Questions and Answers in the PIANC Asian Seminar 2024 (Webinar)

Questions to Professor Yoichi Watabe

Question 1

In the case of Haneda Airport, a combination of SD, SCP, CDM and Pneumatic Flow Mixing method, the combination of those is used, but did the difference in consolidation settlement between SD and SCP cause any problems after the airport inauguration, or were any countermeasures required?

Answer 1

Actually, differential settlement was, became a significant problem at the interface structures connecting between reclamation section and piled pier section because of the very significant change of earth pressures.

However, other places, because of acceleration of consolidation or promotion of consolidation by sand drains or sand compaction piles with low replacement ratio, most of settlements have already occurred during the construction period.

That's why most of residual settlement is caused from the deeper portion without ground improvement.

So, my answer to this question is that we already considered these problems and also most of the application of ground improvement do not have this kind of differential settlement problems, generally.

But, in particular cases, like interface structures between/connecting different structures, we need to give special considerations about this.

Question 2

Do you have experience for successful project of Ground/Soil Replacement Method in offshore? If you do, what is your consideration for choosing that method? What is the key to the success of this method?

Answer 2

Because I have been involved in many projects of onshore and nearshore coastal development, I don’t have any experience of offshore ground improvement. If I try to find an answer to this question, I can say that we have to consider limitations of ground improvement method against a large water depth. For example, SCP can be installed up to 70-m depth from a SCP vessel.

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Questions to Professor Jian Chu

Question 1

As for the horizontal drain enhanced geotextile sheet (HDeG), it is stated that the product is patented by Chu and Guo 2015. Is this product already being mass produced? If not so, in the lab-scale or only certain contractors are able to do it?
Secondly, any approximation for cost compared to PVD?

Answer 1

I don't think the method has been adopted on a large scale. It has been used for small scale projects where the horizontal drains were made in a small factory. So, the product hasn't been produced on a large scale as there is no large-scale demand yet. For that reason, it is not available in the market yet. However, if there is a need, it can be produced on a larger scale. In terms of cost, we will not be able to evaluate the cost at this stage as it is controlled by the economy of scale. It is a chicken and egg problem. The cost will go down when there is a larger scale market. Give you an example. When PVD was first introduced to Southeast Asia in the 80s, the cost was more than 10 US dollars per meter. Currently, the cost of PVD is less than a dollar. So that was the economy of scale.

Question 2

As for the installation of this horizontal drainage before dumping the dredge soils, dumping the dredge soils takes a long time in many cases. So, I'm wondering the deterioration or durability of the performance of horizontal drainage enhanced geotextile, could you let us know?

Answer 2

I don't think there's a durability problem because only the placement of a few meters of fill materials is required to cover each horizontal layer. So, I believe you will be able to finish your project within a year, if not a few months, because your whole project duration will be only up to three or four years. The purpose of using horizontal drains is to cut the duration of soil improvement. The horizontal drain is made of materials similar to that for PVDs. The durability will not be worse than PVDs. So I don't think there's a problem with durability. In fact, we have the opposite problem. Plastic is not very degradable. It can be there for a long, long time.

Question 3

Is there any other alternative method to drain out water from soft dredged clay soil at large area without install short PVD / horizontal drain?

Answer 3

Under pressure, water will be drained out from the soil. However, it will take many years. The only way to accelerate the rate of drainage or the so-called rate of consolidation is to reduce the drainage path by using PVDs or horizontal drains. Of course, you can use chemical methods such as the use of cement. However, that will be a entirely different approach.

Question 4

I understand that horizontal drainage (HDeG) is not particularly sloped, but can it drain smoothly? What was the biggest challenge in inventing the drainage method?

Answer 4

No. you do not need a slope for the HDeG to function as a drain as there is a pressure gradient. The purpose of the drains is to release the pore water pressure by allowing water to drain out. The biggest challenge is the use of HDeG is the placement of the fill materials to cover the HDeG in terms of operation.

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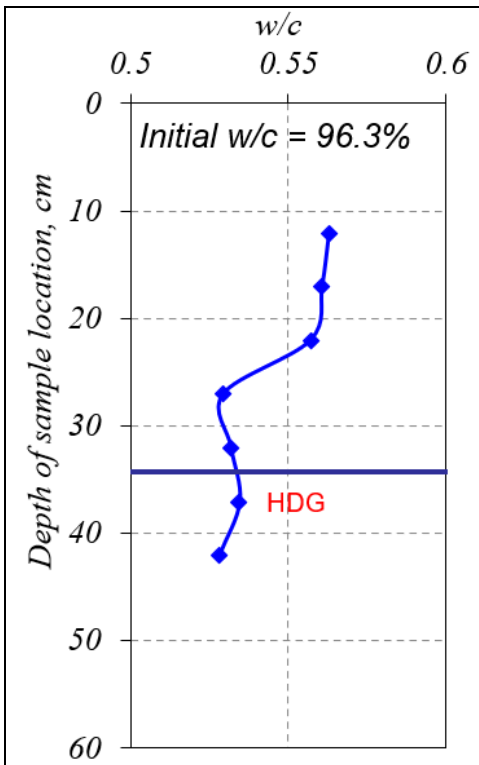
Question 5

In the diagram of water content on your presentation (p.31), the water content is 0.53 at ±10cm of the HDeG sheet, and 0.57 above that, but does the decrease in water content actually become continuous in the direction of depth? Or does it become discontinuous, as in the results of this experiment?

Answer 5



The graph is reproduced in the left. The water content of the soil at 10cm is 57% and 30 cm is 0.53 because the soil at 30 cm is closer to the horizontal drain (HDG) and thus more water could be drained out. This causes the distribution of water content in the soil to be nonuniform. The same happens when PVDs are used.

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Questions to PIANC-Japan*	*This question was initially given to Prof. Jian Chu, however, which is beyond the field of soil improvement. So, PIANC-Japan would like to respond it.

Question

I want to ask, if a port experiences a decrease in sea level so that it makes a port unusable what can be done so that the port can be used again?

Answer

In Japan, we just experienced such a relative sea level fall caused by coastal uplift of approximately 4 meters due to the earthquake that occurred on the Noto Peninsula on January 1, 2024. I think there are two options to deal with a relative sea level fall in a port or harbor. One option is to dredge and deepen channels and basins, where the water depth has decreased due to the sea level fall. In this case, cargo-handling machinery, such as cranes, may need to be upgraded. The other option is to rebuild or extend offshore port facilities, including wharves and breakwaters, to ensure adequate water depth in channels and basins.

In addition, not only coastal uplift but also an increase in ship size including her draft can cause a shortage of water depth in port facilities, which is equivalent to a relative sea level fall. In the same way, the above two options will be effective as well as useful in this case.

(from Yoshiaki Kuriyama, Vice President of PIANC and the Chair of PIANC Japan)

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Questions to Dr. Mitsuo Nozu

Question 1

In this presentation, it says that the amount of cement added to achieve the target strengths varies greatly depending on the clay, but does it vary greatly even for the same site clay?

Also, why does the strength development vary greatly depending on the clay? So could you let us know why its cement content is depend on the clay.

Answer 1

This is because if we have a sandy soil deposit, it's very easy to get the strength as you can imagine the mortar cement which is the only cement and sand mixed and can have a higher strength.

But soft clay like organic clay, it is not easy to get the sufficient strength because sometimes the organic clay disturb the hydration because of the acid effect. So, since we have many kinds of soils, we need to perform the lab mix test prior to the production carefully.

Question 2

So recently, more and more strict requirements degraded on environmental issues when applying of cement, even onshore and offshore construction projects.
Could you share your ideas on the application of CDM in the future, if you consider the environmental issues?

Answer 2

This is a very important issue now. Everywhere, not only in the South-East Asian countries, but in both Japan and the United States also, they request environmental impact verifications for the DMM work. However in Japan, we have a long history of DMM in the past over 40 years, and we have many testing data, for example, the turbidity and pH value data in the sea or river.

So, every time we have to provide that kind of data to the client in each project, and also we need to perform all the required test to get an approval. For example, in Hong Kong airport runway expansion project, the government request us to many tests for the water quality and fortunately we could pass in their strict regulations.

Question 3

Does we can use on seismic fault zone?

Answer 3

As you may know, in Japan, we have had many serious earthquakes so far and it has been verified the effect of DMM (Deep Mixing Method). For example, in Noto Peninsula Earthquake (2024.1.1, M=7.6), the river dike in Niigata city has no damages/no liquefaction because the whole dike has been protected by grid-type DMM layout. Grid type DMM has a function to reduce the shear deformation and excess pore water generation in the loose sandy ground.

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Questions to Dr. Le Phuong Dong

Question 1

In your presentations, do you use a placed Cement Pipe Mixing clay soil above the CDM ground? But the procedure is maybe the opposite, CPM first, then CDM is installed below the surface to the CPM clay layers, but shear strength of cement pipe mixing, or pneumatic flow mixing is approximately 200 kPa, but the deeper portion, CDM, it's CDM column, its strength is maybe 2 megapascal or something, maybe 10 times higher than 200 kPa. So, those significant differences in shear strengths may cause some problems. So do you have any problems about caused by this significant difference in shear strengths of the materials?

Answer 1

Actually, we didn't observe any problem. The CDM column itself has a very strong capacity and it works like a concrete pile. The CPM column has a lower strength compared with the CDM column (4 times), but it's still much stronger and more rigid than sand. As you can see from cross-section, the design capacity of CPM is 200kPa, but constructed strength is more than 500kPa on average. This is strong like very hard clay. So, we assumed that it would behave like a rigid structure, and that we can verify its performance via bending and punching check with some safety margins.

We don't have any concrete evidence to prove the performance or to prove the rigidity of mixture of the CPM and CDM columns except for settlement data that we are collecting. This is the very first project that we combined those two techniques, thus our understanding on the performance of CDM combined with CPM is limited. In the next phase we are going to install various sensors into the ground to understand the performance of improved ground as well as the performance at the interface area.

I just want to correct what you misunderstood about the construction sequence. We constructed the CDM first and then we placed the CPM on top. This sequence has a drawback that CDM near the top of the pile may not be well mixed due to the dispersion of cement into the water column. In fact, when we tested the strength of CDM by coring tests, we experienced about one meter at the top CDM column without a good mixing. But the strength is still more than 200kPa, so we assumed that it still could work like a CPM. Therefore, we allowed the contractor to move ahead with the construction of CPM without any further treatment for the portion of lower strength at the top of the CPM column. So far, there is no issue such as crack or huge settlement.

Question 2

As to the length of the bamboo pile, in your figure presentations, the length is 12 meter long. Do you have any limitation of the bamboo pile lengths, or can you connect two or three bamboo piles to make it longer than 15 meter or something?

Answer 2

At our project, and normally in Indonesia we cannot find any bamboo pile longer than 12 meters. That's why in my design drawings, it shows only 12 meters bamboo piles. At the construction site we finally used 10 meters piles because we figured out that up to 10 meters from the seabed we already found the medium clay.

Regarding the question about the connection, I don't think connecting two or more piles is a good idea because the buoyancy makes it very difficult to control the driving. How can we drive a bamboo pile with buoyancy characteristics at the deep-water area? To against the buoyancy, we need to drive the larger part of bamboo into the ground with only one punch to keep it fixed first. If we, for example, connect several bamboos to make it, say, 20 meters long, driving to fix it in the ground is not that easy, especially at offshore sites. So, I don't think that it is practical.

Question 3

How do the CPM and CDM methods influence project efficiency and quality in the development of Patimban Port?

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Answer 3
The impact of the CDM and CPM method in our project is very significant. As I explained earlier, the congestion at Tanjung Priok port is very serious, thus our Employers have requested us to complete Phase 1-1 of the project as soon as possible, in about 2-2.5 years' time without the sacrifice for the quality.
When we examined various methods for soil improvement and reclamation work, we concluded that only CDM-CPM solution can help us to deliver the project in such a short time. In fact, we could complete the project within 33 months despite Covid 19 disruption. Specifically, the reclamation works including the soft soil treatment of 64 ha of land is completed in less than 24 months. For comparison, it took about 4 years to complete 40ha reclamation at Haneda Airport runway D by using different soft soil treatment methods such as sand compaction piles.
In terms of quality, up to the current date, the large consolidation settlement has not been observed. After 3 years, the measured settlement is in the range of 1-2cm. Please note that for a similar large scale reclamation project in the Jakarta area, the residual settlement of 5-10cm in a single year is a norm for Java clay.

Question 4
In the CPM and CDM applications, how do you control the secondary/residual settlement occur for the design lifetime? And are there any requirements for the occurrence of the residual settlement?

Answer 4
Our design concept is to embed the CDM columns to the stiff layer (NSPT >10). In Japan, this layer is often selected as fixed foundation with minimum consolidation settlement beneath the CDM column tips. So, we do expect that only the settlement occurs from the tip of CDM upward to the surface would matter us. However, as I explained in question 1, we assumed CDM-CPM would work like a rigid structure. Therefore, we didn't expect any residual settlement rather than deformation of CDM column or the bending deformation of CPM beam itself. We are still monitoring the settlement of our terminal, and we noted that the settlement has not developed further during the last year.
For your information, there is no specific requirement for the occurrence of residual settlement in Japanese port standard. However, 30cm unbalanced settlement between the quay wall and rear terminal area is often adopted as the threshold for a major maintenance work.

Question 5
Your presentation on bamboo pile foundations was very interesting. In your opinion, are there any other materials that are as effective as bamboo? For example, has wood or rattan been tested?

Answer 5
I would think the use of bamboo for soft soil strengthening has much more merit than wood or rattan, and so far I don't find any material better than bamboo. The unique characteristics of bamboo are its high strength-to weight ratio, especially tensile and shear strength thus can provide significant shear resistance for original ground. Furthermore, bamboo piles are more durable than wood or rattan when it is submerged.

Question 6
As to bamboo piling, could you provide more information about the bamboo pile retrieval from 1961? I understand bamboo is an organic material, but to what extent was it preserved in its natural state? Additionally, what driving methods were used during the installation of bamboo piles, and what challenges, such as breakage or damage, were encountered?

Answer 6
Unfortunately, I don't have any further information about that bamboo retrieval apart from the visual check. Currently our project team is collecting further data.
We used a guide frame to fix the bamboo into the driving position, and then a hanging hammer will be used to drive it. The hammer and wire sling used for driving the bamboo piles will be marked to provide a visual reference, allowing the team to measure and confirm that each bamboo pile reaches the specified depth below the seabed.
The challenge that we normally encounter is the breakage of bamboo at the very first blow. Bamboo is lighter than water (700-800 kg/m3) so it is floated inside the guide frame. Therefore, the first blow to fix it to the seabed is always the most difficult part.