GROUND SETTLEMENT PREDICTION OF EMBANKMENT TREATED WITH PREFABRICATED VERTICAL DRAINS IN SOFT SOIL

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- GROUND IMPROVEMENT LAYOUT
- METHODOLOGY
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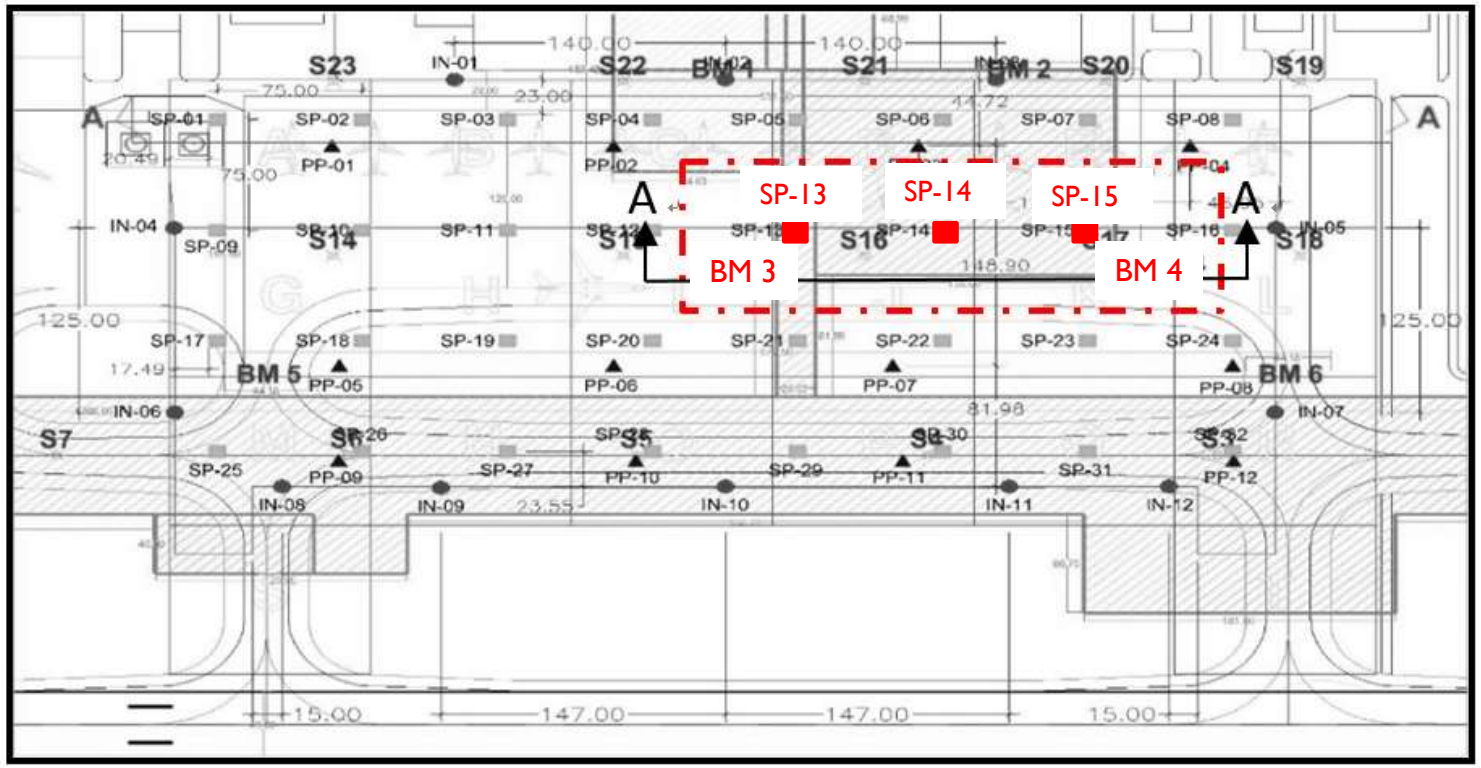
GEOTECHNICAL SITE CONDITION



However, the location that we want to study is focus on A-A cross section in dash red square.

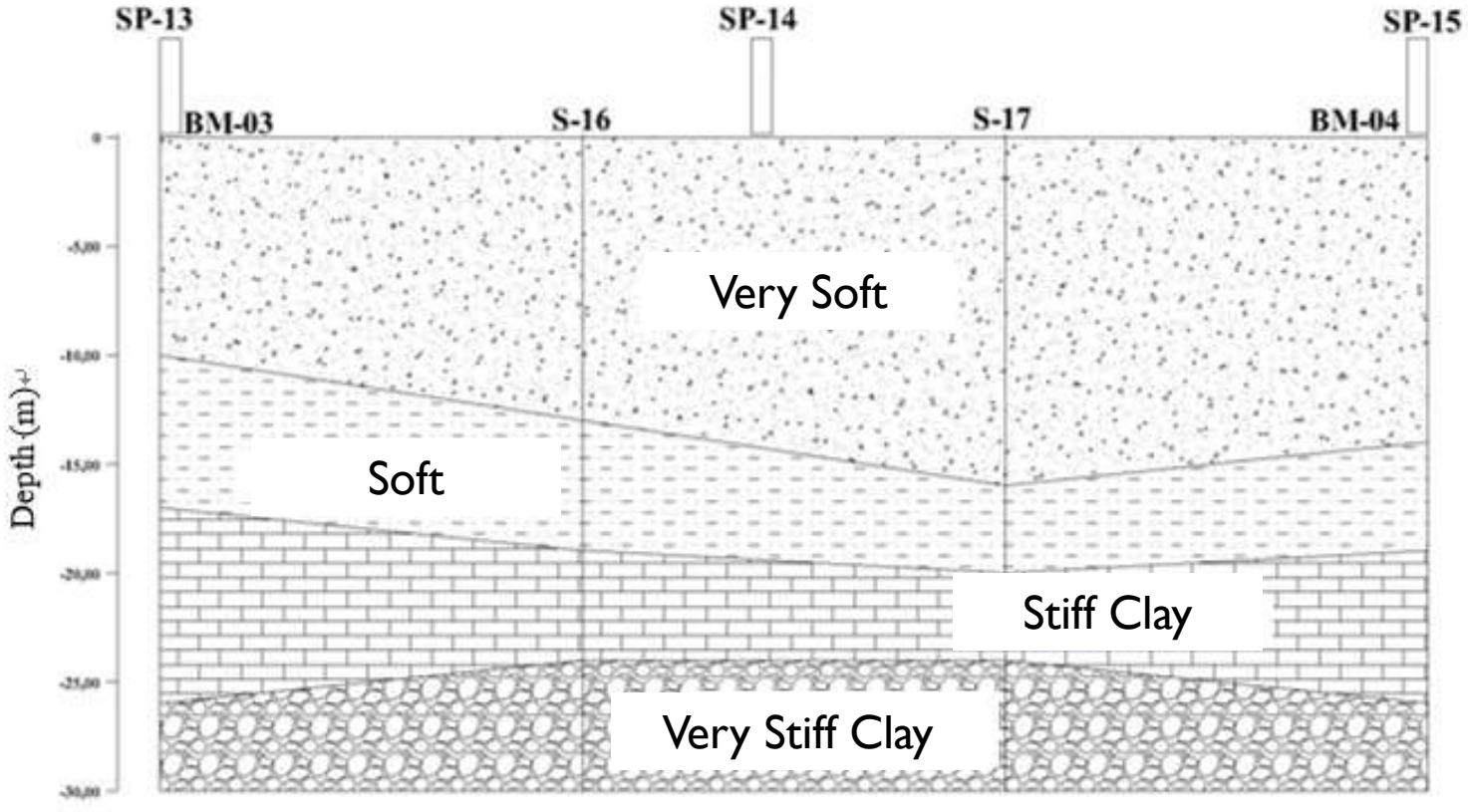
The study case was taken from Ahmad Yani airport expansion project in Semarang, 2012-2013.

The soil investigation was done by:
1. Standard Penetration Test (SPT) at 6 points with 30 m depth. (BM-01 to BM-06)

2. Cone Penetration Test (CPT) which was conducted at 23 points with 25-28 m depth variation (S1 to S23)

3. laboratory test such as of soil properties, soil strength, as well consolidation

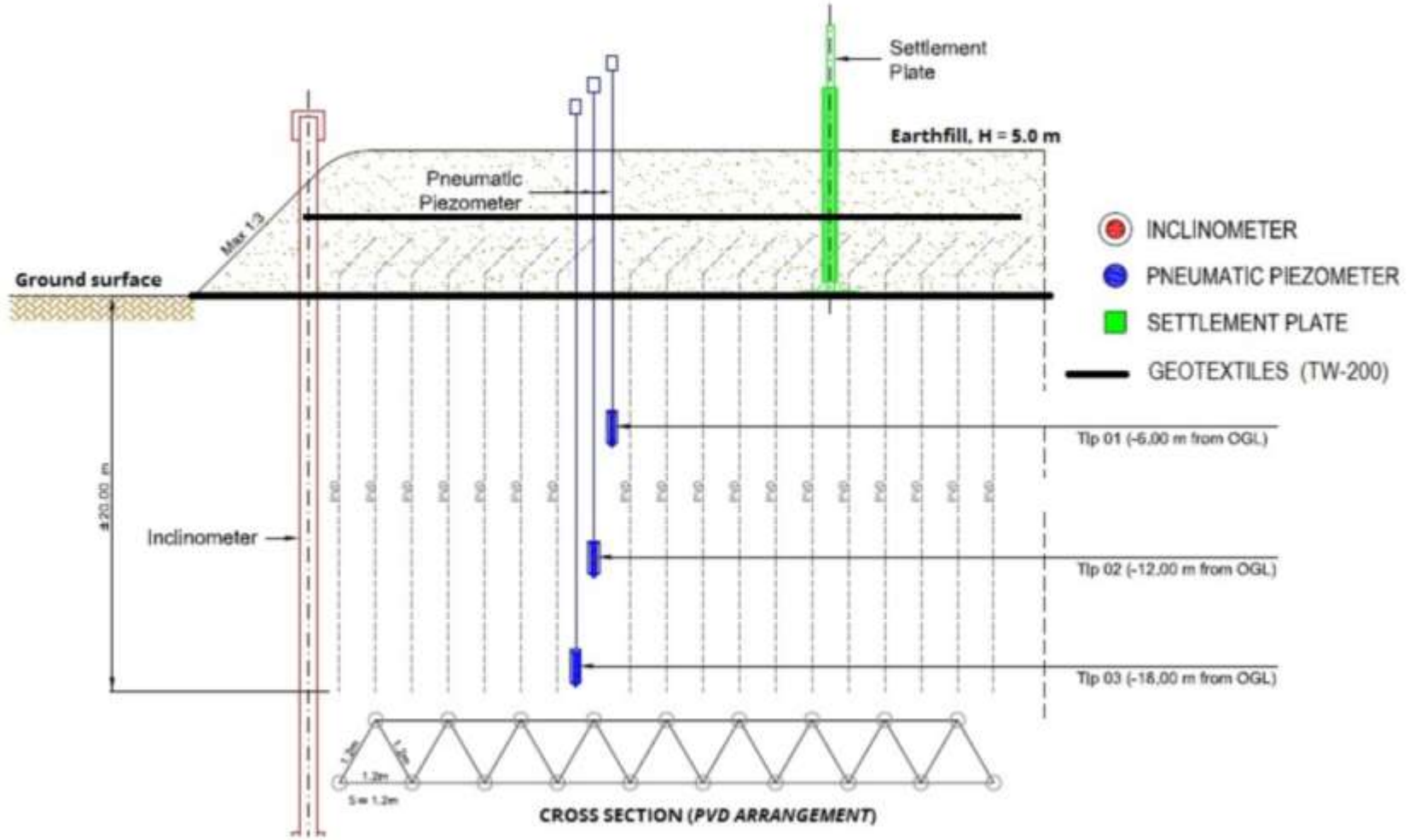
SOIL LAYER (A-A CROSS SECTION)



In this study, the soils that we want to simulate are borehole BM-03 and BM-04.

Based on the figure, the simulation result will be compared with the field measurement from SP-13, Sp-14 and SP-15 because the settlement plate location is nearby the borehole location with assumption that the model has same condition with the actual condition.

GROUND IMPROVEMENT LAYOUT

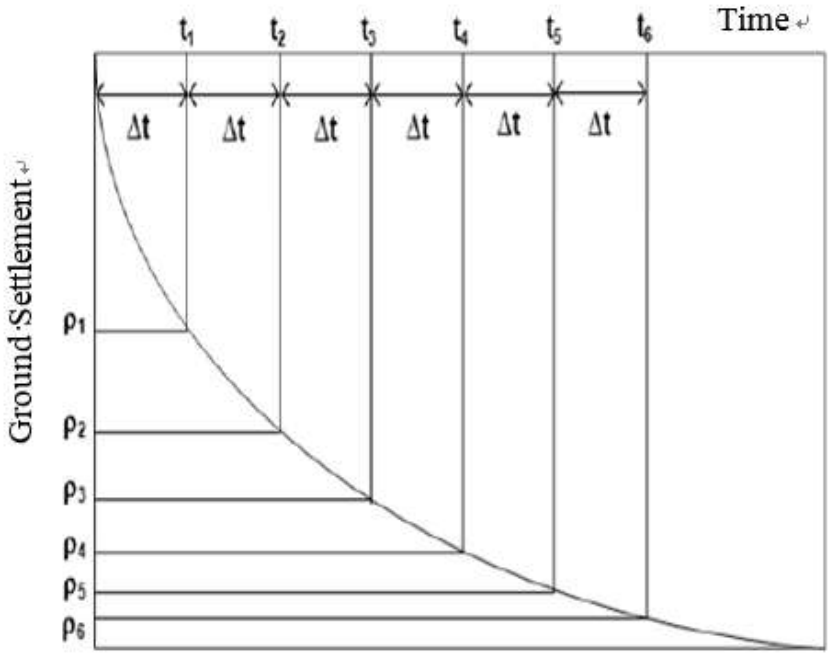


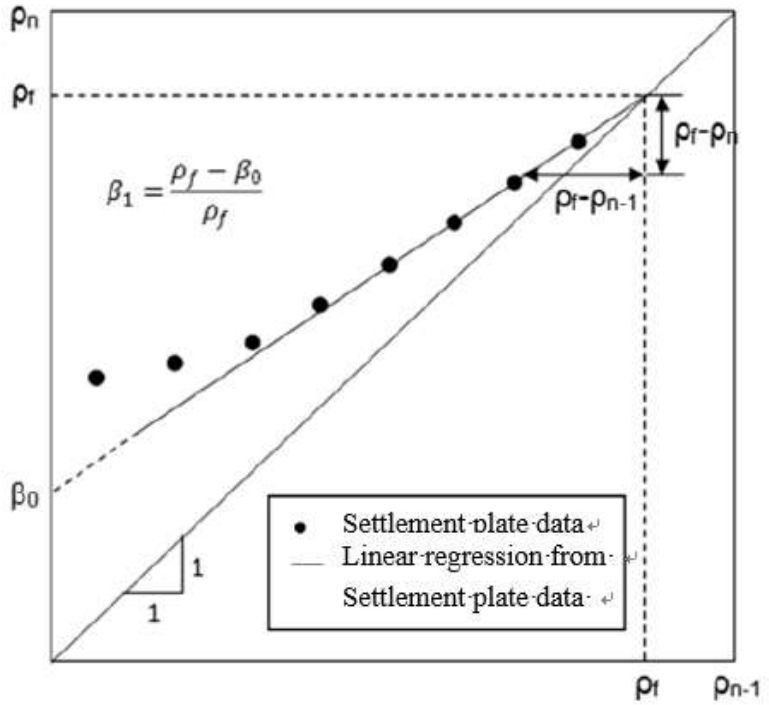
The embankment was built in 5 meter height with one third slope whether PVD were installed in triangular pattern with 1.2 meter spacing.

Some instrument such as inclinometer, piezometer, and settlement plate were installed to monitor the soil condition and to obtain the daily ground settlement.

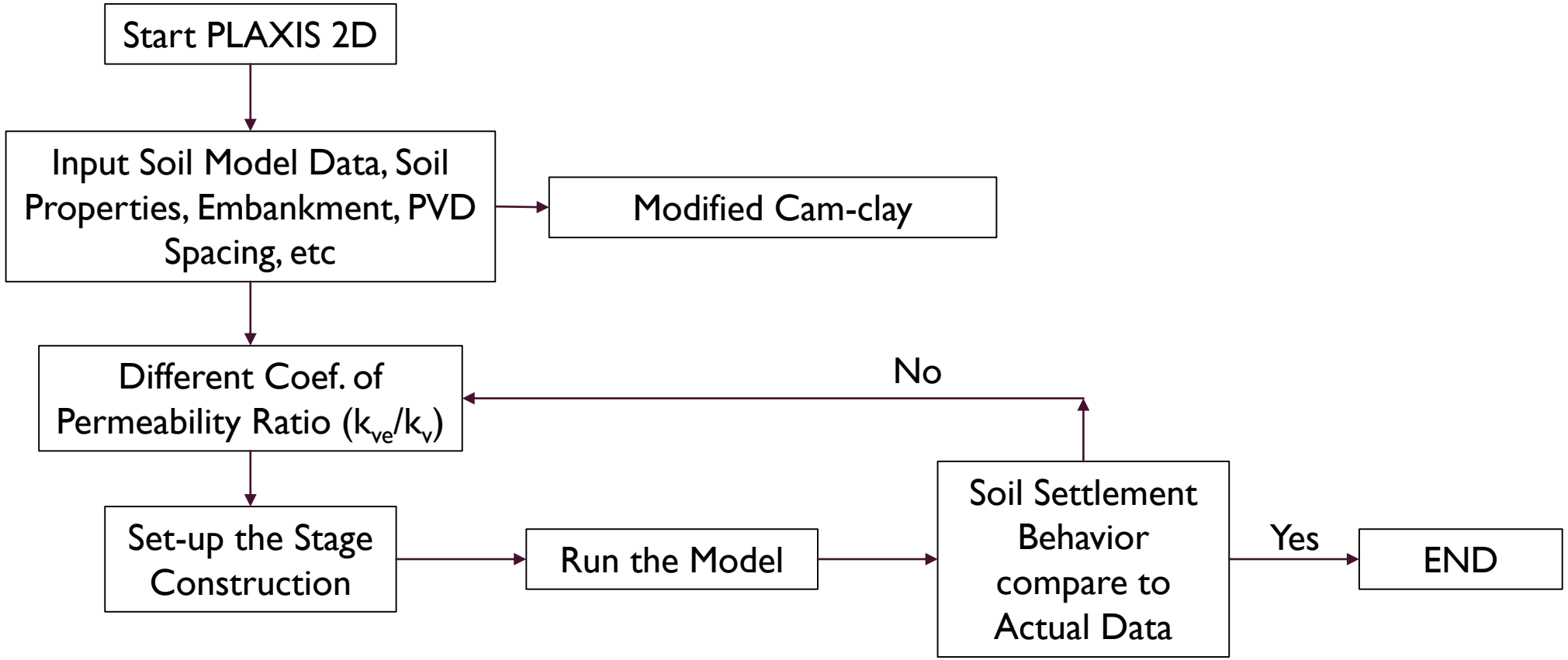
METHODOLOGY

ASAOKA METHOD





NUMERICAL METHOD



SOIL PROPERTIES (MODIFIED CAM-CLAY)

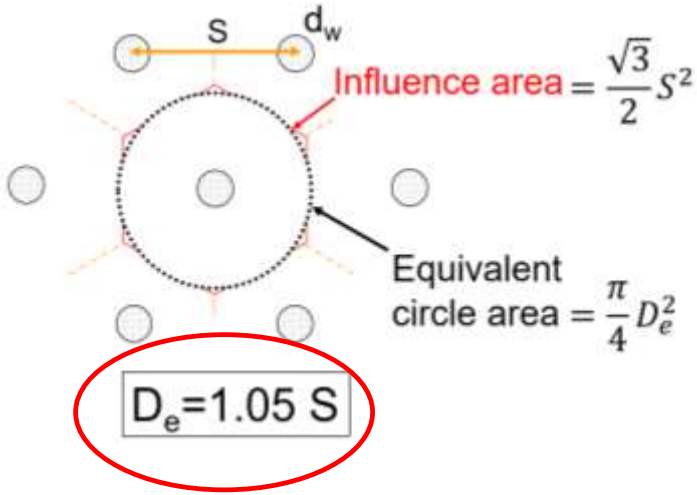
Compression index (λ) and Modified swelling index (κ)

$$\lambda = \frac{C_c}{2{,}3\ .(1+e_0)}$$

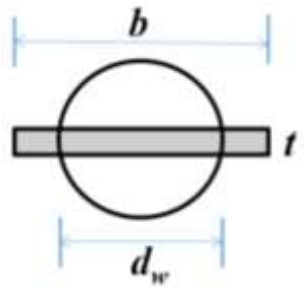
$$\kappa = \frac{2.C_s}{2{,}3.(1+e_0)}$$

where, C_c is compression index, C_s is compression index, and e_o is initial void ratio.

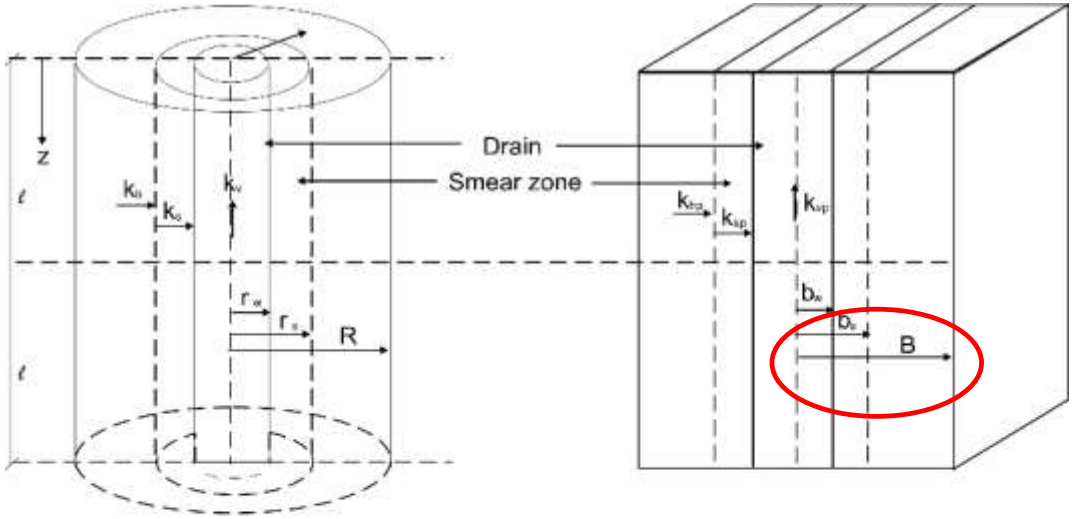
PVD PROPERTIES EQUIVALENCY

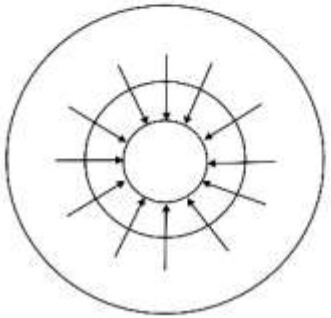


$D_e = 1.05\ S$

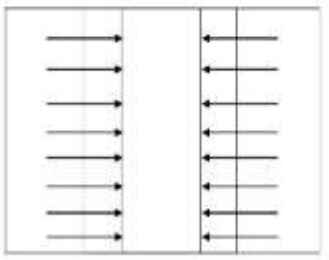


$$d_w = \frac{2(t+b)}{\pi}$$



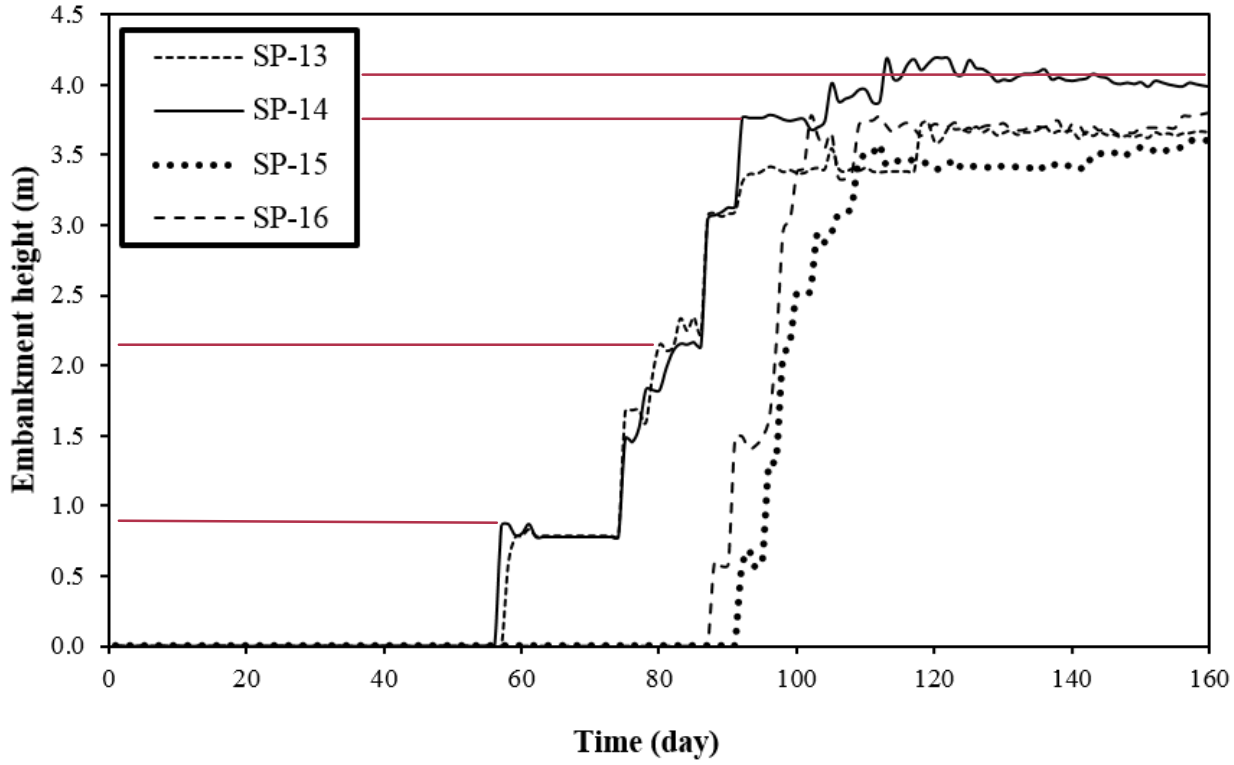


Axisymmetric

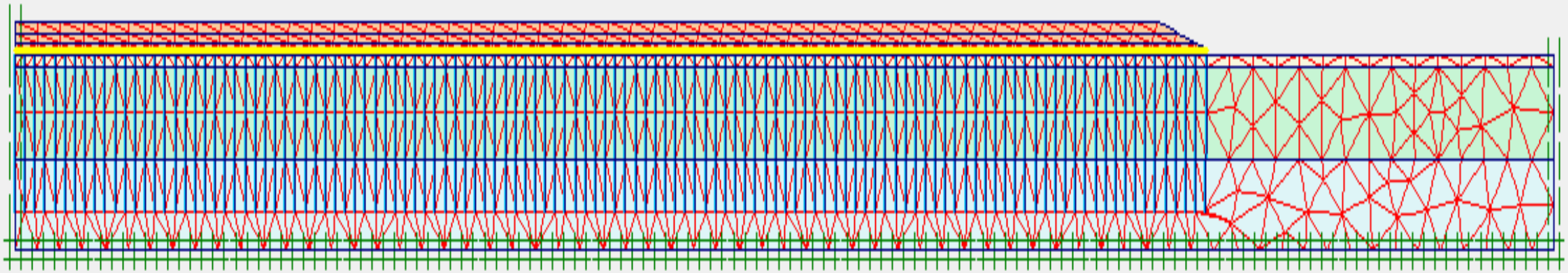


Plane Strain

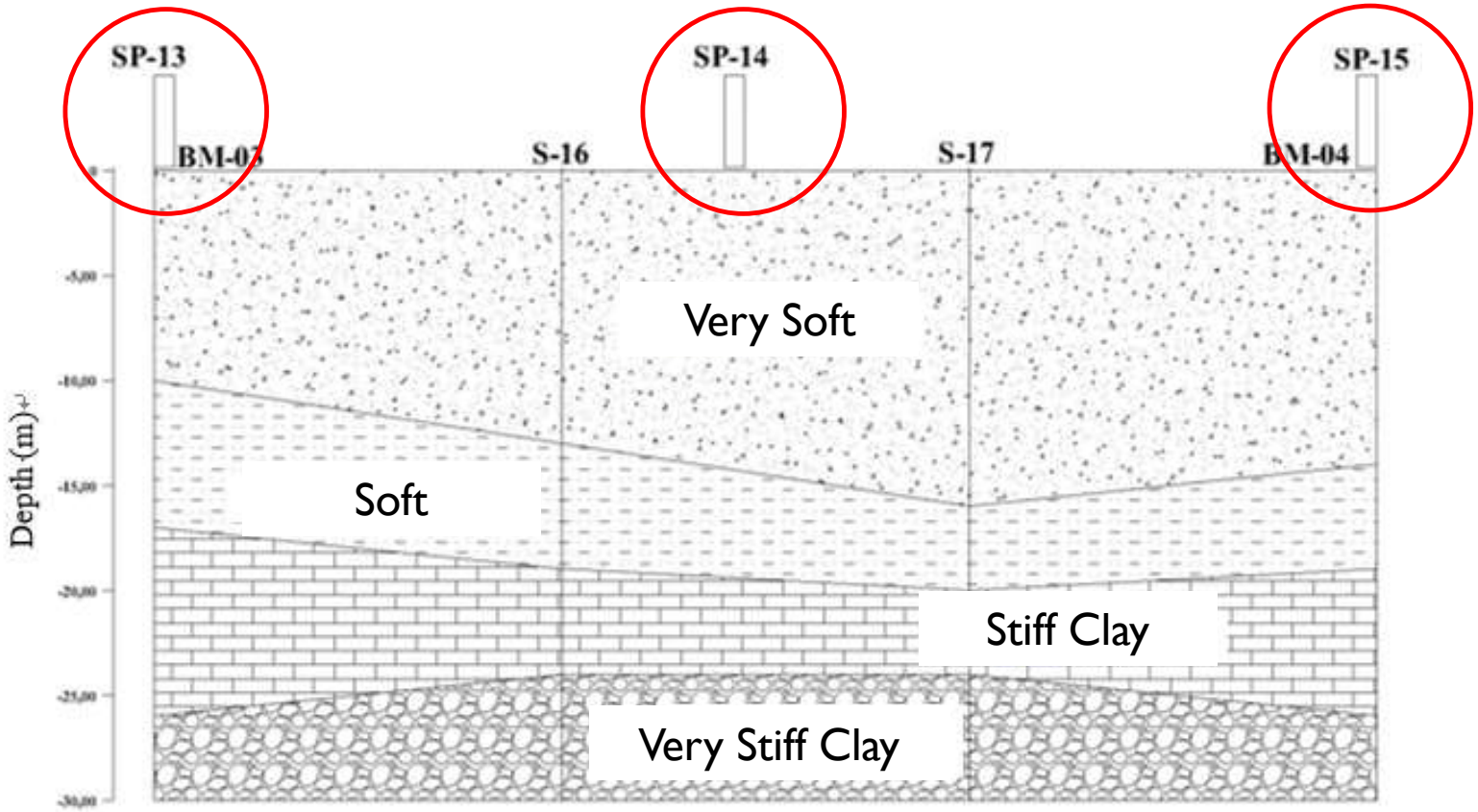
STAGE CONSTRUCTION



NUMERICAL MODEL (MESHED)



RESULT AND DISCUSSION



SP-13, SP-14 and SP-15 data is used to make comparison between actual data and numerical analysis

NUMERICAL RESULT

- The model in PLAXIS 2D were build with different coefficient of permeability (k) ratio which done by trial error.

Coefficient of Permeability Ratio (k_{ve}/k_v)
0.1
0.5
1
2

GROUND SETTLEMENT BEHAVIOR
SP-13

SP-13

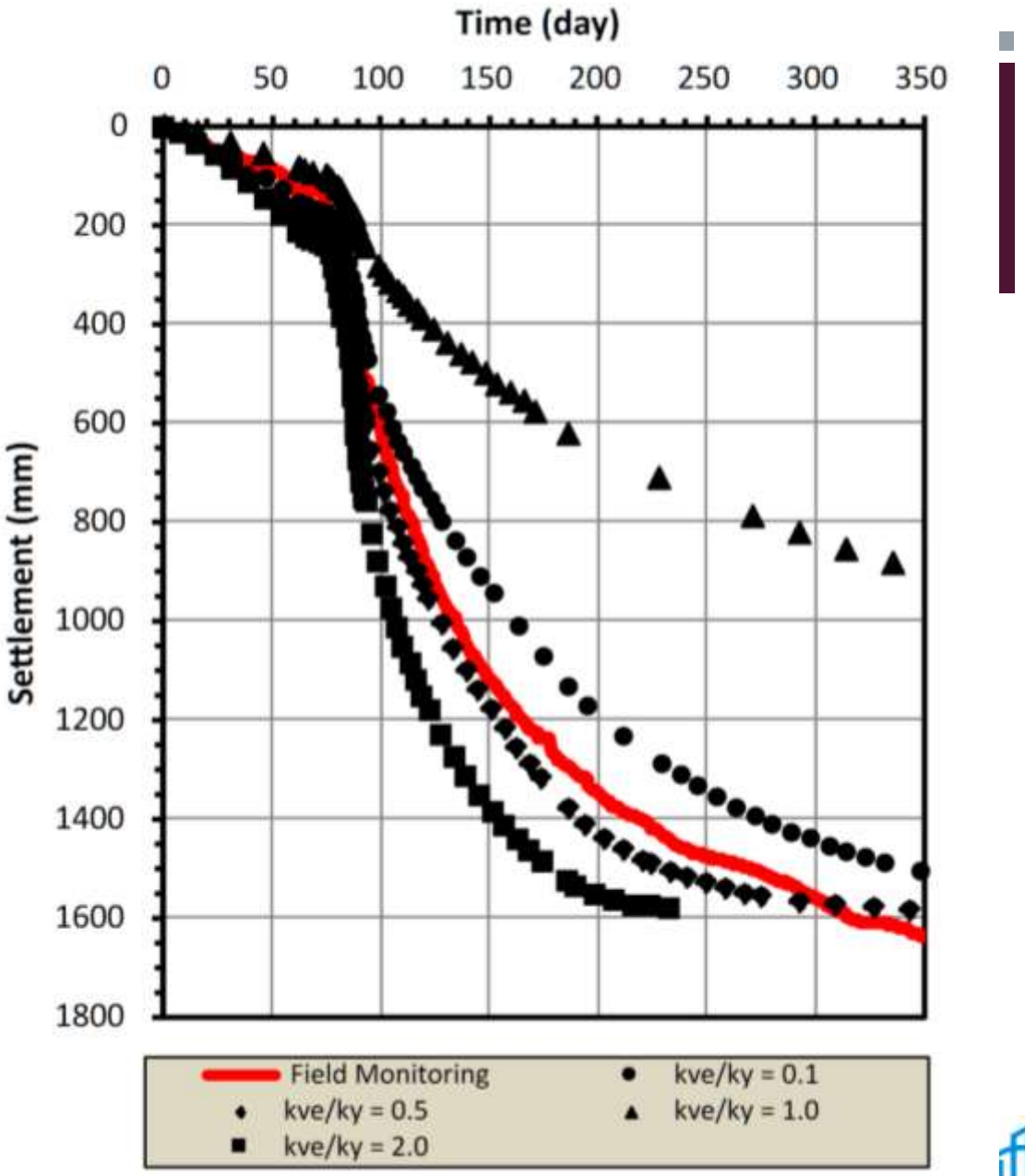
RMSD for each ratio:

Ratio 0.1 = 106.6

Ratio 0.5 = 57.7

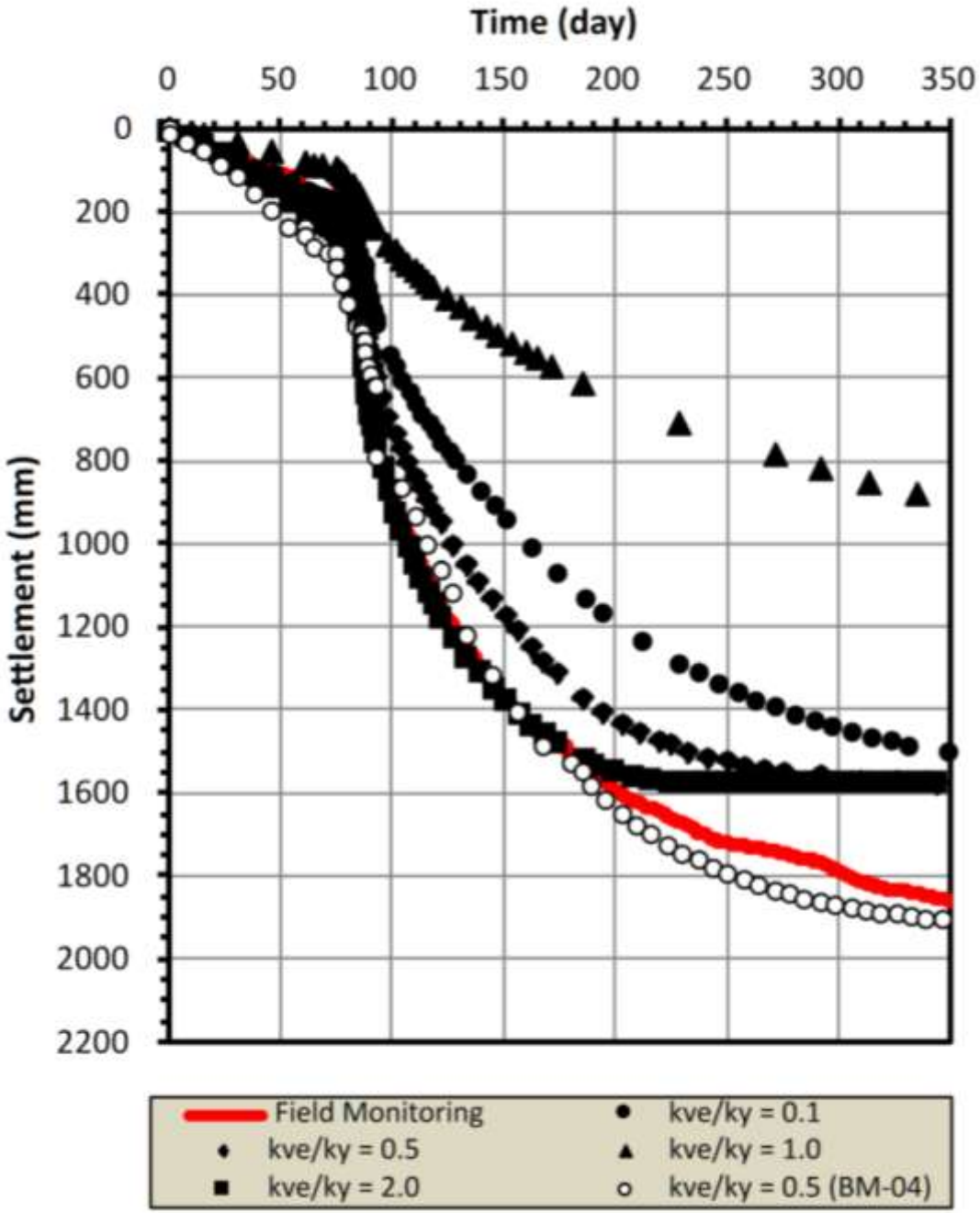
Ratio 1 = 405.7

Ratio 2 = 187.5



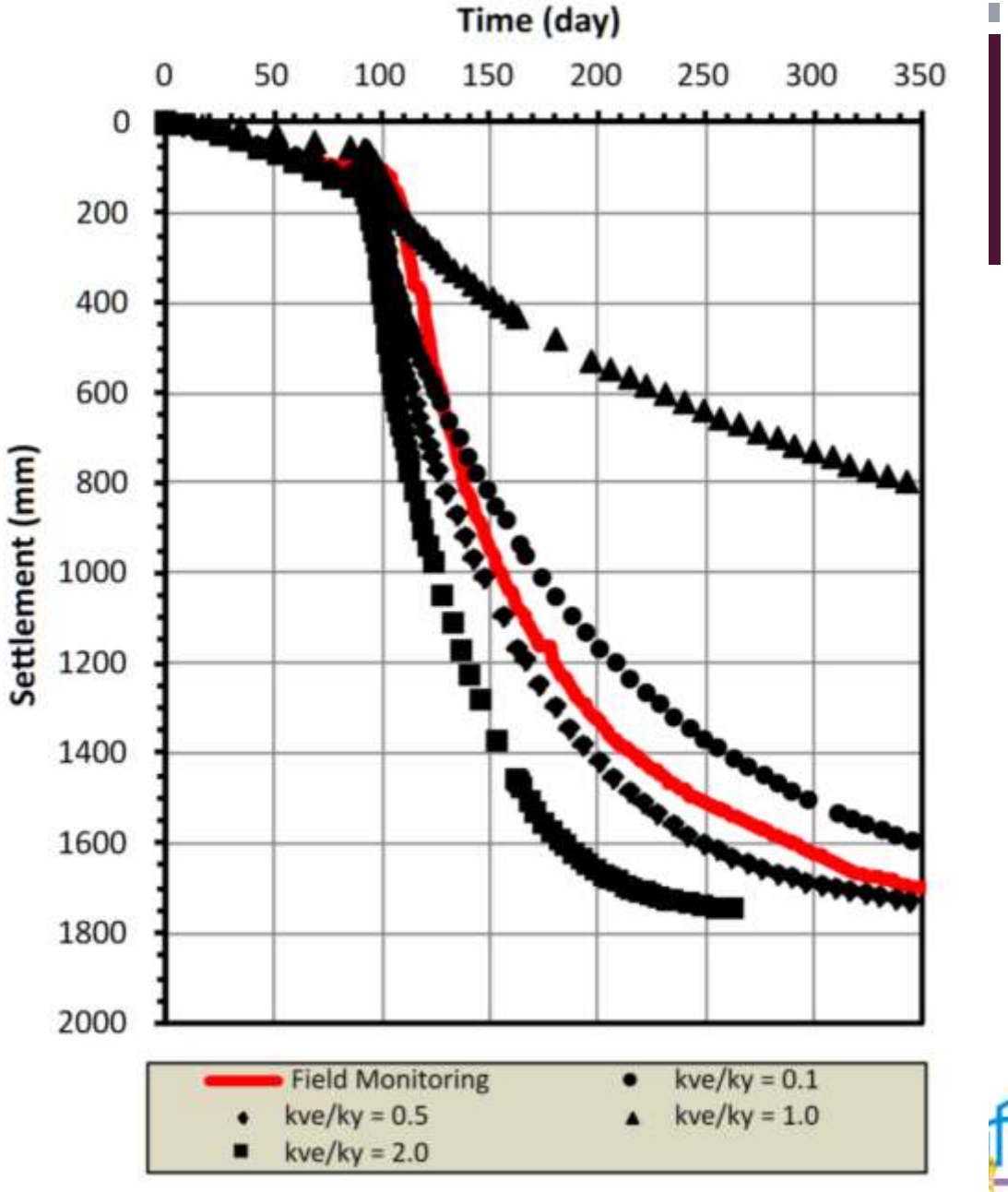
GROUND SETTLEMENT BEHAVIOR
SP-15

SP-15
RMSD for each ratio:
Ratio 0.1 = 146.4
Ratio 0.5 = 34.5
Ratio 1 = 566.8
Ratio 2 = 213

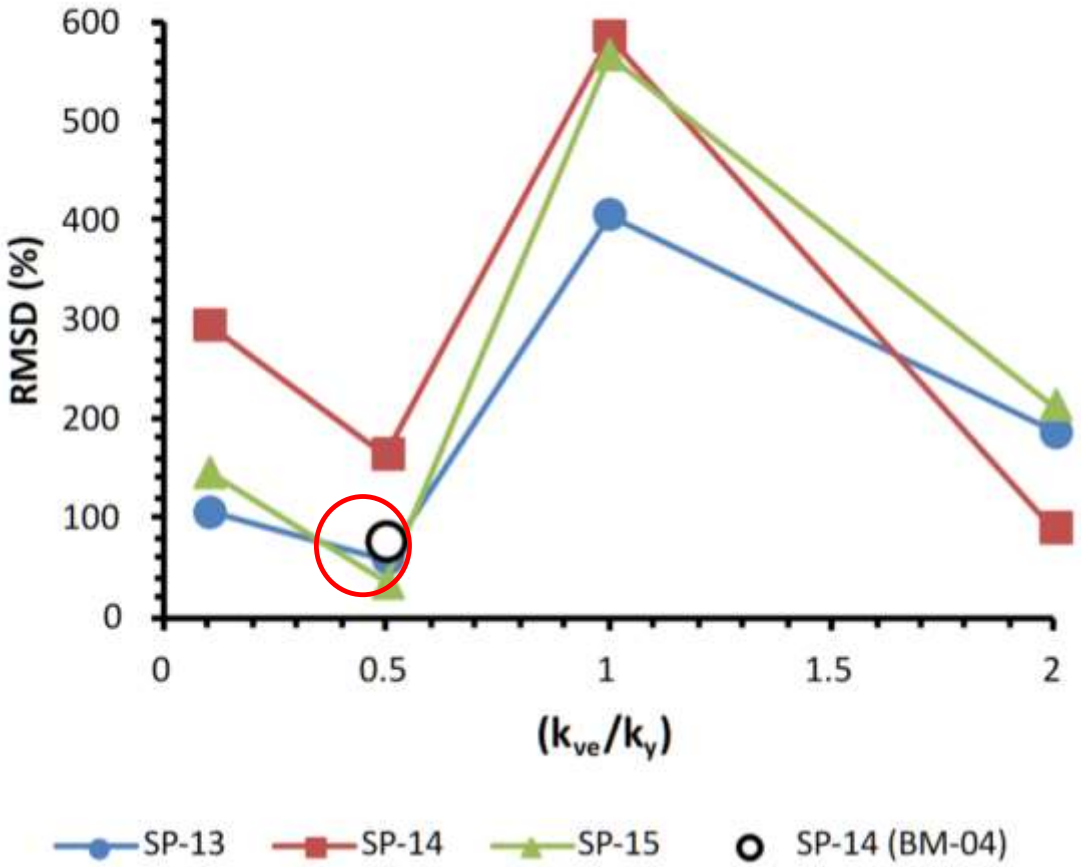


GROUND SETTLEMENT BEHAVIOR
SP-14

SP-14
RMSD for each ratio:
Ratio 0.1 = 107.6
Ratio 0.5 = 163.6 (BM-03)
Ratio 0.5 = 77.5 (BM-04)
Ratio 1 = 584.5
Ratio 2 = 89.1



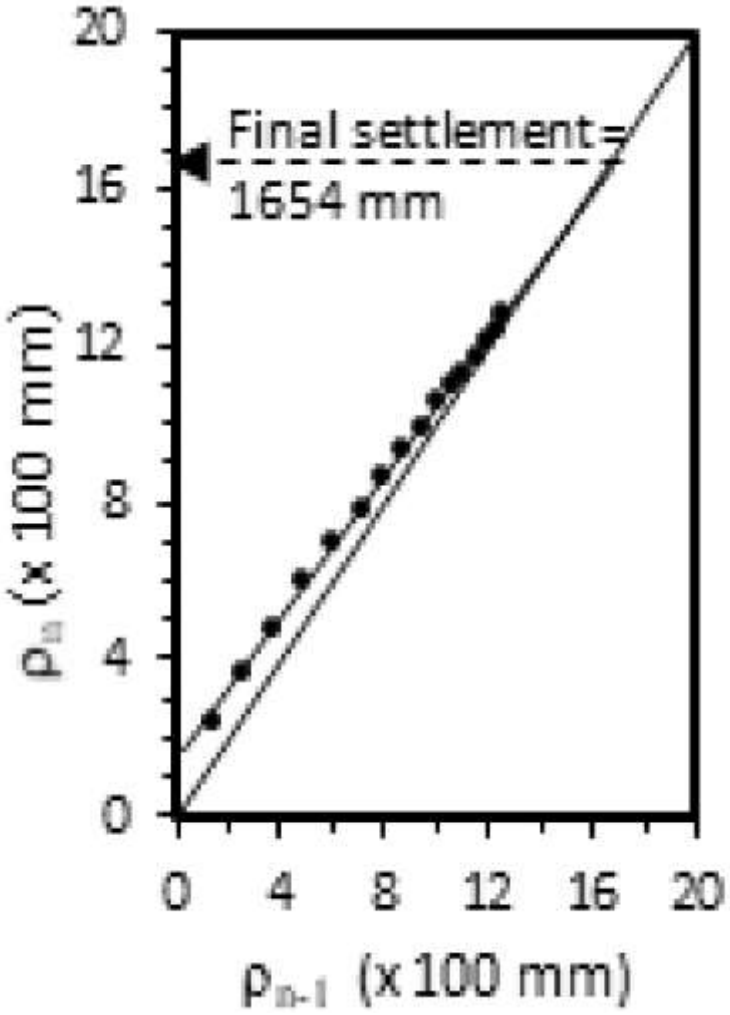
RMSD
(ROOT MEAN SQUARE DEVIATION)



To evaluate the result of ground settlement behavior, the RMSD was analyzed to know which model has lower error from RMSD value.

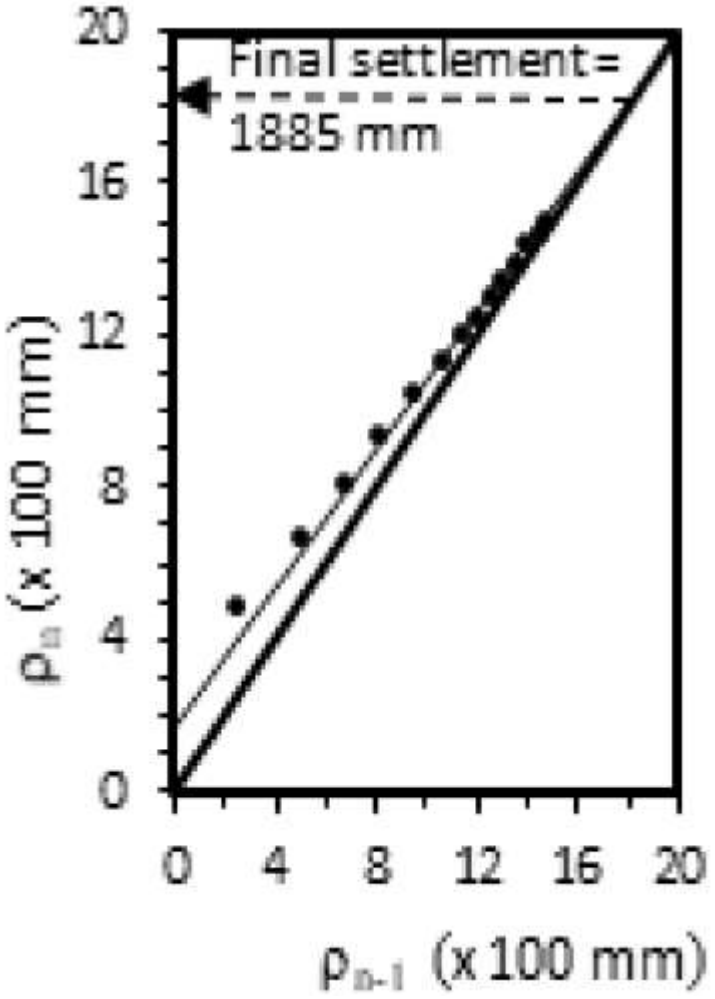
The model with ratio 0.5 has lower RMSD for all settlement plate (SP). Except for SP-14 which has soil characteristic more closely to borehole BM-04 (refer to Fig.1 and Fig. 2). The model of SP-14 has closer result with actual when the model used the soil parameter from borehole BM-04.

ASAOKA METHOD RESULT
SP-13



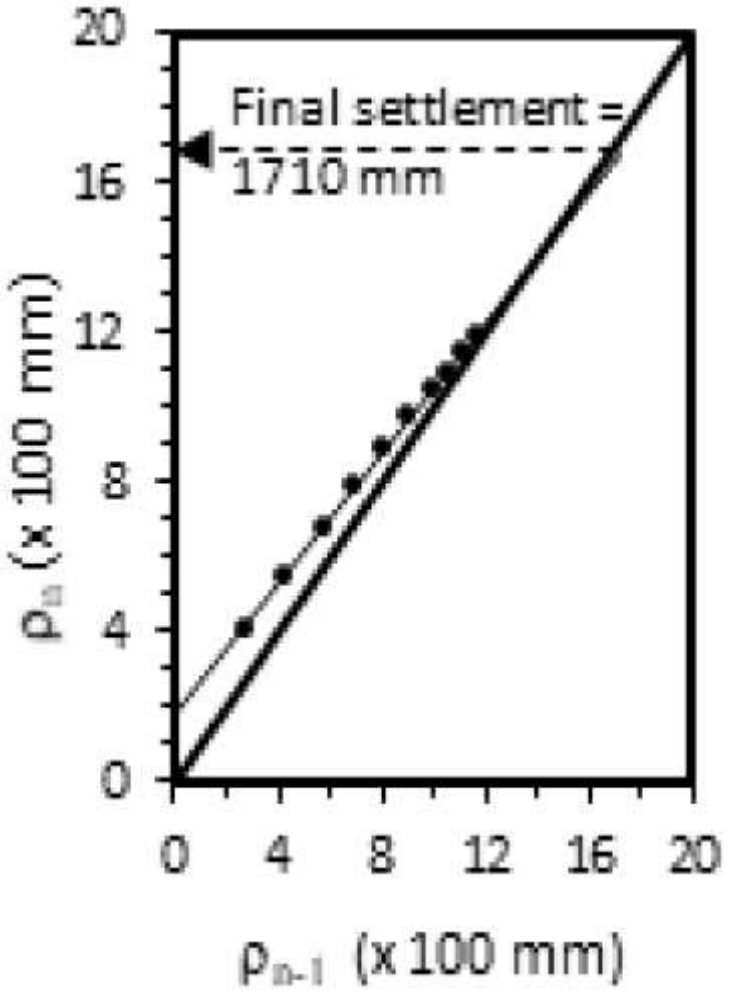
Final settlement
Actual = 1637 mm
Analysis = 1654 mm
Error ratio = +1.0%

SP-14



Final settlement
Actual = 1860 mm
Analysis = 1885 mm
Error ratio = +1.3%

SP-15



Final settlement
Actual = 1701 mm
Analysis = 1710 mm
Error ratio = +0.5%

FINAL GROUND SETTLEMENT

Soil Properties	Settlement Plate	Final Settlement (mm)		
		Asaoka	Numerical	Actual
BM-03	SP-13	1654	1580	1634
BM-03	SP-14	1885	1575	1860
BM-04			1917	
BM-04	SP-15	1710	1746	1701

CONCLUSION

- Asaoka (Observation Method) shows almost perfect proximity to field measurement because the availability of complete observation data
- The ground settlement behavior simulated using finite element analysis produce the closest to the field measured data when the permeability ratio (kve/kv) is equal to 0.5.
- The coefficient of permeability plays crucial role in estimating the consolidation rate and settlement behavior of the soft clayey soil in this numerical analysis.
- Hence, the soil parameter plays a significant rule and is very sensitive in this numerical analysis

THANK YOU FOR YOUR ATTENTION

“If We Knew What It Was We Were Doing, It Would Not Be Called Research”

--- Albert Einstein ---