10TH INTERNATIONAL CONFERENCE ON GEOSYNTHETICS
21 – 25 SEPTEMBER 2014

Hydraulic Reclaimed Sludge Consolidation Using EKG

Yan-feng Zhuang
Associate Professor in Geotechnical Engineering
School of Civil Engineering
Wuhan Uinversity
Wuhan, 430072
P.R.China
(zhuang@tsinghua.edu.cn)

Y. Huang, F. Liu, W. Zou & Z. Li
Wuhan University
P.R.China

Hydraulic reclamation

- Increasing environmental concerns as well as land demands has led to a growth of hydraulic-filled areas.

- Land reclamation has played a significant role in many countries, such as Netherlands, Japan, Singapore, Korea and China.

- A reclamation area of 300 hectare was completed in Wenzhou in 2012 and three artificial islands, whose area is 350 ha for total, is on reclaiming for the Hong Kong-Zhuhai-Macau Bridge project.

Electro-osmosis and EKG by Dr. Yan-feng Zhuang

Hydraulic reclamation

- Large area: Millions of square meters
- High water content & low hydraulic conductivity
- Deep soft ground: over 10 meters and sometimes deeper than 90 meters.

Hydraulic reclamation

- Typical treatment includes two stages

- **Stage 1:** Vacuum consolidation to create a working plan so that construction machine can walk on;
- **Stage 2:** Secondary treatment to meet requirement of specific construction on the ground. (Further consolidation via surcharge, pile, etc.)

Electro-osmosis and Electrokinetic Geosynthetics (EKG)

- Phenomenon of electro-osmosis was discovered by Reuss in about 200 years ago.
- E-treatment has been promising but never popular in projects like large scale hydraulic-filled ground consolidation.
- EKG: New type of geosynthetics proposed by CJFP Jones etc. in ~1996.

Electro-osmosis and EKG by Dr. Yan-feng Zhuang

Patented, mass producible & commercially available in China

- 19m×15m×5.8 m;
- 20 days of treatment, 16 days of intermittence;
- Energy consumption 5.6 kwh/m^3

Case study

- Water content: 62%→36%;
- Unconsolidated-undrained shear strength: 0→25kPa;
- Bearing capacity: 0→70kPa.

- The treatment took only 36 days and it would take 3 years for preloading method to achieve the same effect;
- The preloading need to be 132kPa, which is amount to 6~7m high of soil surcharge.

Challenges for large scale application

- Power source:

Energy consumption is not high compared with vacuum consolidation, but electric power required is much higher.

Electro-osmotic consolidation is much quicker therefore energy input required to be quicker as well, namely, power required is higher.

Therefore, power source is big and heavy.

Electro-osmosis and EKG by Dr. Yan-feng Zhuang

Challenges for large scale application

- Time, cost and bearing capacity

In this case study, the bearing capacity was improved to 70kPa, this is higher than vacuum consolidation (~50kPa).

However, it is not high enough. Usually, construction requires 100kPa or higher bearing capacity. If 70kPa, then secondary treatment of soft ground is still required.

Conclusions

- A novel geosynthetics, EKG, was developed. It is made from electric conductive polymer with two copper wires embedded. The EKG is in a shape similar to PVD and has an electric resistivity of 10^{-3} Ω·m.
- Electro-osmosis took only 36 days to reduce water content of dredged sludge from 62% to 36% and improve the bearing capacity from 0 to 70kPa; It would take 3 years for preloading method to achieve the same effect for this specific case.
- The average energy consumption was 5.6kwh/m^3.

Thank you for your attention. Any questions?

Yan-feng Zhuang
Associate Professor in Geotechnical Engineering
School of Civil Engineering
Wuhan Uinversity
Wuhan, 430072
P.R.China
(zhuang@tsinghua.edu.cn)

Y. Huang, F. Liu, W. Zou & Z. Li
Wuhan University
P.R.China