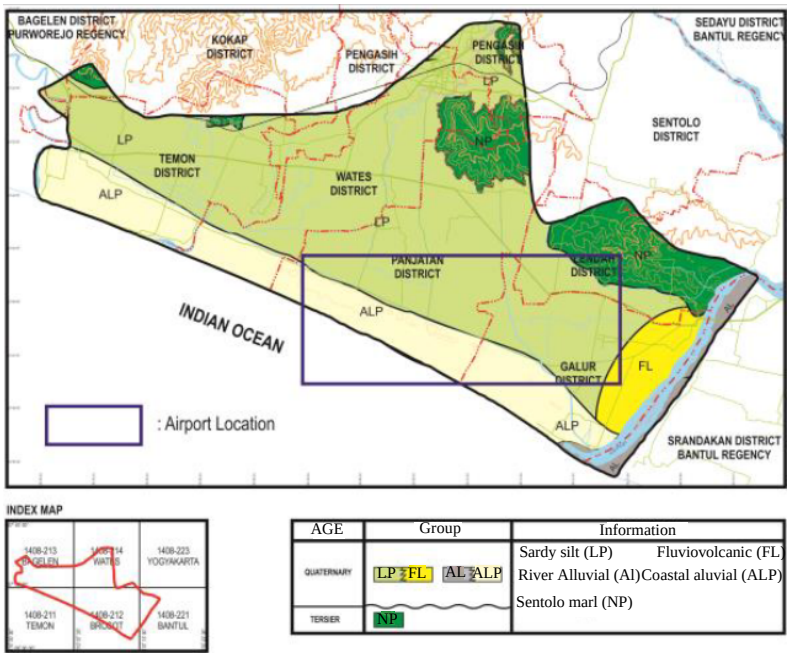

Fig. 2: The geological map of airport location and surrounding area

Table 1: The results basic properties test

	Basic properties		
Samples	γwet (g/cm^3)	γdry (g/cm^3)	W (%)
A	1.50	1.20	22.3
B	1.20	1.05	10.6
C	1.02	0.90	9.6
D	0.70	0.55	5.8

Based on the data, it can be seen that the samples A-C are sandy shale which has a fairly the high water content, the difference of bulk density and the low dry bulk density. The sandy shale not only can save water but also, pass water. In contrast, the D samples have a sand lithology which has low water value content value, thus, if it was added water, it will easily saturate and increase the potential risk of seawater intrusion. This test is processed to determine the gradation and the homogeneity of the material sampling. In the research area, it had chosen 3 samples, namely B-D. The A samples were not analysed because it has a clay size. Having the analysis that processed on three samples resulted in the curve are relatively same even though the result of homogeneity Cu value and heterogeneity Cc gradient. Having finished, it was matched with the curve of soil distribution according to the USCS, thus, the three samples filled into the uniform graded types. It had shown that the soil had the same grain size. The distribution of silt to medium sand and it is a zone that can pass water.

Table 2: Chemistry water data from sample

LP	Mg+ (mg/L)	Ca+ (mg/L)	Na+ (mg/L)	K+ (mg/L)	SO^4 (mg/L)	HCO^3 (mg/L)	Cl (mg/L)
2	0.99	1.42	1.44	0.13	0.40	2.85	0.31
3	0.92	1.83	1.13	0.05	0.10	1.84	0.21
4	2.28	5.45	4.18	0.20	3.25	7.75	1.34
6	2.47	3.75	6.92	0.31	0.88	8.77	1.82
11	5.29	1.79	9.87	0.51	0.31	15.90	2.88
14	2.14	3.56	3.96	0.23	0.63	7.24	1.30
19	4.89	5.40	13.57	1.23	3.08	11.42	4.93
24	2.49	3.36	8.53	0.33	1.25	11.42	1.95

On the research, location was obtained the clay soil samples sized (sample A) and was processed with an Atterberg limit test to determine the type of clay. The results of test demonstrated the value of Liquid Limit (LL) = 38%, Plastic Limit (PL) = 22.7%, Plasticity Index (PI) = 19.3%.

Based on test results of Atterberg limits was obtained that the CL type is clay with low liquid limit premises PI = 19.3%. CL type of clay is a clay that can not expansive which is the clay when it adds the water, it will not cause the changing volume that results in reduced soil porosity (Purwanto *et al*., 2015).

The groundwater chemistry: Table 2 shows that the chemical content of groundwater in the sample can be consumed as drinking water.

The value of the elevation groundwater table map of the research area was made with the distribution of groundwater level, it appeared that the trending groundwater flow from North-West to the South-East

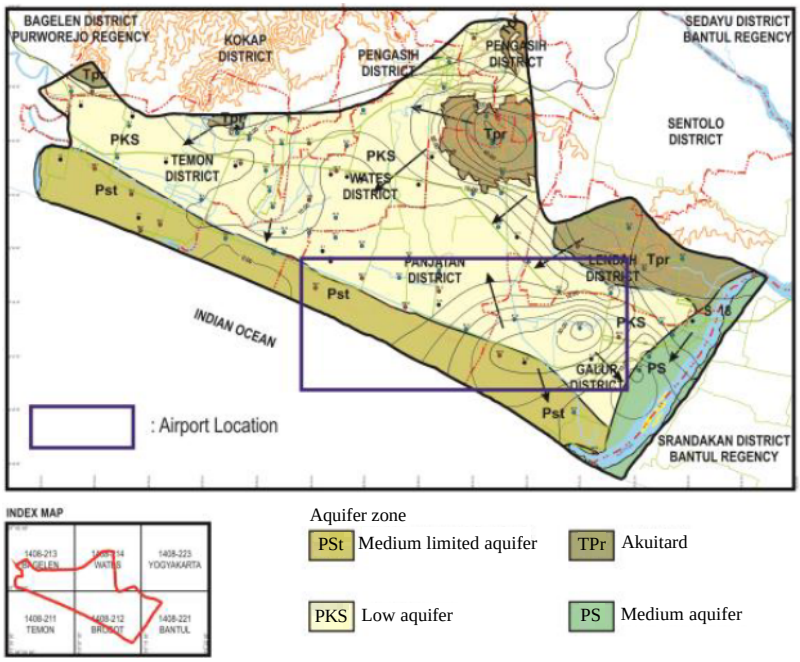

Fig. 3: Geohydrology map of groundwater wates basin

Table 3: Groundwater depth data on the research areas

Cordinates			b (m)	a (m)	GWL (m)
396274	9129756	11	2.00	0.590	9.590
396435	9129524	9	1.40	0.500	8.100
397451	9129764	7	1.90	0.660	5.760
397388	9129083	6	1.80	0.500	4.700
398176	9129279	7	2.05	0.570	5.520
398186	9128399	5	1.75	0.480	3.730
396285	9128428	6	1.62	0.300	4.680
396052	9128226	5	2.10	0.720	3.620
396275	9127901	4	2.12	0.650	2.500
397078	9127710	3	1.65	0.750	2.100
397310	9127978	4	1.95	0.710	2.760
397796	9127866	4	1.50	0.457	2.957
397867	9127386	4	1.31	0.320	3.010
398224	9127307	4	1.30	0.310	3.010
398968	9127353	4	1.85	0.600	2.750
399093	9127372	3	1.20	0.550	2.350
399129	9127643	3	1.10	0.400	2.300
399032	9127663	3	1.90	0.580	2.680
398998	9127662	4	2.12	0.560	2.440
398807	9129582	5	2.62	0.650	3.030
399118	9127978	4	1.60	0.600	3.000
399509	9129612	3	1.40	0.500	2.100
399548	9127868	3	1.35	0.570	2.220
400079	9128192	4	2.00	0.620	2.620
400055	9127707	3	1.30	0.410	2.110
400081	9127192	3	1.25	0.500	2.250
398498	9126143	3	2.00	0.500	1.500
397972	9126283	4	2.80	0.620	1.820
397335	9126636	3	1.80	0.720	1.920
396639	9126973	3	1.92	0.510	1.590
396091	9127143	4	1.74	0.840	3.100

(Fig. 3). The groundwater table has the lowest value located on the observation site about 27. The groundwater level has on the highest at observation sites 1. The groundwater table depth data and the height of groundwater in the research area can be seen in Table 3.

CONCLUSION

Based on the analysis of geological conditions, geomorphology, Hydrogeology, water chemistry and physical properties of soil, the research area has a potential of sea water intrusion around the southern runway location. This thing can occur if the extraction of groundwater on the airport site would exaggerate. One of the action to prevent this issue, it should look up the alternative of water resources to fulfil the water which comes from outside of the airport.

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