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ESTIMATION OF SOIL HOMOGENEITY OF MODIFIED AJKWA DEPOSITION AREA LEVEE, TIMIKA PAPUA

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ABSTRACT

The Modified Ajkwa Deposition Area (ModADA) and its levees is an embankment that developed to retain tailing originated from PTFI mining activities situated at Timika, Papua. Two engineered Levees with approximately 52 km long each are constructed to contain the tailing situated at the eastern and western part of ModADA. A statistical modeling concerning to spatial distribution of the Dutch penetration value of resistance (sondir) of high density data was performed. The model separates into uncertainty that originated in the statistical primary factor that accompanies calculating among these results. Based on statistical uncertainty using Soil CPT Program, this is shown the trend of homogeneity of soil in western part of ModADA levee.
Keyword: geostatistics model, sondir, ModADA, soil investigation analysis, embankment

INTRODUCTION

Stability of embankment is one important aspect to the success of retention of tailing management effort at the Modified Ajkwa Deposition Area (ModADA) to retain tailings produced by PTFI mining activities at Mimika Region, Papua Province.

The design of embankment is supported by the soil investigation results such as sondir, drilling, SPT etc. The total number of soil investigation is decided depend on the homogeneity of soil. This paper mentions one approach that could be used as preliminary information of soil homogeneity of the West Levee in ModADA Papua (Figure 1).

RESEACRH METHODOLOGY

Soil CPT Program is used to evaluate the homogeneity of soil. The accuracy of this program had been evaluated using data of Sondir Test (Dutch Cone Penetration Tests—DCPT) that much used in Indonesia i.e. tropical soil (Setiawan and Setiojati, 2010).

SOIL CPT PROGRAM

The Soil CPT software contains five soil classification methods, as follows:

Schmertmann's Method (1978)

Schmertmann's method is one developed on the base of data obtained by CPT (mechanical cone data) in the areas of North Central Florida (California, Oklahoma, Utah, Arizona and Nevada) through conversing the data into those of drilling test, and based on the result of such correlation the division into four zones for each of the soil types occurred (Figure 2).

Douglas Olsen's Method (1981)

Douglas Olsen's classification method shows soil classification based on correlation between USCS classification and data of CPT (electrical cone penetrometer) collected from many testing regions in the western areas of the United States. Douglas Olsen classified soil into three arching lines in

vertical direction, representing coarse-grained soil and four horizontally arching lines to differentiate many regions of sandy zones (metasable sands) and of sensitive zone (mixed soil and clay soil). The weakness of the method is that it cannot provide accurate prediction to find out the kind of soil on the base of soil composition (grain size distribution), but serves as guide of determining the behavior of soil type.

Robertson's Method (1986)

Robertson et al. (1986) developed a soil behavior type classification method derived from PCPT data (qc, fs, u). They proposed two charts, one chart uses corrected tip resistance (qt) and friction ratio (Rf) as input data; while the other chart uses qt and pore pressure parameter ($B_q = (u2 - uo)/(qt - \sigma vo)$) as input data. They identified twelve different soil behavior types. Incase a soil falls within two different zones in respective charts, engineering judgment is required to classify the soil behavior correctly.

Region Estimation Method and Fuzzy Logic Method (1999)

The Probability Region Estimasion Method is one similar with classic soil classification method, namely, method developed on the base of grain size distribution. It identifies soil based on three kinds of soil, namely, clayey, silty and sandy soil. Output results show as a percentage of soil composition (grain size distribution). The probability region estimation method determined the probability of each soil constituents (clay, silt, sand) at a certain depth.

Fuzzy Logic Method is one method that developed based on the Probability Region Estimation Method, but in fact output of the fuzzy logic method did not result in soil composition (grain size distribution), but classify the soil only based on the behavior of soil types. It divides the soil classification into three kinds, i.e.; High Probable Sand (HPS), High Probable Mixed (HPM), and High Probable Clay (HPC).

DISCUSSION

Soil CPT Output

Initial data processing is carried out by processing the data of DCPT using the Soil CPT Program. *Data input is required to data processing such as* the depth, the cone resistance value (q_c) and friction ratio (f_s). Output of the program is five models of soil layer profile following five soil classification methods. The data processing results from series of bore holes situated at MA 160 section is shown in Figure 6 below.

Output of the five models of soil profile from the Soil CPT Program is analyzed by comparing the depths of output of the five models of soil profile of each method based on the depth of soil sample (bore log), and followed by the laboratory test (based on USCS classification). After recapitulation of program outputs and the data of laboratory test on the base of USCS classification, the next stage is to compare recapitulation (result of software output above for each classification method) with the result of data on the soil sample of laboratory test, i.e. USCS soil classification, by using USDA and USCS classification approaches. The data analysis is done by looking at the result of output from running the program by using a result of the laboratory test such as the USCS classification.

The following is a table of the percentage of accuracy level of Soil CPT Program based on five soil classification methods by using the input of data from bore log the DCPT compared with that based on result of (USCS classification) at 5 locations of West Levee.

HORIZONTAL PROFILE

Based on the result of Soil CPT Program, each result of sondir data is correlated as cross section of West Levee and shown in Figure 7. The distance of each point is about 1000 meters and *shown some variability of each boring data*, therefore is shown some homogeneity in some bore hole data such as MA178 and MA184.

Generally, the embankment is dominated by sand with thick layer of silt and clay such as in MA-152 (down stream from MA 160), and thin layer of silt and clay such as in MA-160 and MA-170, otherwise a thick layer of sand as go up stream (MA 190). It is need future work by using the statistical analysis such as mean, coefficient of variation (COV) and scale of fluctuation (SOF) or autocorrelation. The value of SOF is shown the relationship between each point that is low SOF

mean fluctuation of soil properties and high variability (tend to heterogeneity) and high SOF mean soil properties is low variability (tend to homogeneity).

Based on those statistic and probabilistic analysis, the number of soil investigation such as CPT, SPT etc, would be define to estimate of soil properties and optimum design.

CONCLUSION

1) The Soil CPT Program is developed based on soil grain sizes (sand, silt, clay) only, using five soil classification methods.
2) Based on analysis result of soil profiles from the output of the Soil CPT Program, it can be concluded as follows:
   a) The Probability Region Estimation and Fuzzy Logic Methods can be used to find out the thickness of soil layer.
   b) The Schmertmann's, Robertson's, and Douglas Olsen's Methods can be used to map (identify) the characteristics of soil layers in detail at each interval.
3) The Soil CPT Program employing a five soil classification method can be utilized as an initial information of the classification, profile and depth of soil by the requiring parties such as users of construction service, considering that the software is faster and more efficient for the soil classification in general (sand, silt, clay).
4) Generally, the embankment is dominated by sand with thickening of silt and clay layer starting from MA 160 going down stream.
5) It is need future works by using statistical analysis by employing mean, coefficient of variation (COV) and scale of fluctuation (SOF) or autocorrelation.
6) Based on those statistic and probabilistic analysis, the number of soil investigation such as CPT, SPT etc, would be utilized to determine of soil properties and optimum design.

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Point	Location	Schermann	Douglas Olsen	Robertson	Probability Region Estimation	Fuzzy
CPT-W9	West Levee MA 160	70	60	60	80	80
CPT-W10B	West Levee MA 165	90	90	90	90	90
CPT-W11	West Levee MA 170	70	70	60	60	60
CPT-W13	West Levee MA 184	100	100	100	100	100
CPT-W14	West Levee MA 190	66,7	50	33,33	50	50
	West Leeve MA 220	100	100	100	100	100
Average (%)		82,78	78,33	73,88	80	80

TABLE 1: The Recapitulation of Processing Data Five Soil Classification Methods

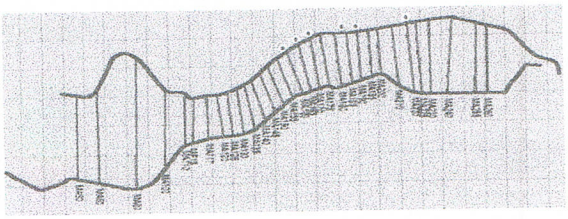


FIGURE 1: Location of sondir data at West Levee

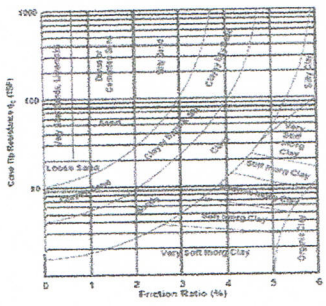


FIGURE 2: Schmertmann soil classification charts

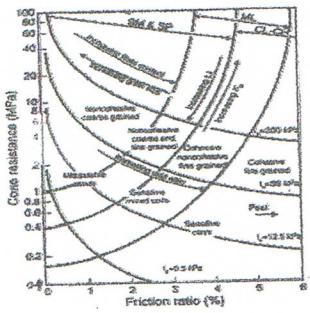
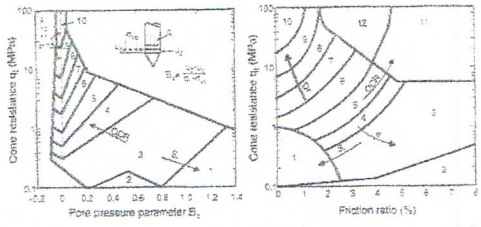


FIGURE 3: Douglas Olsen (1981) classification charts



1. Sensitive fine grained, 2. Organic material, 3. Clay, 4. Silty clay to clay, 5. Clayey silt to silty clay, 6. Sandy silt to clayey silt, 7. Silty sand to sandy silt, 8. Sand to silty sand, 9. Sand, 10. Gravelly sand to sand, 11. Very stiff fine grained, 12. Sand to clayey sand.

FIGURE 4: Robertson et al. (1986) classification charts

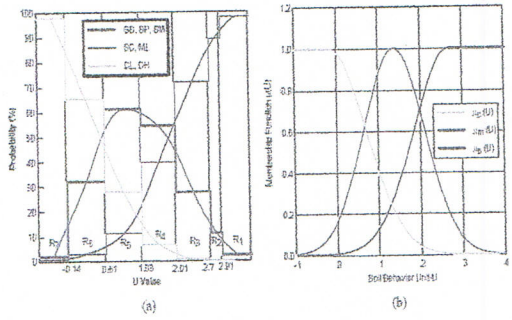


FIGURE 5: (a) Region's boundaries and the corresponding probabilities of each soil group; (b) CPT fuzzy soil classification chart

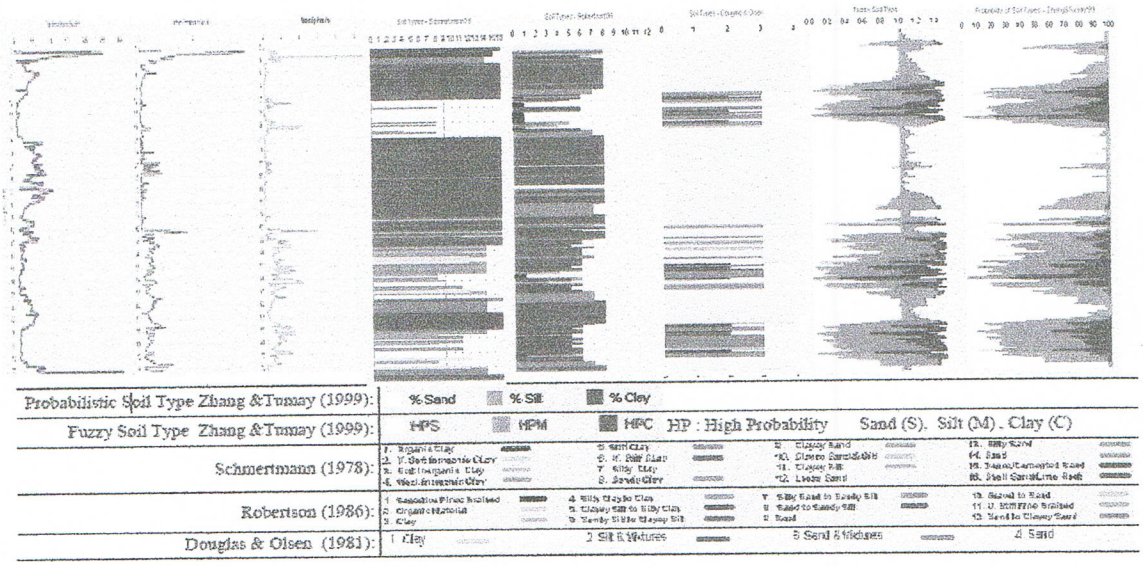


FIGURE 6: Soil classification of MA 160 Section

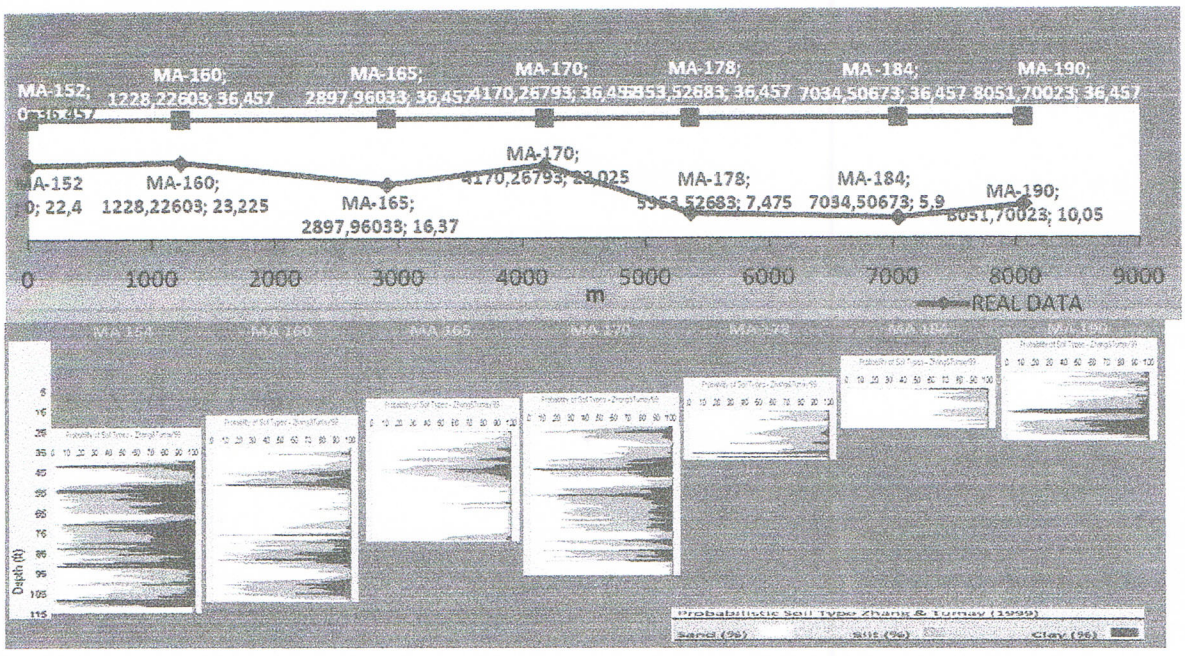


FIGURE 7: Cross section of West Levee based on Soil CPT Program

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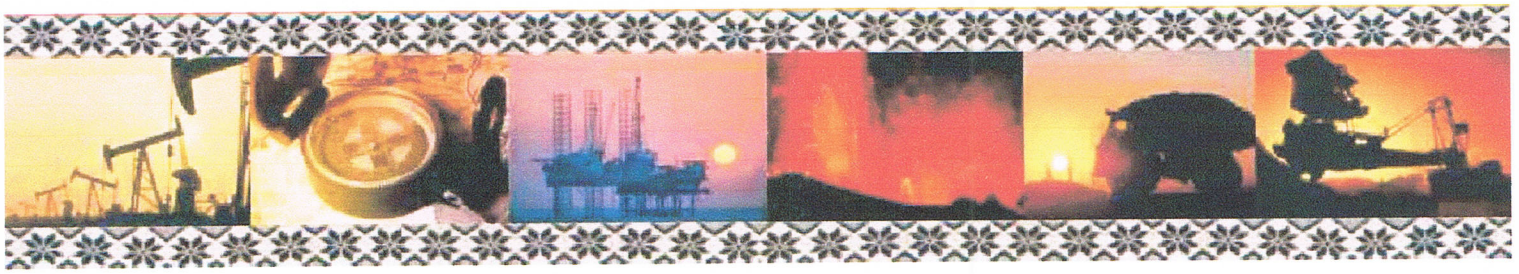

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7	Endapan Pasir Kromit Di Dataran Pantai Wosu, Bungku, Sulawesi-Tengah	H Utoyo
8	Weathering of Overburden from A Gold Mine by Organic Amendment	Baiq Dewi Krisnayanti

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5	Fractures Pattern Analysis Related to the Geological Structures and Carbonate Facies of Rajamandala Formation, Case Study; Pasir Aseupan Area, Sukabumi – Jawa Barat	Maisi Asri Riswanty; A.M. Surya Nugraha; Agus H. Harsolumakso; Yan Rizal R
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26	Endapan Melange-Tektonik di Kota Jayapura, Papua.	Bari R. Hanafi; Bambang Priadi
27	Peranan Geologi Dalam Menguak Arsitektur Bangunan Situs Candi Kimpulan	Andre Prasetyo, Asrizal, Raditya Putra, Subagyo Pramumijoyo
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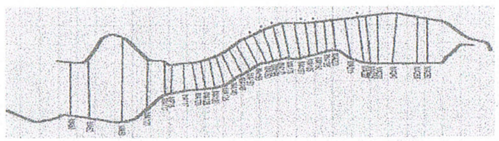
PROBABILISTIC MODEL OF SOFT SOIL USING DUTCH CONE PENETRATION TEST DATA

Budhi Setiawan[1], Edy Sutriyono[2], Wahyu Sunyoto[3], Didiek Subagyo[4]

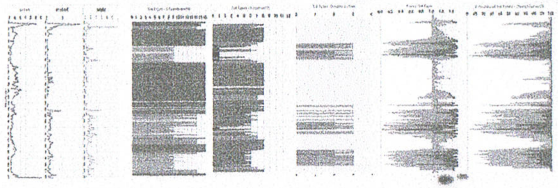
INTRODUCTION

Since on soft soil, large settlement might be occur under loaded foundation without actual shear failure occurring, the soil profile based on soil investigation in soft soil areas e.g. Palembang region and levee embankment are become important. A statistical modeling concerning to spatial distribution of the Dutch penetration value of resistance (sondir) of high density data is performed. The model separates into uncertainty that originated in the statistical primary factor that accompanies calculating among these results. The probabilistic model of soil is used Soil CPT Program to show the trend of heterogeneity in Palembang region and homogeneity of soil in western part of ModADA levee.

WEST LEVEE OF MODADA, TIMIKA - PAPUA



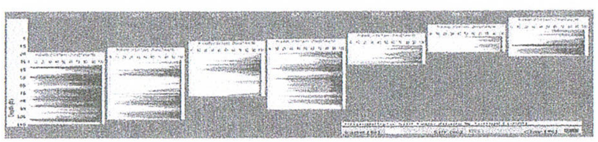
Location of DCPT data at west levee



Output of Soil CPT Program

Point	Location	Schermann	Douglas Olsen	Robertson	Probability Region Estimation	Fuzzy
CPT-W9	West Levee MA 180	70	80	80	80	80
CPT-W10B	West Levee MA 165	90	90	90	90	90
CPT-W11	West Levee MA 170	70	70	60	60	60
CPT-W13	West Levee MA 184	100	100	100	100	100
CPT-W14	West Levee MA 190	86,7	50	33,33	50	50
	West Leave MA 220	100	100	100	100	100
	Average (%)	82,78	78,33	73,88	80	80

Comparison Method in Soil CPT Program



Longitudinal soil profile using Soil CPT Program

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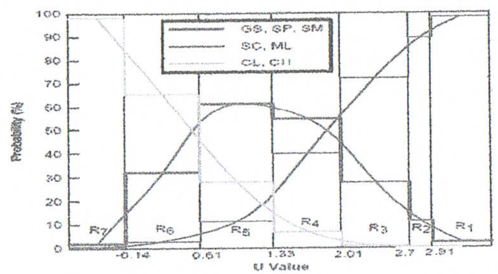
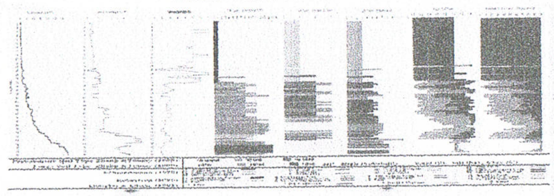
PROBABILITY REGION ESTIMATION METHOD



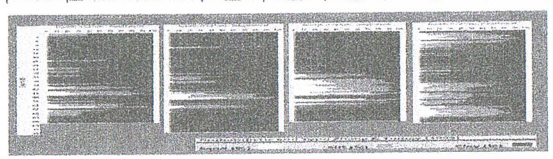
This method developed on the base of grain size distribution. It's identifies soil based on three kinds of soil, namely, clay, silty and sandy, and the output from this method we would getting the percentage of soil composition (grain size distribution).

PALEMBANG, SOUTH SUMATERA



Output of Soil CPT Program

Number	Project	Schmertmann	Douglas Olsen	Robertson	Probability Region Estimation	Fuzzy Logic
P1	The Insurance building Wakanen ([illegible])	100	66,67	100	100	100
P2	Tower (Anton Bambang Utoyo)	66,67	66,67	66,67	66,67	66,67
P3	Tower ([illegible])	100	100	100	100	100
P4	Tower (Sei Selincah)	100	100	100	100	100
P5	Tower (Jl Swadaya Lr. Masjid Srijaya)	100	100	100	100	100
P6	Tower ([illegible] Lorong Kenangan)	100	100	100	100	100
P7	[illegible] Plaza (Jl. Prabu Mangkunegara- Pasal)	100	100	100	100	100
P8	PLTG (PLTG [illegible])	66,67	66,67	66,67	66,67	66,67
P9	Show Room (Jl Jendral Sudirman)	100	100	100	100	100
P10	Telkomsel Building (Jl. Veteran)	100	100	100	100	100
P11	The Workshop (Sukabangun II)	33,33	50	66,67	50	50
P12	GOR Jakabaring	94,44	94,44	94,44	94,44	94,44
P13	Show Room ([illegible] (KM-5))	100	100	100	100	100
P14	PLTG ([illegible])	100	100	100	100	100
P15	Hotel (7 Ulu)	65	82,5	67,5	77,5	77,5
P16	Tutup quay and Beton Bridge at the Musi I	50	71,5	86,5	87	87
P17	Islamic Center (Jakabaring)	79,63	73,87	53,33	92,15	92,15
P18	Rubber Factory Hoktong ([illegible])	83,33	70,17	78,167	82,15	82,15
P19	2 floors of PDC Auto 2000 (Tanjung Api-A	37,5	20,17	37,5	37,5	37,5
P20	Tutup 9-10 Ulu	100	100	100	100	100
	Rate	89,20	82,18	87,14	87,2	87,3



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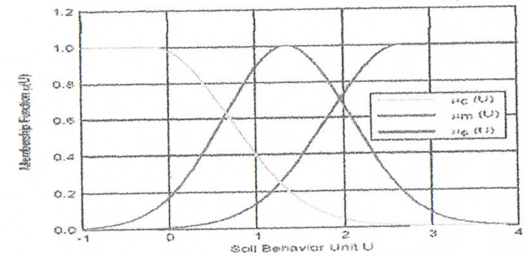
FUZZY LOGIC CHART



Fuzzy Logic Method is one developed based on the Probability Region Estimasion Method, but in fact output of the fuzzy logic method did not result in soil composition (grain size distribution), but classify the soil only based on the behavior of soil types.

CONCLUSION

1. Based on analysis result of soil profiles from the output of the Soil CPT Program, it can be concluded as follows:
   - The Probability Region Estimation and Fuzzy Logic Methods can be used to find out the thickness of soil layer.
   - The Schmertmann's, Robertson's, and Douglas Olsen's Methods can be used to map (identify) the characteristics of soil layers in detail at each interval.
2. The Soil CPT Program employing a five soil classification method can be utilized as an initial information of the classification, profile and depth of soil by the requiring parties such as users of construction service, considering that the software is faster and more efficient for the soil classification in general (sand, silt, clay).
3. Generally, the soil in Palembang region is dominated by clay with high variability of thickness. On the other hand, the embankment is dominated by sand with thickening of silt and clay layer starting from MA 160 going down stream.
4. Based on those statistic and probabilistic analysis, the number of soil investigation such as CPT, SPT etc, would be utilized to determine of soil properties and optimum design.
5. It is need future works by using statistical analysis by employing mean, coefficient of variation (COV) and scale of fluctuation (SOF) or autocorrelation.

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