Bringing mass stabilisation technology to China

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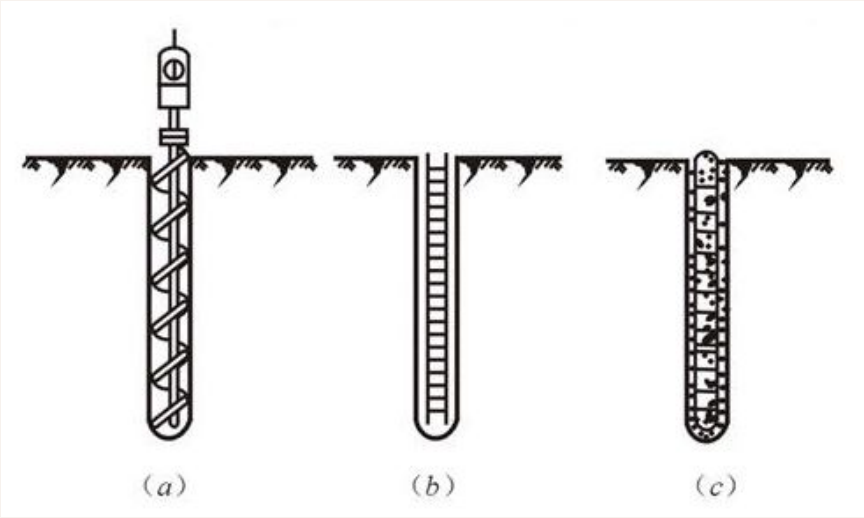
Contents

1. Background
2. Pilot test preparation
3. Major Construction Procedure
4. Results of the pilot test
5. Quick view of another case and potential application in China

Background



Major construction procedure of borehole pile

The bore hole cast-in-situ pile foundation has been widely used in foundation Engineering.

Soil slurry was commonly used for dealing with caving or squeezing soils.

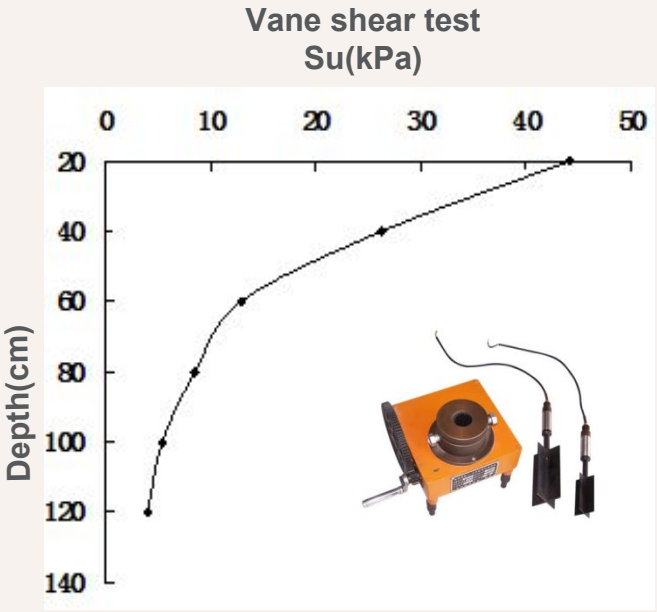
The drilling slurry was usually a mixture of water and benonite clay.

Background

Site photo-soil slurry storage area in Yuhuan

- The site was used for soil slurry storage in YUHUAN city.The total area of the storage site exceeds 300,000 m^2.
- A playground will be developed at the slurry storage site.
- **Different regions will meet the different requirements of bearing capacity .**

Pilot test preparation



Only top 10-20cm is hard soil layer.
pH is neutral or slightly alkaline(7-9),
natural water content is around 90%.

Pilot test preparation

Basic physical parameters of the in-situ soil

			Particle size distribution			
Liquid Limit W_L	Plastic Limit W_P	Plastic Index IP	sand 0.25-0.075 mm	silt 0.075-0.005mm	clay < 0.005mm	specific gravity Gs
45.8%	21.1%	24.7	6.1%	63.6%	30.3%	2.74

Natural water content 87.7%, Natural Density 1.6g/cm³.

Unconfined compression test

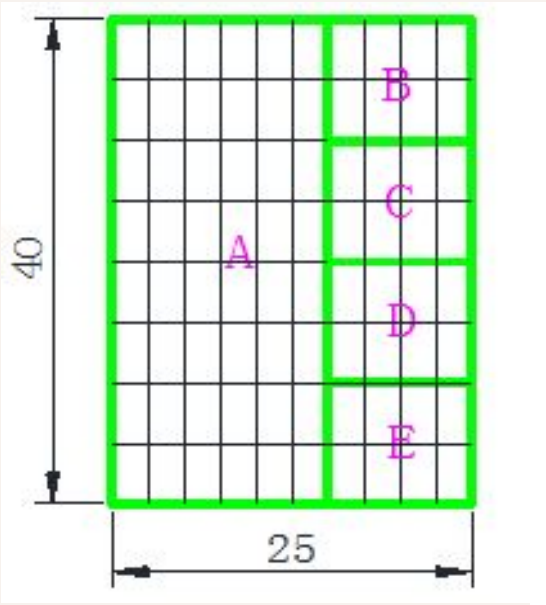
To determine binder recipe.

Portland cement,quick lime, blast furnace slag,plant ash,sand etc. were used to stabilise the soil slurry in laboratory.

The strength of stablised soil at 7days, 14days and 28days were measured at laboratory. Finally, we chose two type of binders (Binder A & Binder B).

Binder A and B -cement + fly ash with different ratios.

Pilot test preparation



unit: m

Block	Bearing capacity requirement / kPa	Total depth/m	Treatment depth/m	Treatment area/m^2	Treatment volume/m^3
A	50	1.4~4.0	1.3	600	780
B	50	1.2~1.5	1.4	100	140
C		1.3~2.3	1.9	100	190
D		2.1~2.3	2.3	100	230
E	80	2.2~2.5	2.5	100	250
In total				1000	1590

The pilot test area was divided into 5 blocks.

Major Construction Procedure

Block	Binder	Depth	Vane shear test		Plate load test	
			Date	Finish time	Date	Finish time
A	A	1.3m	2015.01.25	37	2015.01.31	43
B	A	1.4m	2015.01.25	31	-	-
C	0~1.2.m:A 1.2~1.9.m:B	1.9m	2015.01.25	31	2015.02.01	38
D	0~1.1.m: A 1.1~2.3m:B	2.3m	2015.01.25	30	-	-
E	0~1.4m: A 1.4~2.5m: B	2.5m	2015.01.25	29	2015.02.02	38

Single point mix

Mix in small blocks (**5m×2.5m**)

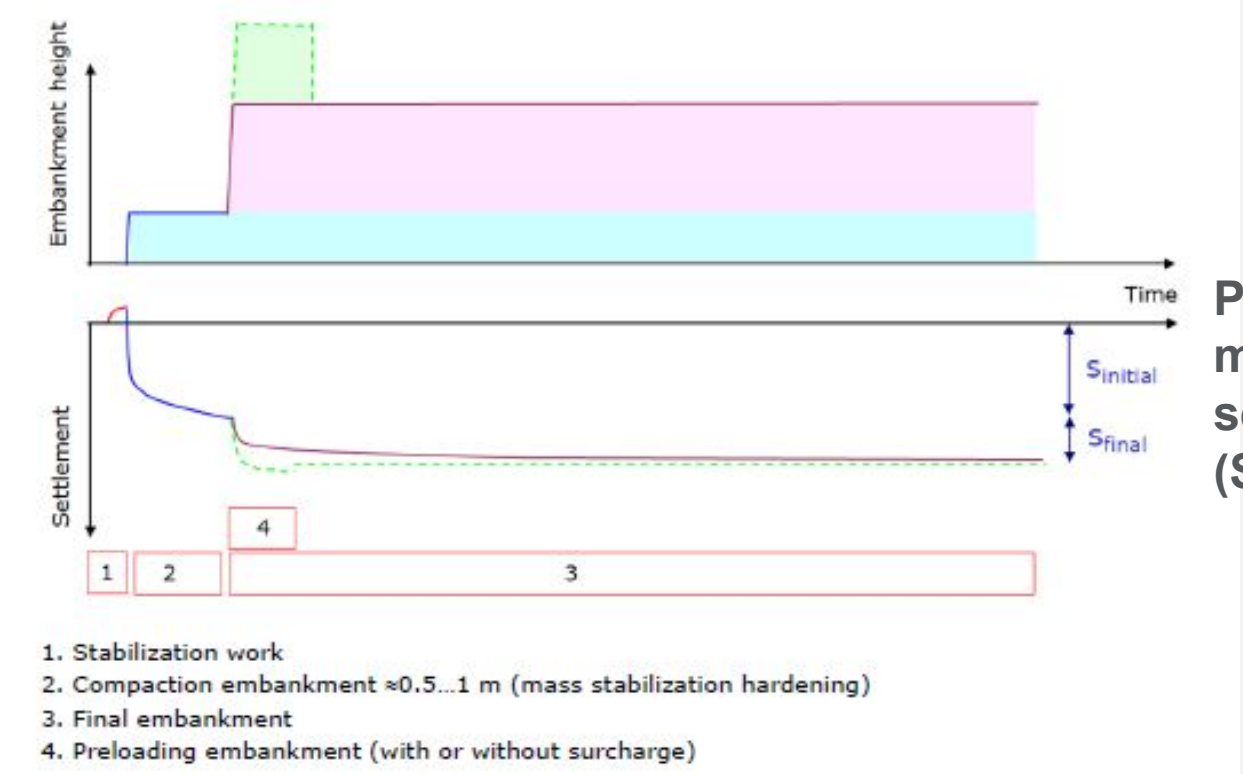
Major Construction Procedure

Precompress treated area

Leveling the site

Major Construction Procedure

Use the self-weight of the excavator as the preloading.



Phases of settlement in mass stabilized layer and settlement time diagram. (Source: Forsman 2008).

Major Construction Procedure

After site formation

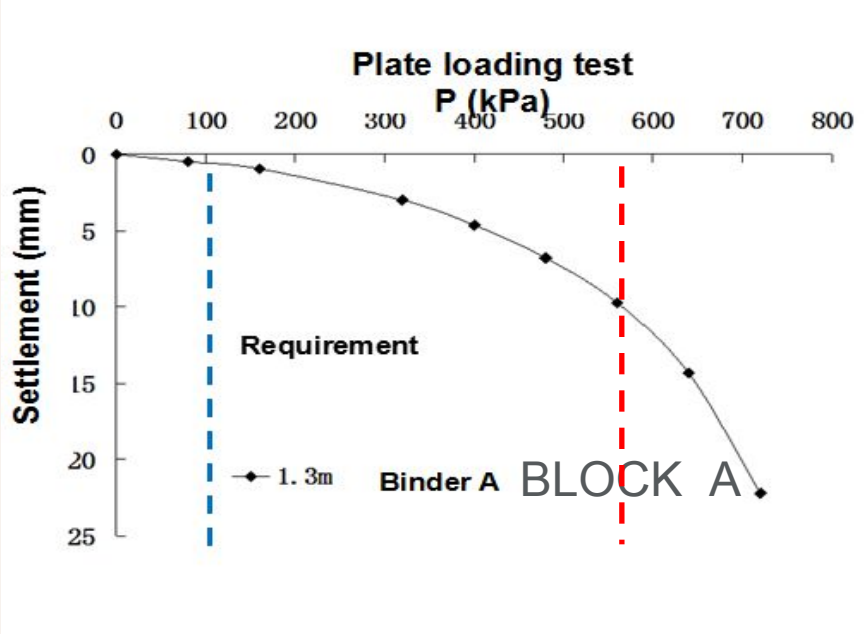
Close view

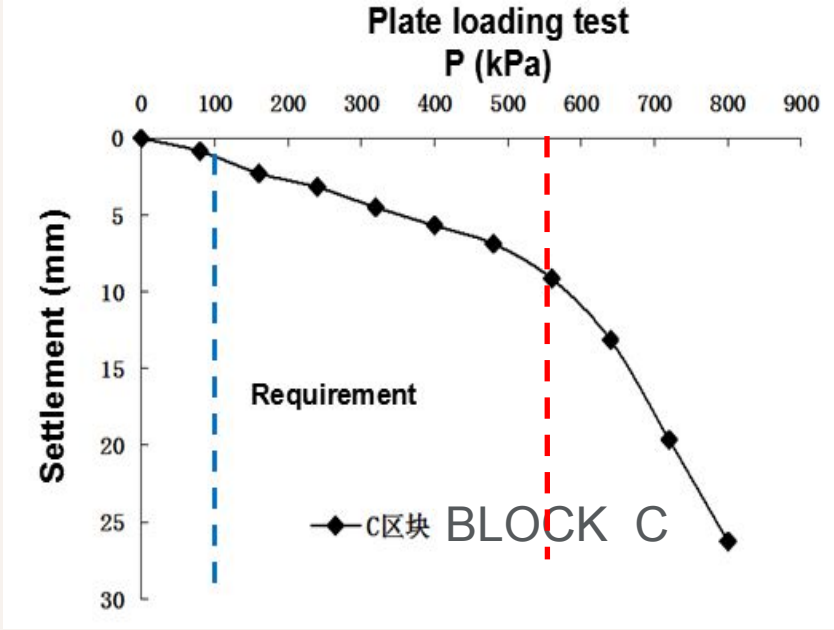
Quality control

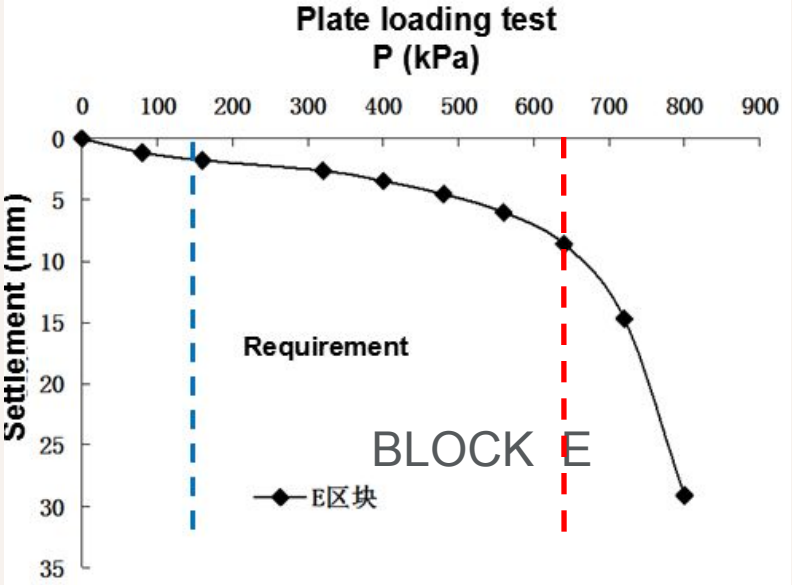
CPT

PLT

Results of field test







Results of field test

Summary of test results

Block	Binder	Depth	Vane shear test		Plate load test	
			Su（kPa）	Finish time (days)	fa（kPa）	Finish time (days)
A	A	1.3m	168.7	37	240	43
B	A	1.4m	178.4	31	-	-
C	0~1.2.m: A 1.2~1.9.m: B	1.9m	158.5	31	280	38
D	0~1.1.m: A 1.1~2.3m:B	2.3m	110.3	30	-	-
E	0~1.4m: A 1.4~2.5m: B	2.5m	112.8	29	320	38

The cost of the soil slurry treatment is approximate 15€/m^3

Ground improvement 2nd stage

PVD

Deep mixing column

Precast pile

Quick view of another case and potential application in China

Excess sttlement after construction at the connection portion between bridge and road.

Quick view of another case and potential application in China

A road embankment construction

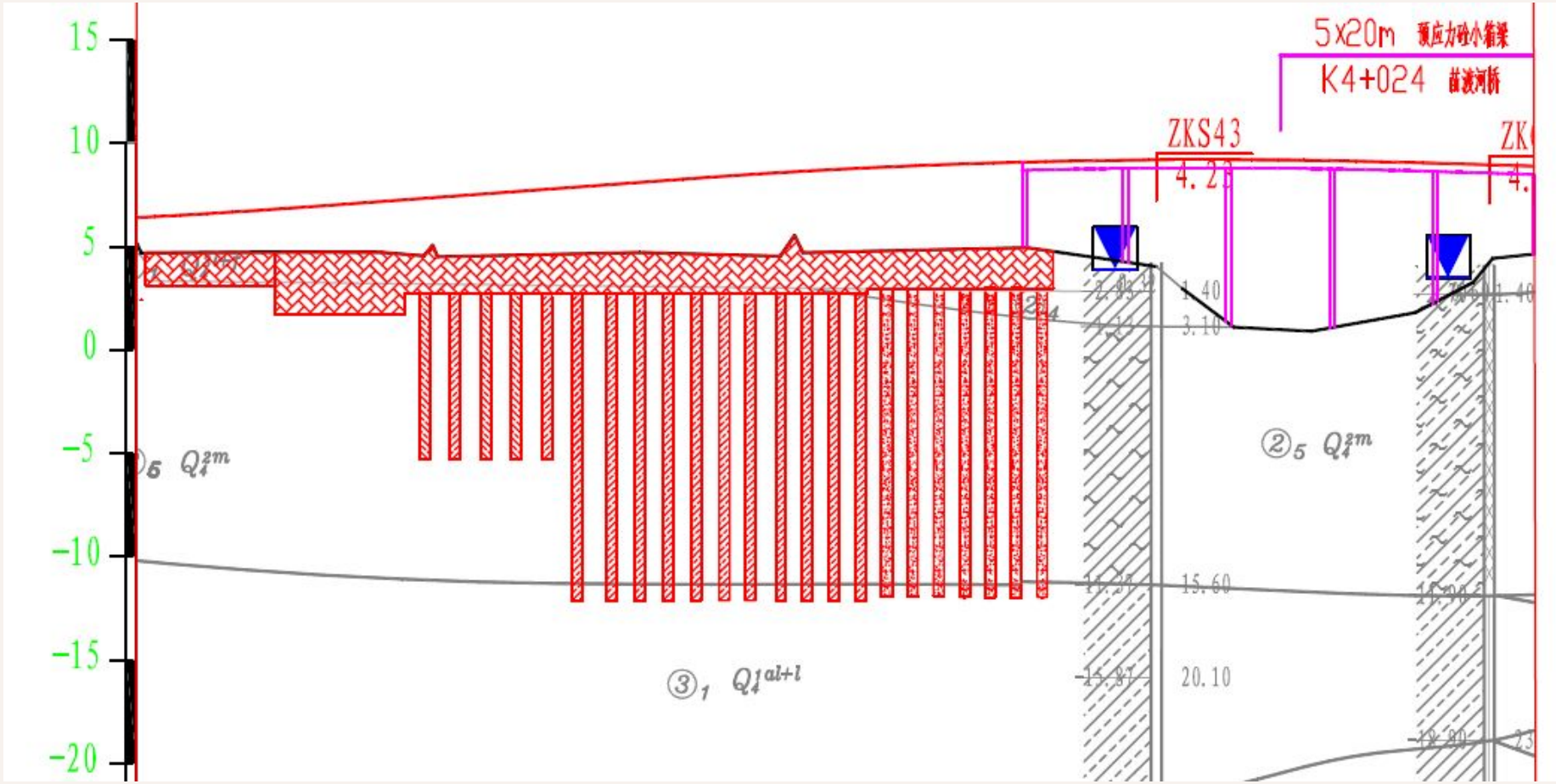
Basic information of the mass stabilisation area

Mass stabilised area is approx. 50m * 176m = 8800m²

The depth of the mass stabilisation will vary from 1.6 meters up to 2.6 meters.

As a binder, normal cement is used around 130 kg/m³.

(Wet-binder Cement slurry is used in the project.)



Geological profile


Before


After


专业软基板块造地

Stabilisation in blocks, when pulling the mixer out of the treated soil, a large cavity will be formed.

How to deal with this problem?

Quality control

Two key issues about embankment filling in Chinese standard:

- Degree of compaction

The degree of compaction of a soil is a ratio between field dry density and the max dry density.

- CBR

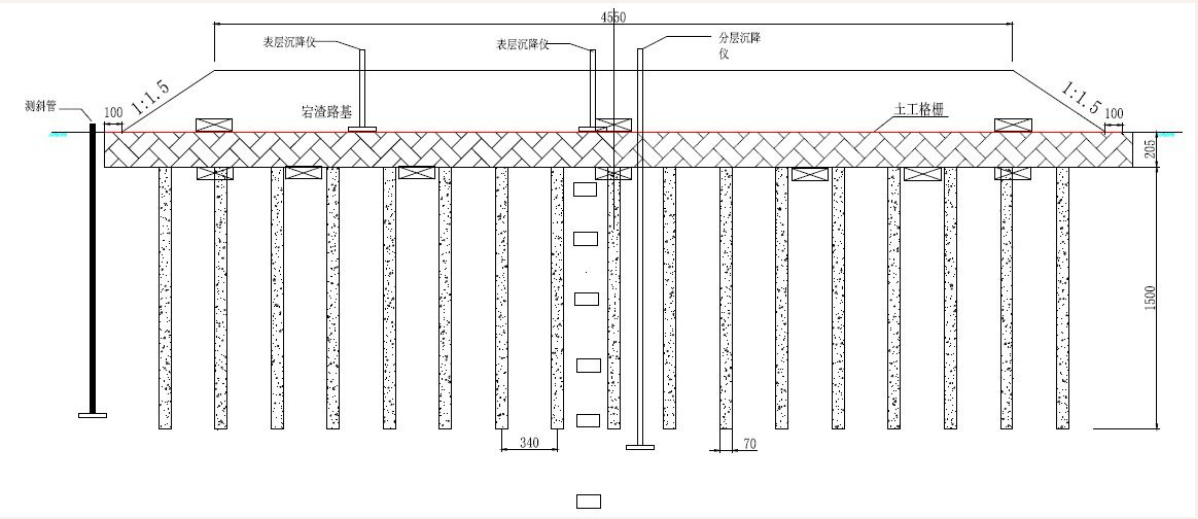
California bearing ratio (CBR) is a technical judgment indicator of the intension of subgrade and pavement strength. It is important to the selection of subgrade padding.

$$CBR = \frac{p}{p_s} \cdot 100$$

CBR = CBR [%]

p = measured pressure for site soils [N/mm²]

p_s = pressure to achieve equal penetration on standard soil [N/mm²]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表层沉降仪
分层沉降仪
测斜管
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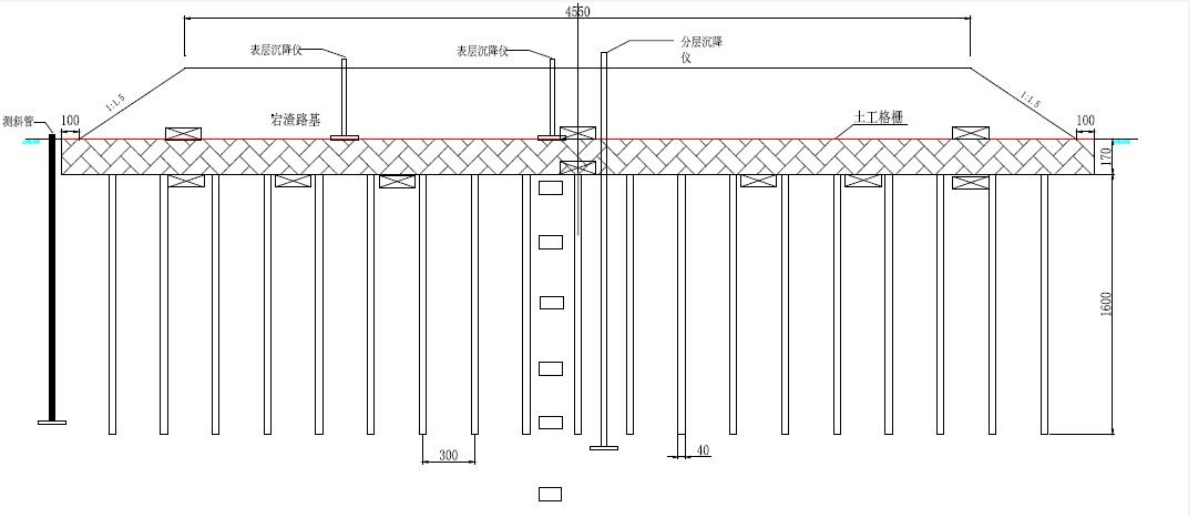
1:1.5
岩渣路基
土工格栅
1:1.5
100
205
1500
340
70


4550
表层沉降仪
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分层沉降仪
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岩渣路基
土工格栅
1:1.5
100
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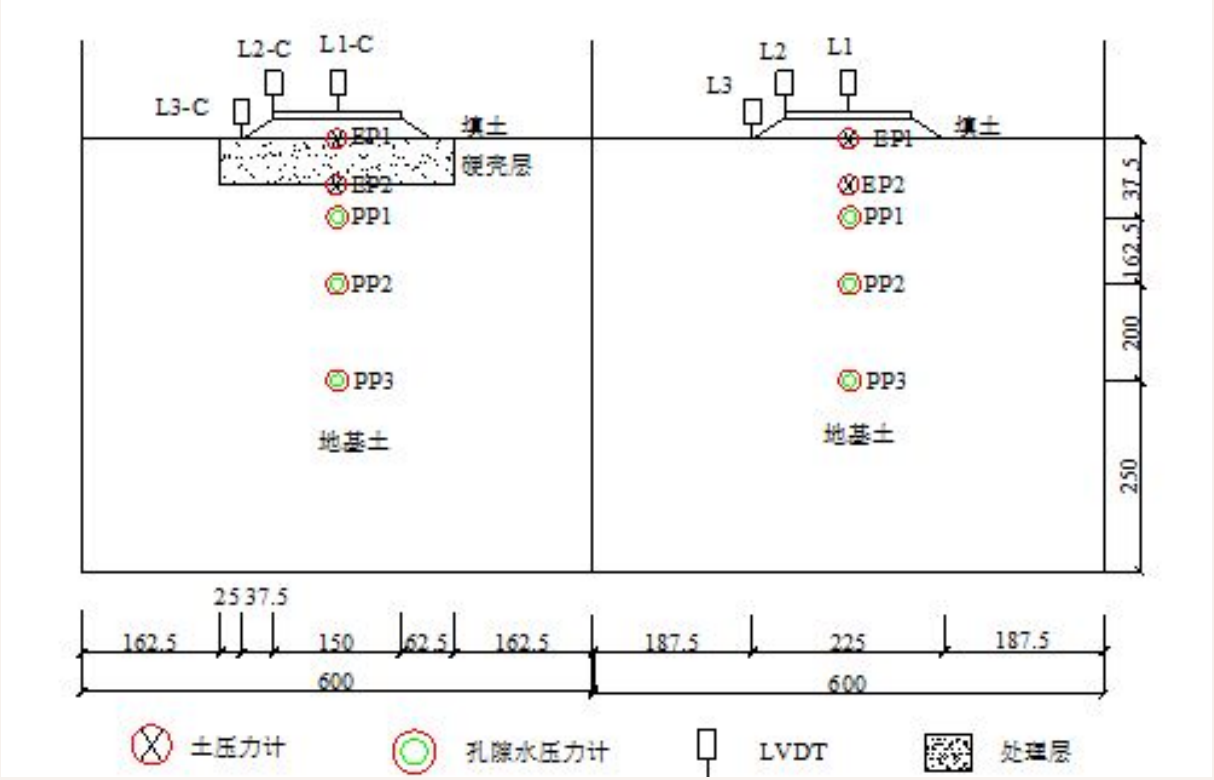
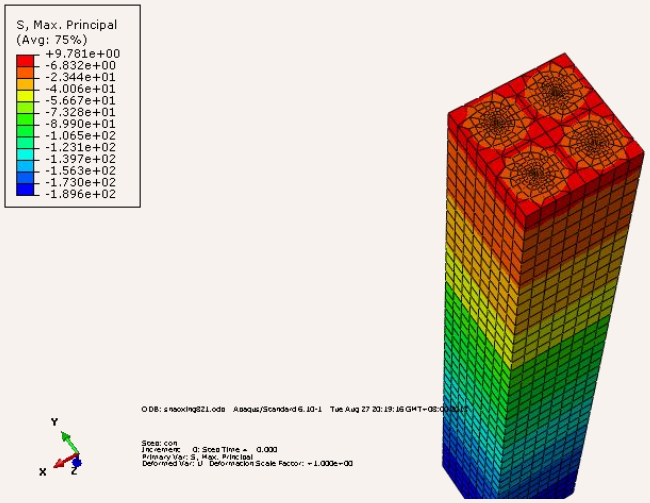
1600
300
40



Centrifuge test

FEM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(Avg: 75%)
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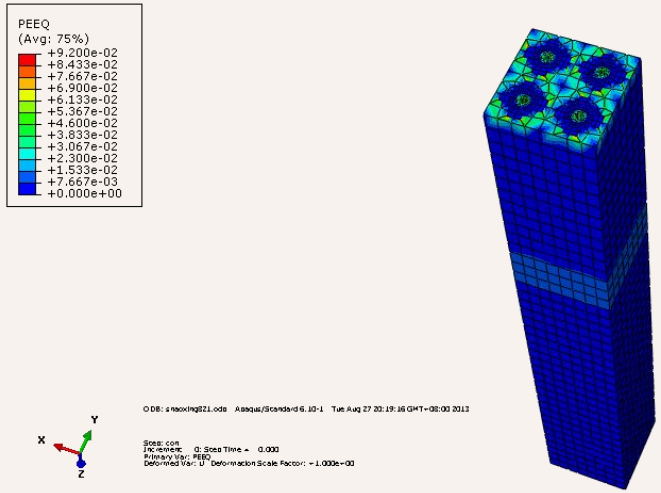
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(Avg: 75%)
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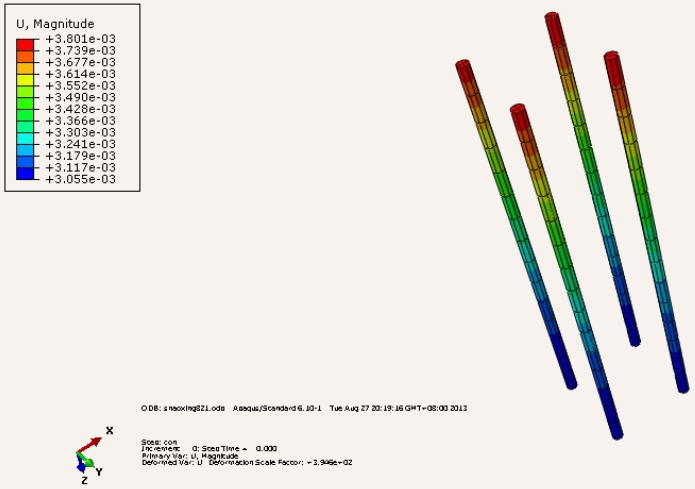
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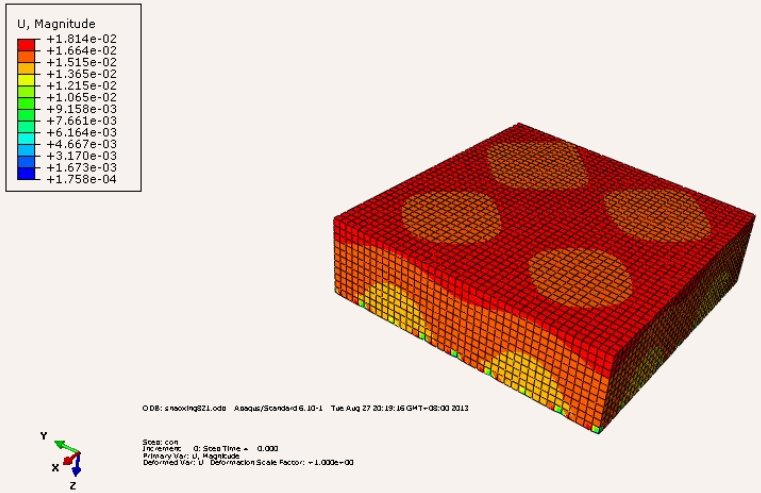
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+4.667e-03
+3.170e-03
+1.673e-03
+1.758e-04

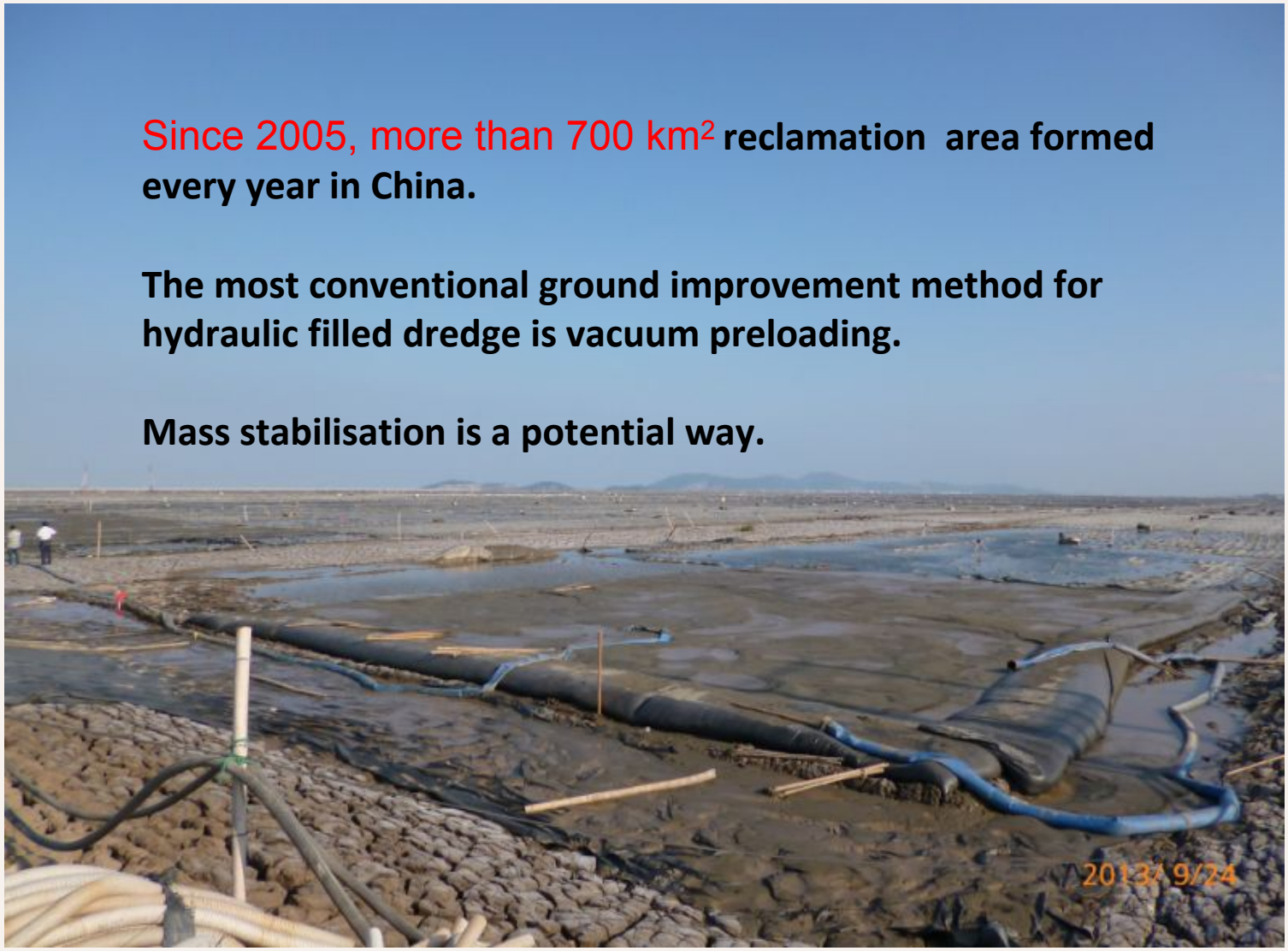
Potential application in China

Contaminated soil (from sewage plant) treatment

Potential application in China

Hydraulic filling for ocean reclamation

25



Reclamation area treated with Vacuum preloading

Mass stabilisation for hydraulic filled dredge (Wenzhou, China)

River dredging

Small river dredging

Caustic sludge/Alkaline residue

(calcium chloride, calcium carbonate, calcium sulfate)

Thanks for your kind attention!