Ground Improvement Techniques in Land Reclamation

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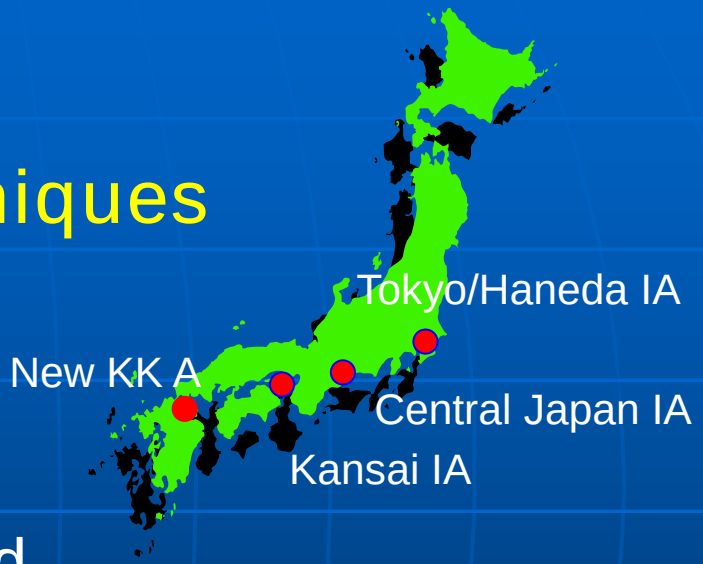
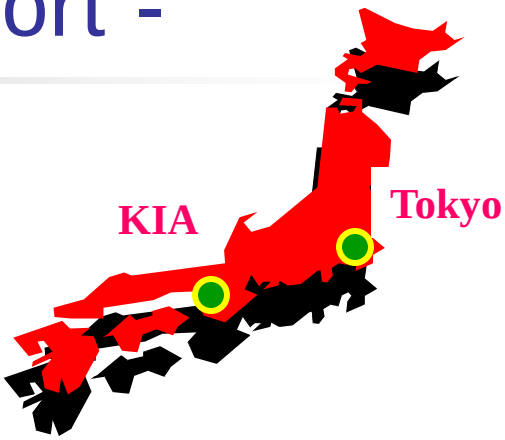


Kansai International Airport

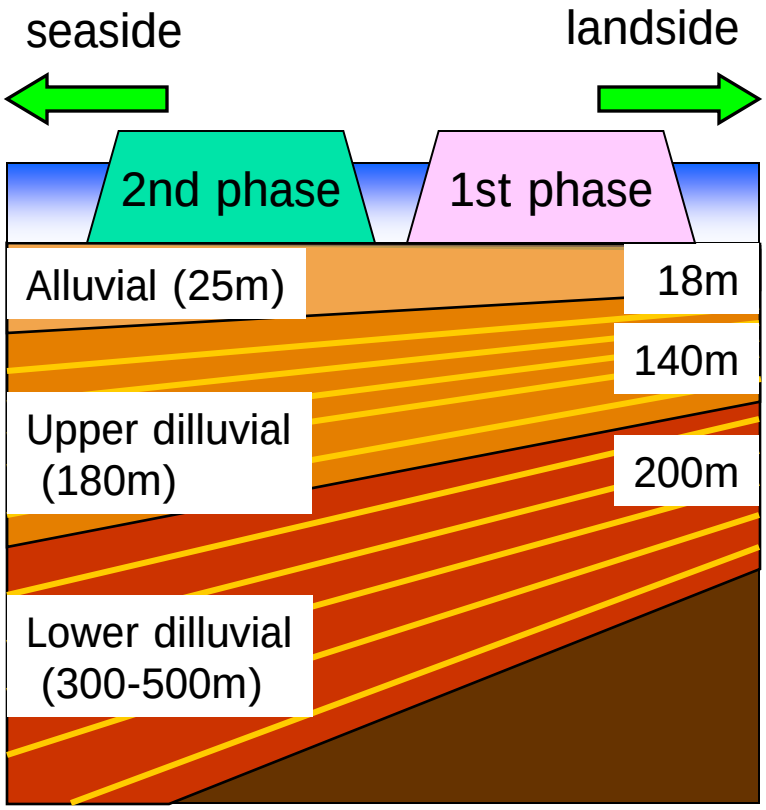
- Land Reclamation with mountainous soil
- Sand drain method

Land Reclamation with Mountainous Soil - Kansai International Airport -



	area	total of seawall length	reclaimed sand	Ave. seabed depth	Ave. estimated settlement
1st phase	510 ha	11.2 km	180 Mm^3	-18 m	11.5 m
2nd phase	545 ha	13 km	250 Mm^3	-19.5 m	18 m

Geotechnical condition

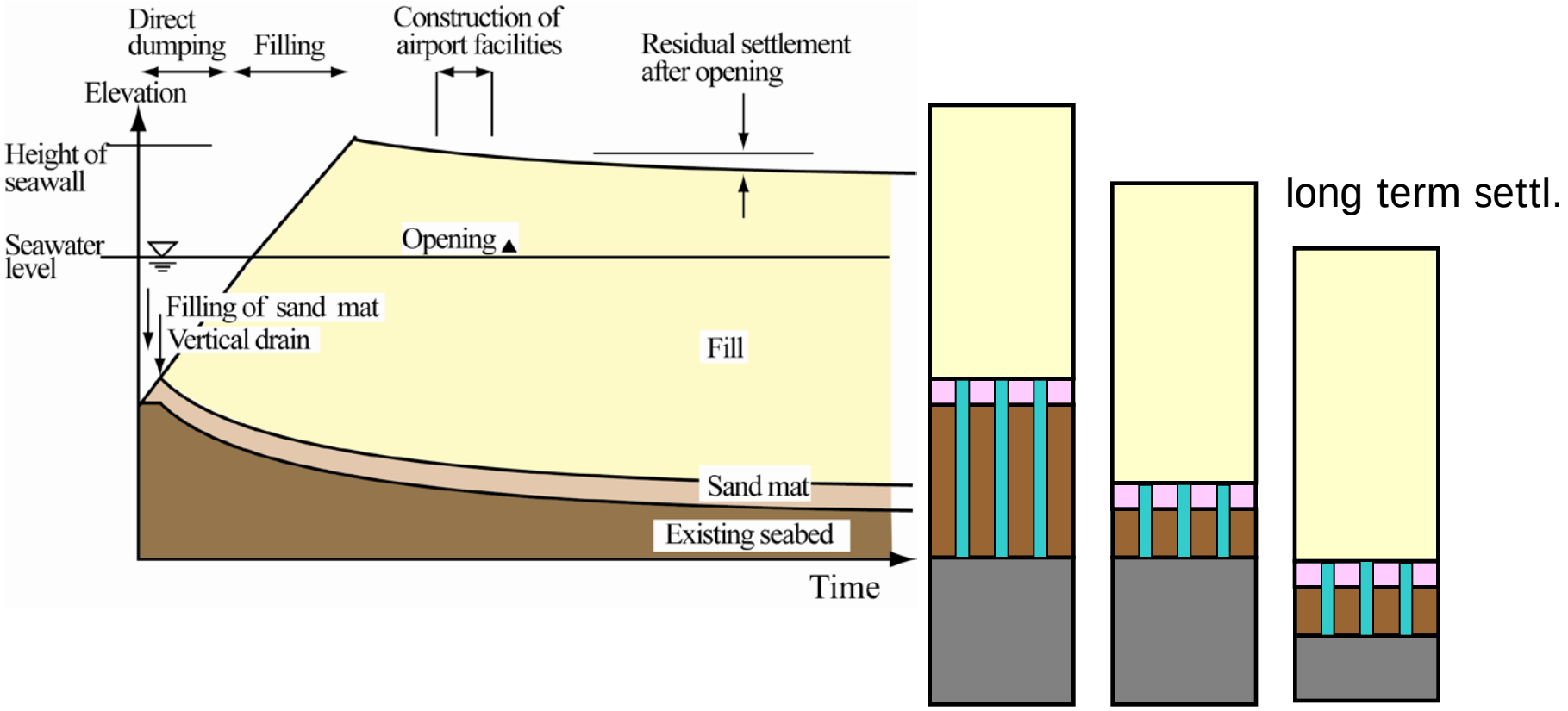


Water depth: from 18 to 20 m.

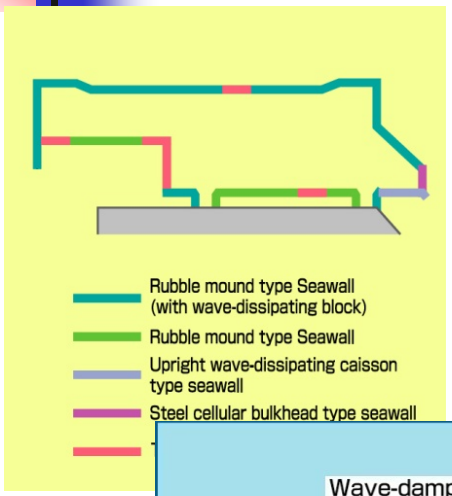
Alluvial layer:
thickness: 20 m to 25 m
normal consolidation condition
natural water content of 80% to 120%
q_u increases with depth.

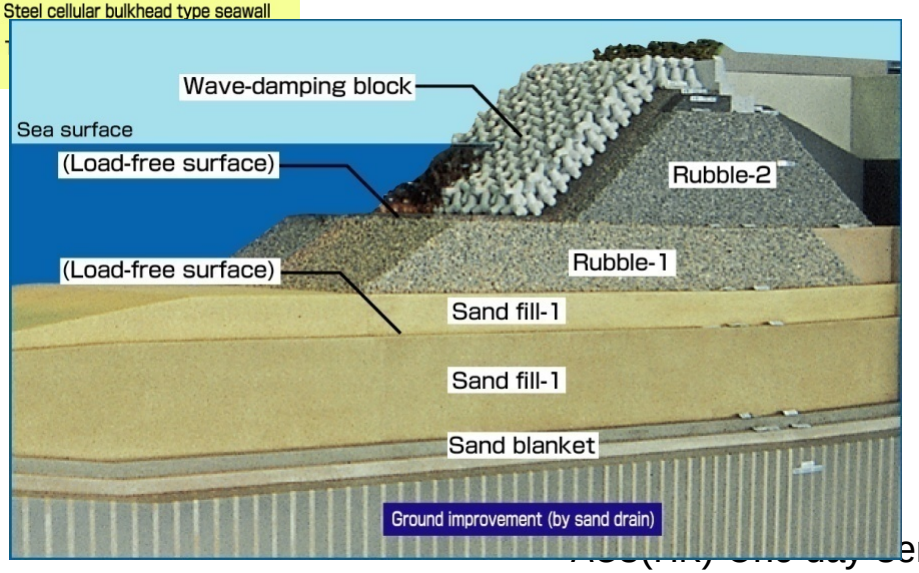
Dilluvial layers:
over-consolidated Pleistocene clay,
OCR value of around 1.3

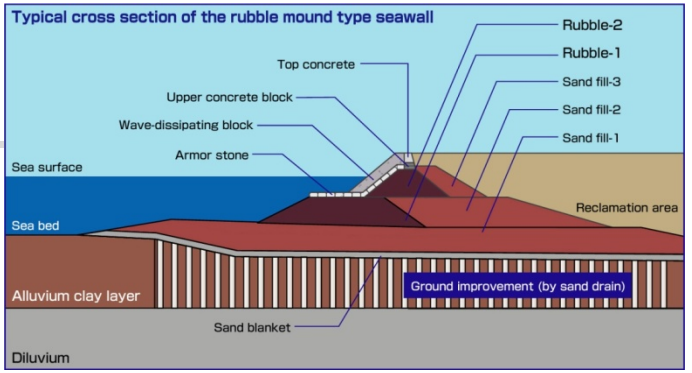
construction scheme

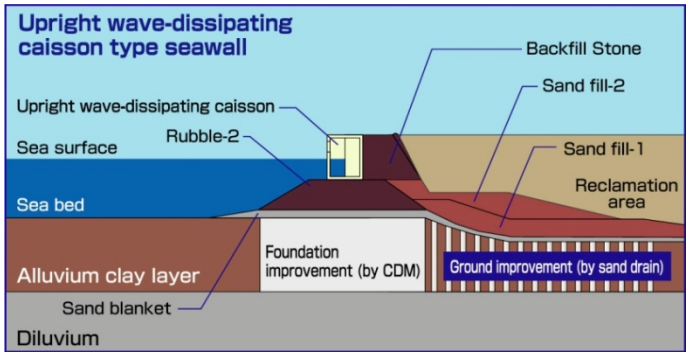


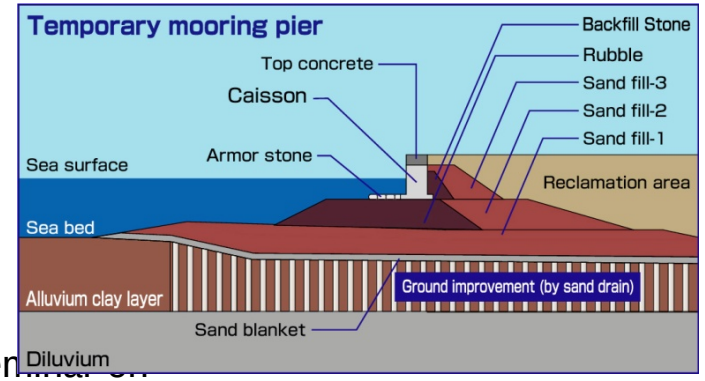
Seawall dike



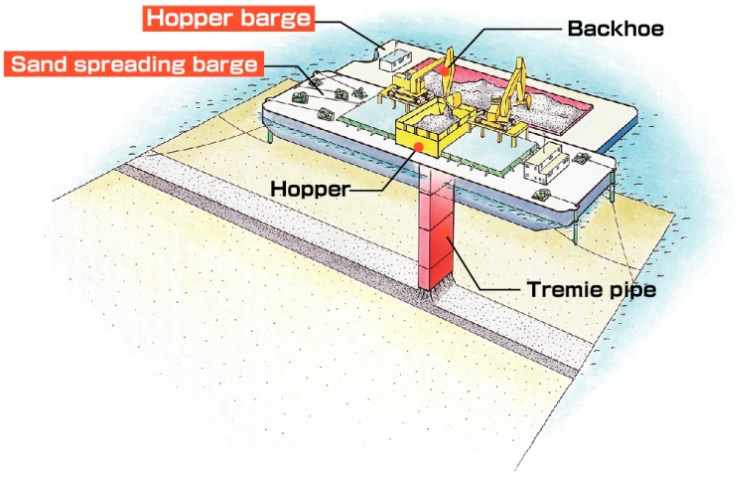


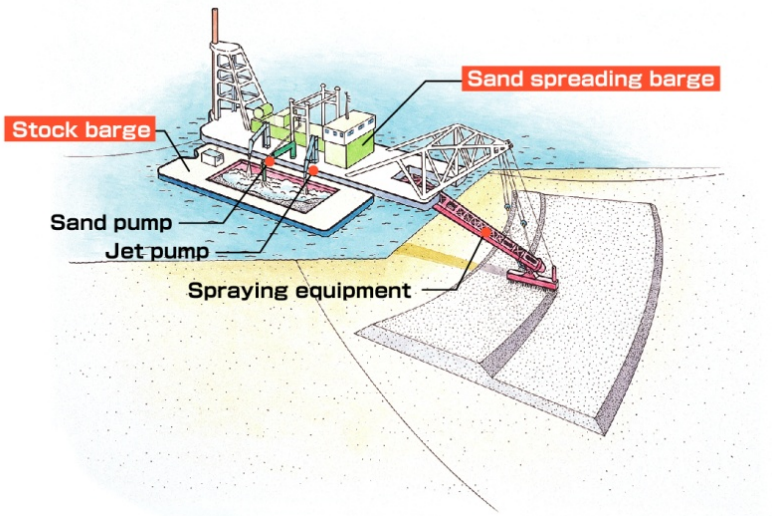






Ground improvement
1. construction of sand mat layer

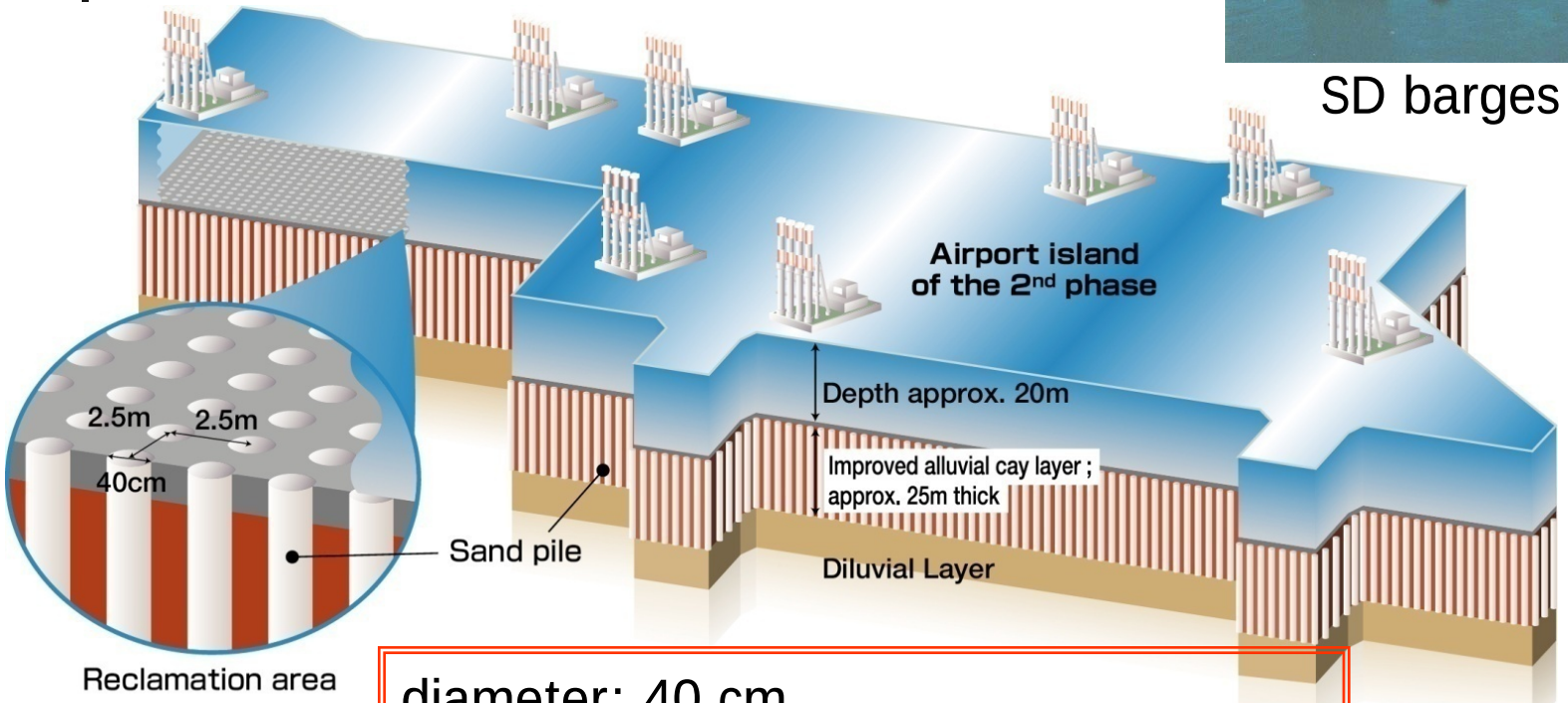




In the beginning, total of 1.5 m thick sand mat layer was created uniformly over the seabed by means of sand spreading barges. The sand mat layer should be constructed in two or three steps to prevent local ground failure due to undulation of the layer.

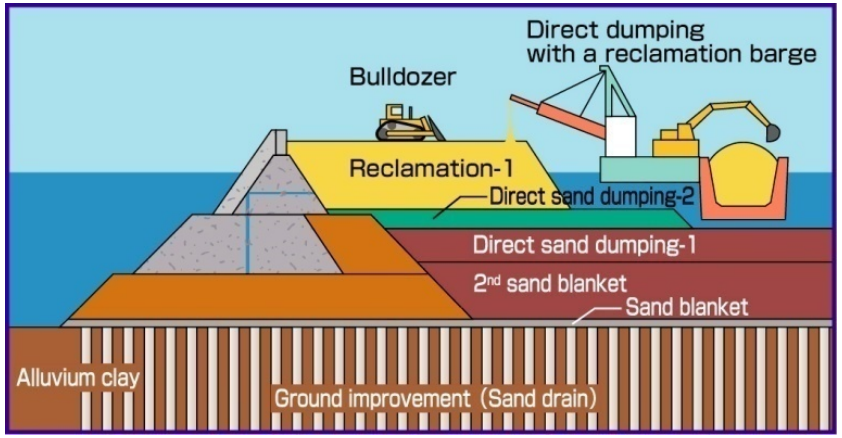
Ground improvement
2. SDs installation

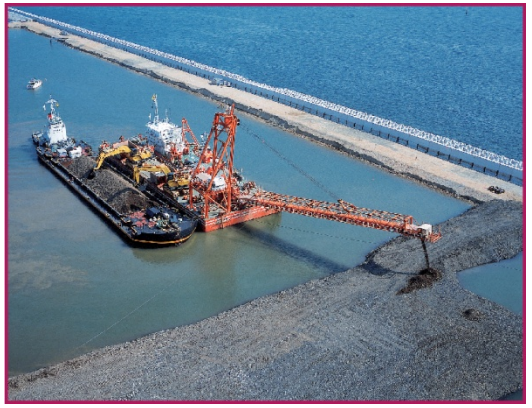
SD barges at site

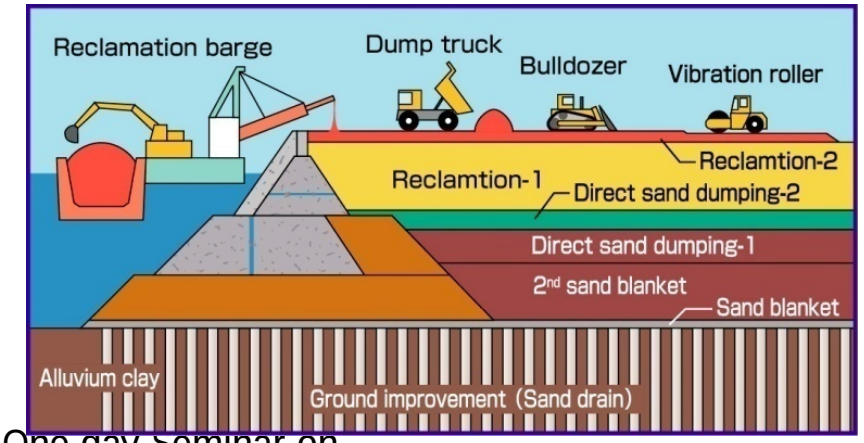


diameter: 40 cm
spacing: 2.5 m x 2.5 m in square grids
depth: - 45m
more than 120 million

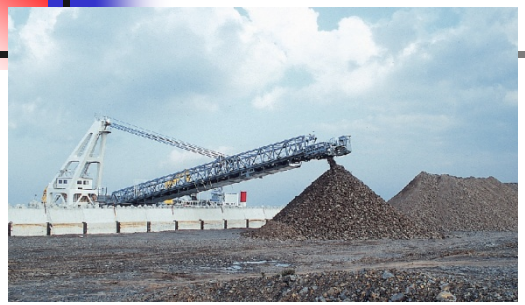
Land reclamation

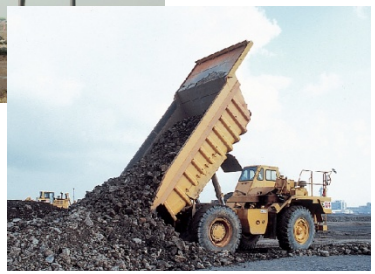


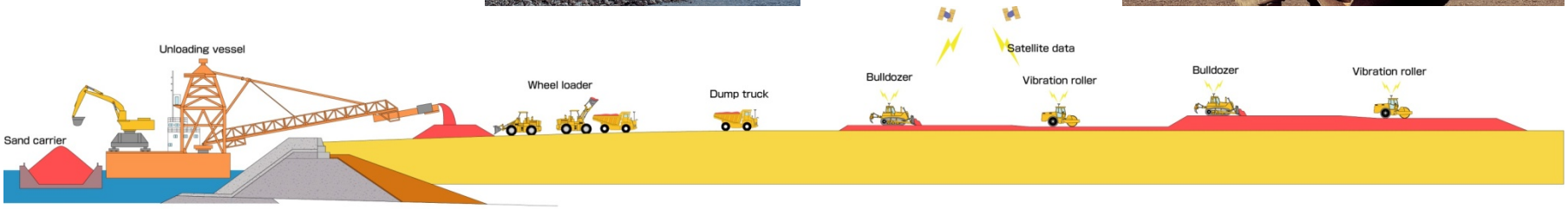




Land reclamation

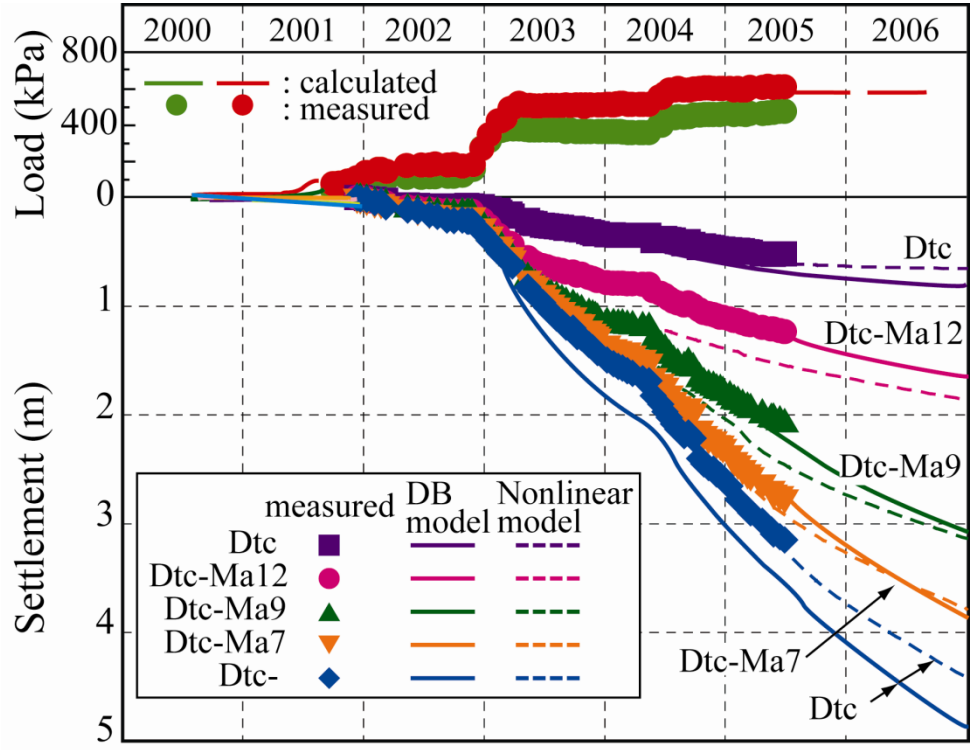


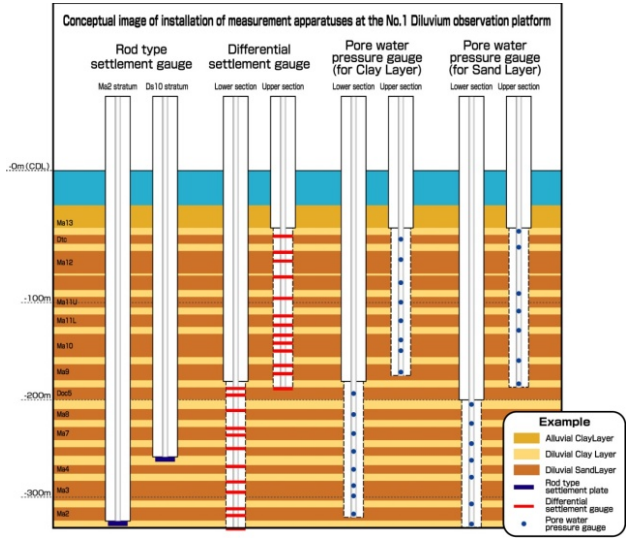




Land reclamation

Settlement measurements





The settlement prediction:
about 8 m for the Holocene layer
about 10 m for the Pleistocene layer.

New Kitakyushu Airport

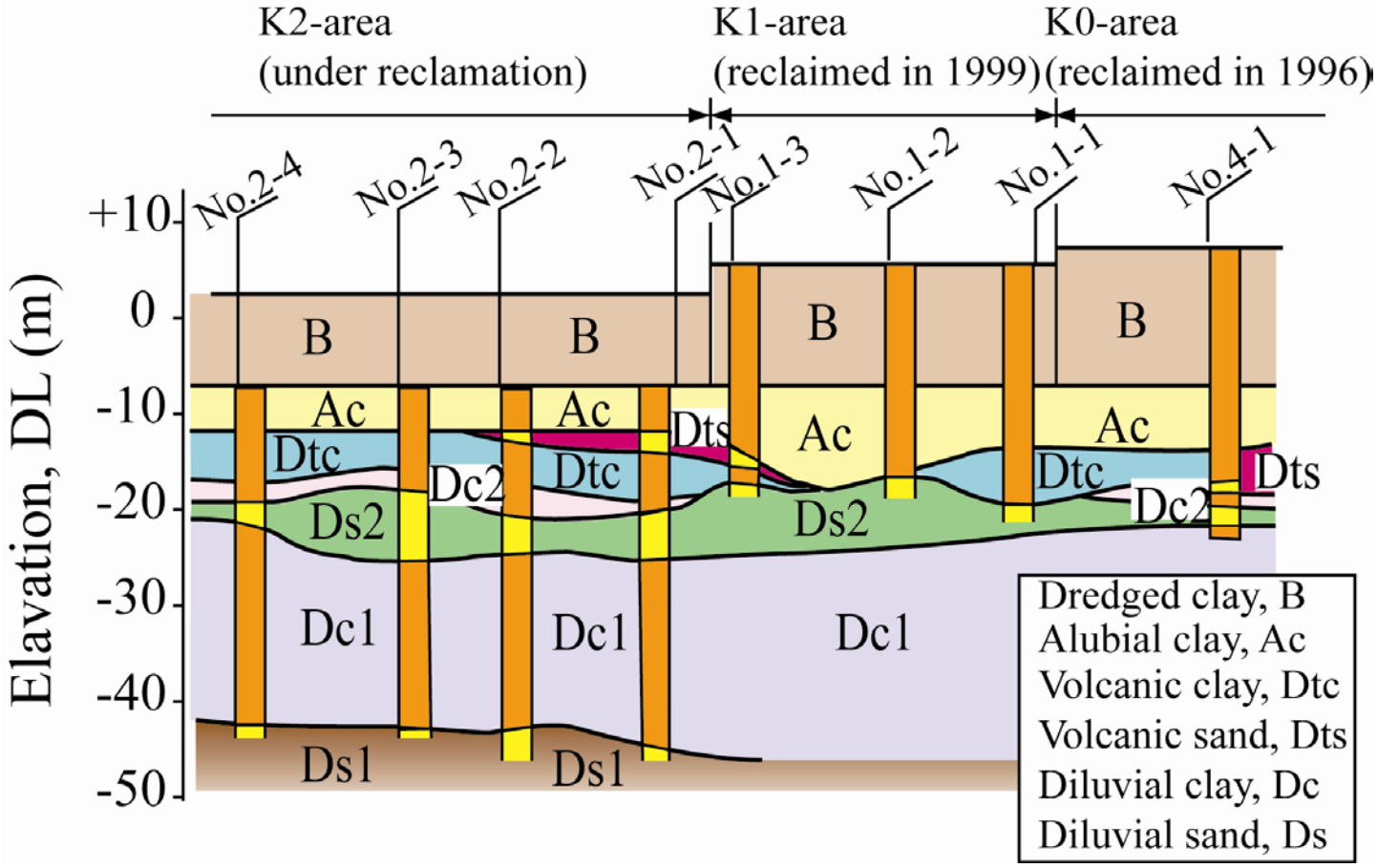
- Land Reclamation with dredged soil
- PVD drain method

LAND RECLAMATION WITH DREDGED SOIL

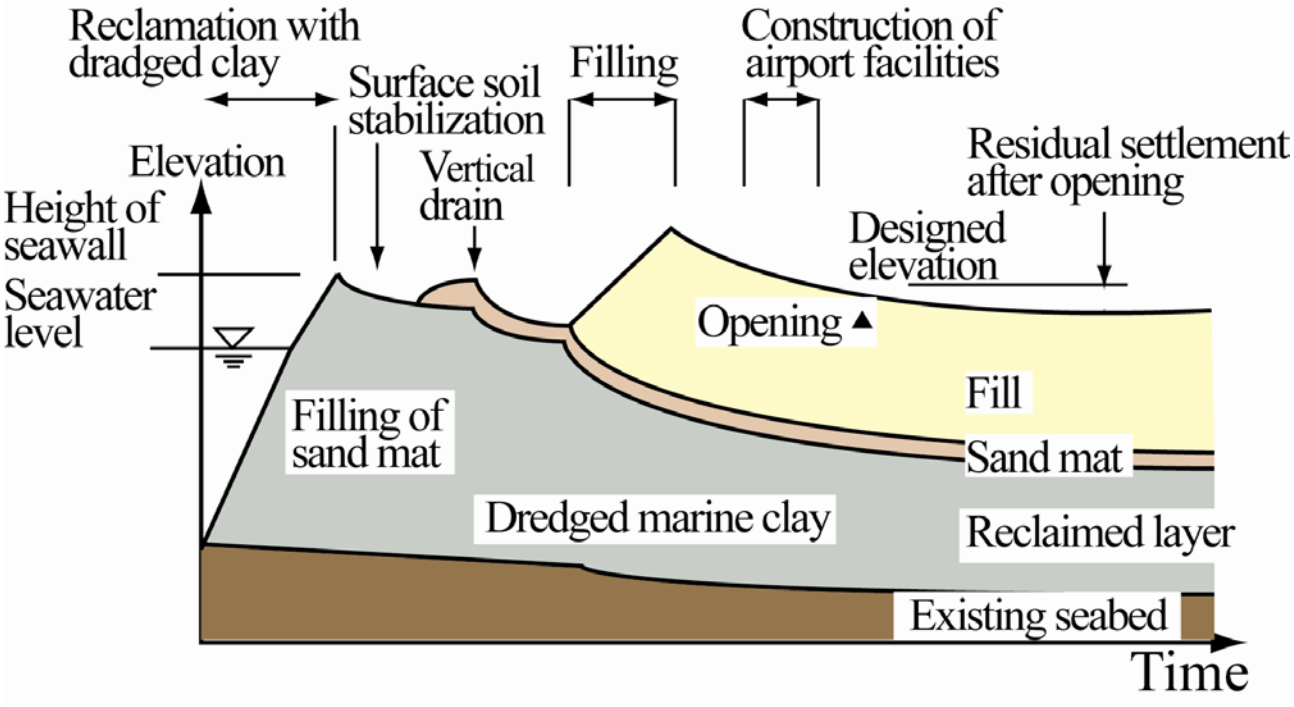
- NEW KITA-KYUSHU AIRPORT -

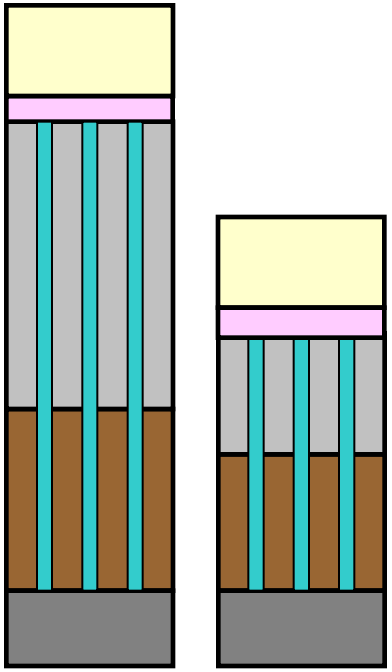
Airport island	**4,125m * 900m**
	373ha
Runway	**2,500m**
Construction period	**1994 to 2006**
Open	**March 2006**

Ground condition



Construction scheme

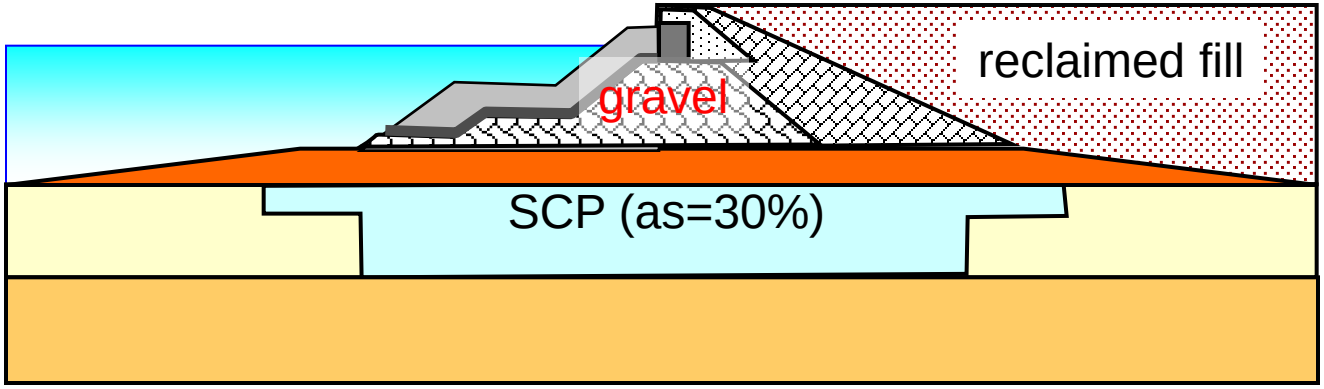




Construction of seawall dike

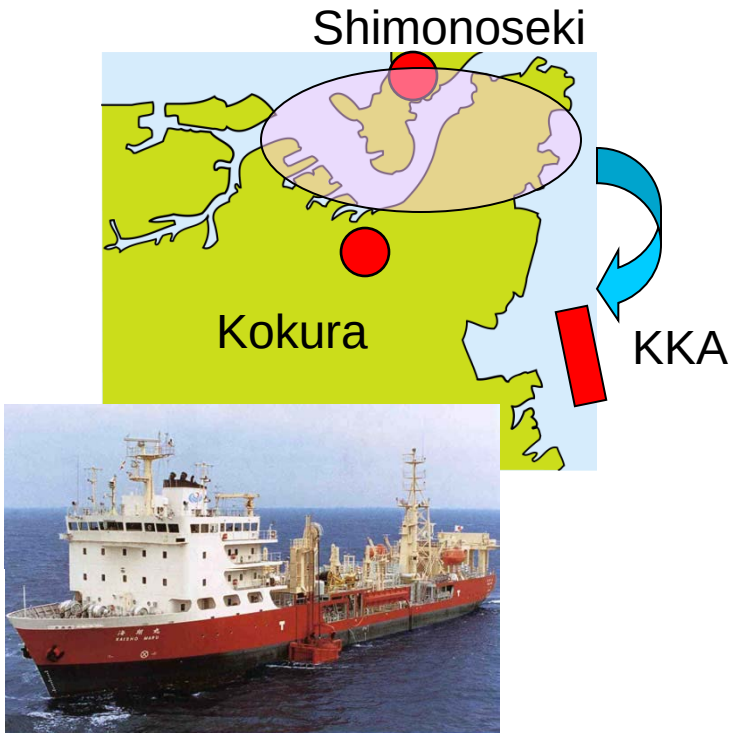
Seawall dike

Sand Compaction Pile Method



Cross section of seawall dike

Dredged soil at Kanmon Channel

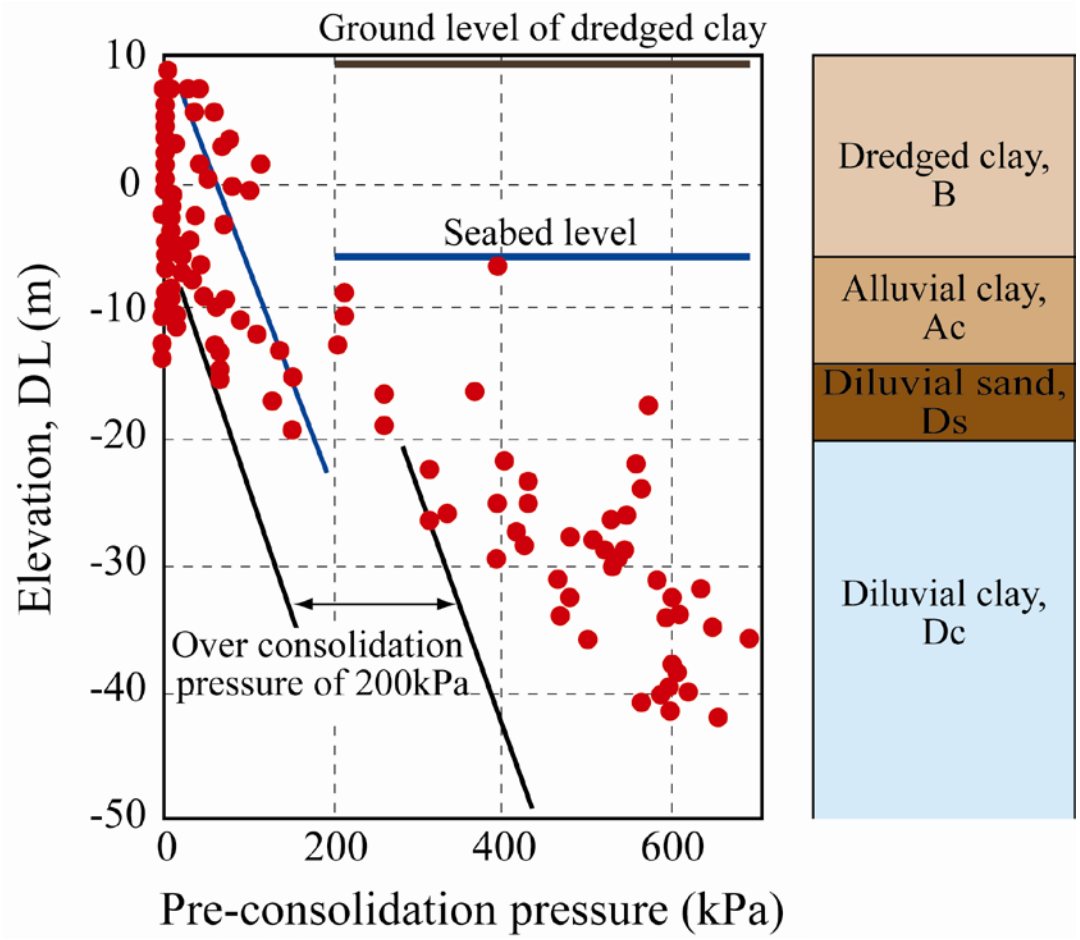


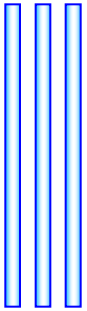
gravel > 2mm	coarse sand > 0.42mm	sand > 0.074mm	silt > 0.005mm	clay < 0.005mm
0.0 – 11.9%	0.4 – 9.7%	2.8 – 30.7%	2.3 – 20.3%	43.8 – 87.1%

Vertical drain technique

0.9 million PVDs, total length of 18,000km

Settlement Prediction and Measurement

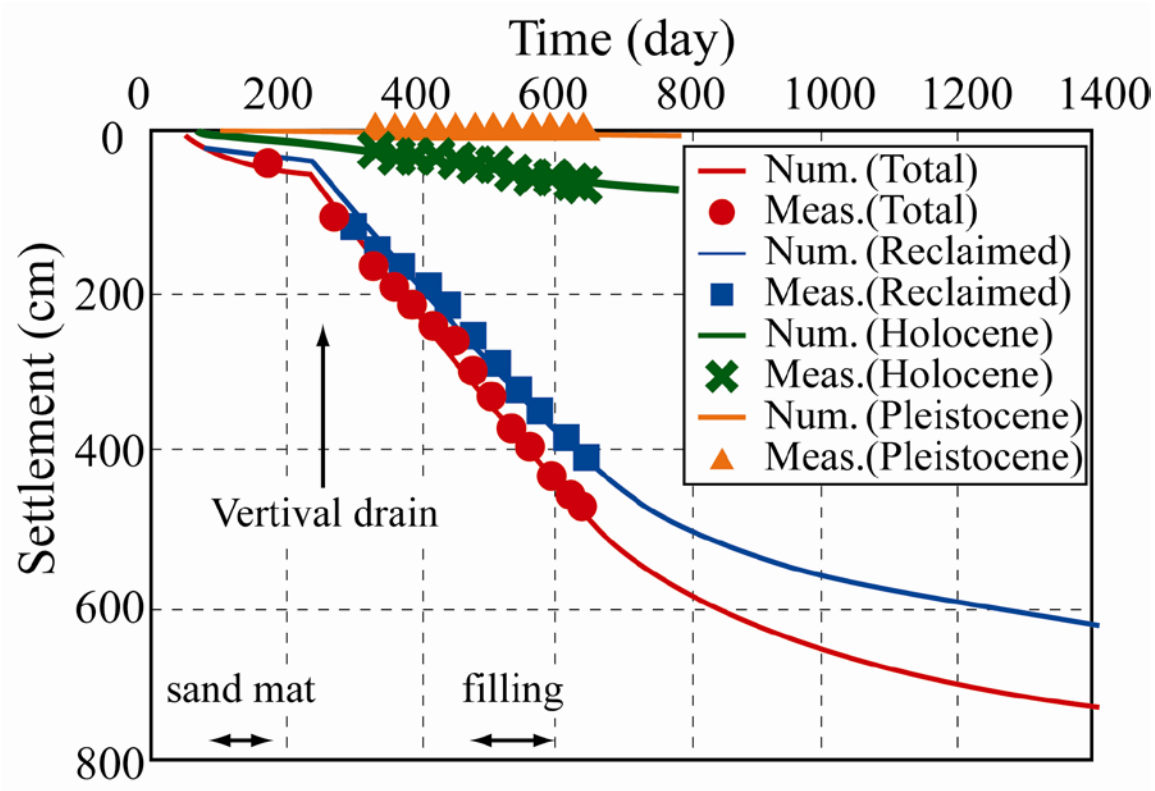




PVD improvement

PVD improvement:
width: 10cm
thickness: 0.5cm
spacing: 1.4m

Settlement Prediction and Measurement



The measured settlement data for individual layer was consistent with each prediction.

At 660 days, the total settlements were varied from 450 to 540 cm.

Another settlement of about 250 cm is expected in future.

Construction of facilities

lower subgrade layer

upper subgrade layer

Construction of terminal building

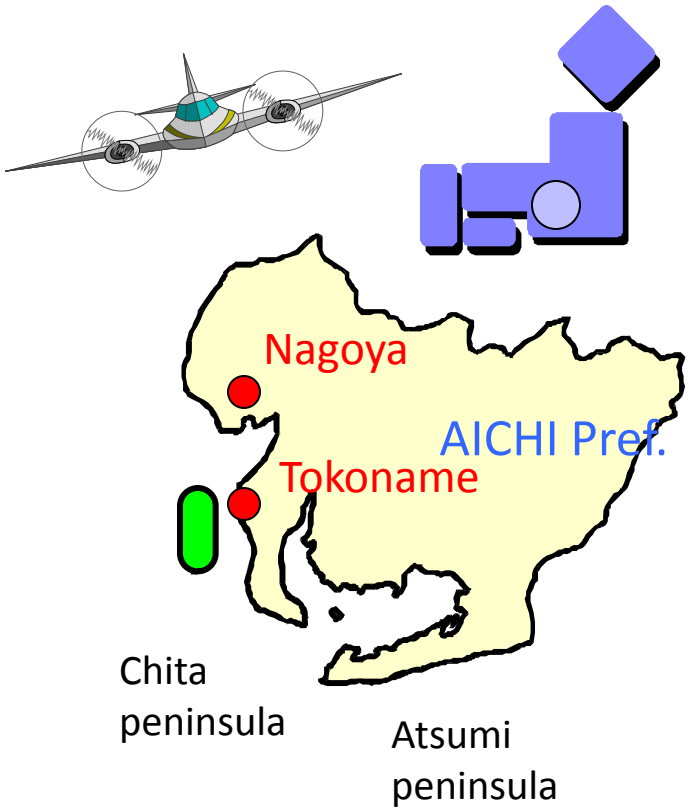
Central Japan International Airport

- Land Reclamation with cement treated dredged soil
- Pneumatic flow mixing method

Land reclamation with dredged soil with cement treatment

- Central Japan International Airport -

Land reclamation with dredged soil with cement treatment
- Central Japan International Airport -



Airport area	
Phase Ⅰ	Runway : 3,500 m Plane area : about 470 ha
Future	Runway : 2 * 4,000 m Plane area : about 700 ha

Estimated airport demand (per year)			
	passengers (million)	cargo (million tons)	take off (million)
Phase Ⅰ	8	0.43	0.13
Future	10	0.53	0.16

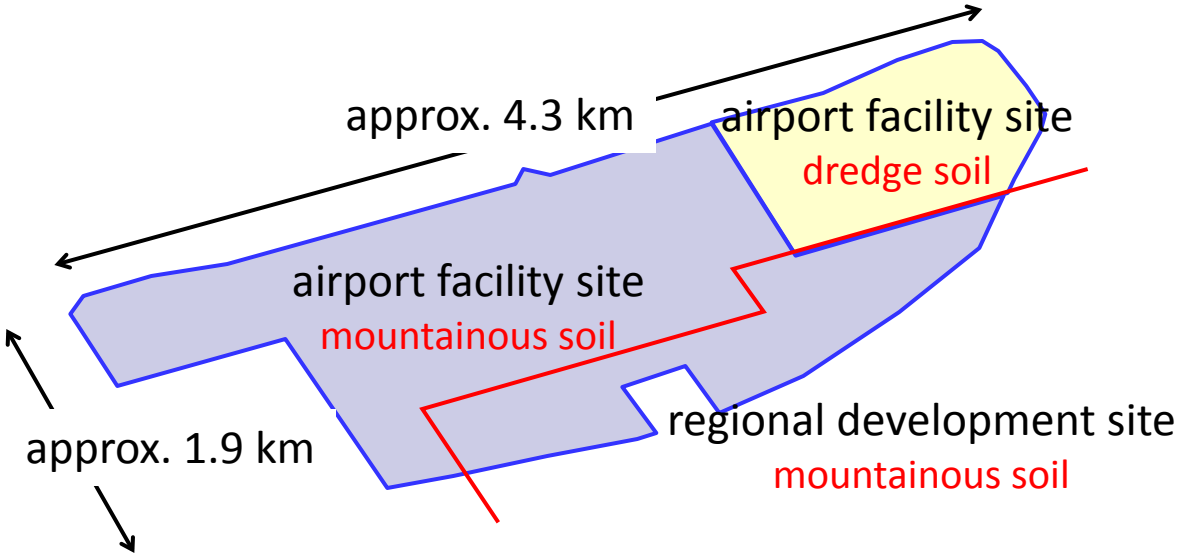
Land reclamation

Reclamation by mountainous soil (approx. 61.8 million m^3)

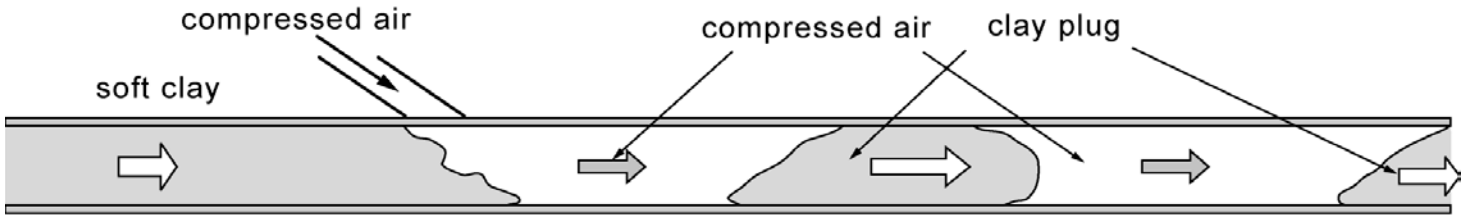
by dumping, shooting

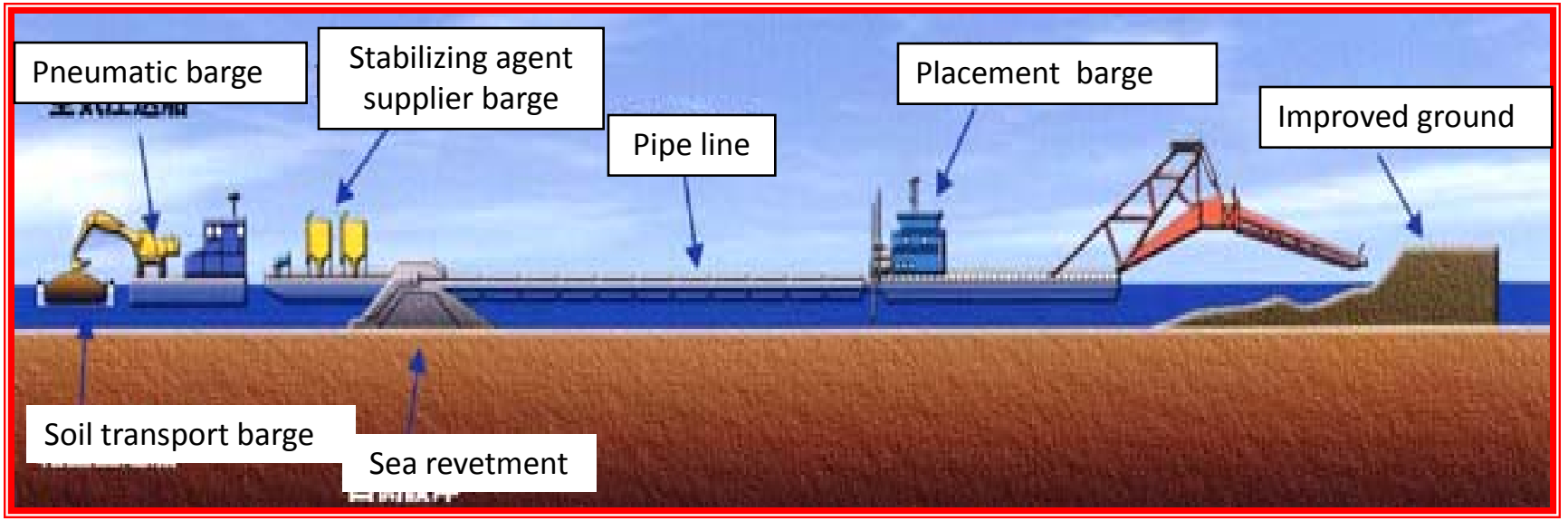
Reclamation of dredge soil (approx. 8.2 million m^3)

by PNEUMATIC FLOW MIXING METHOD

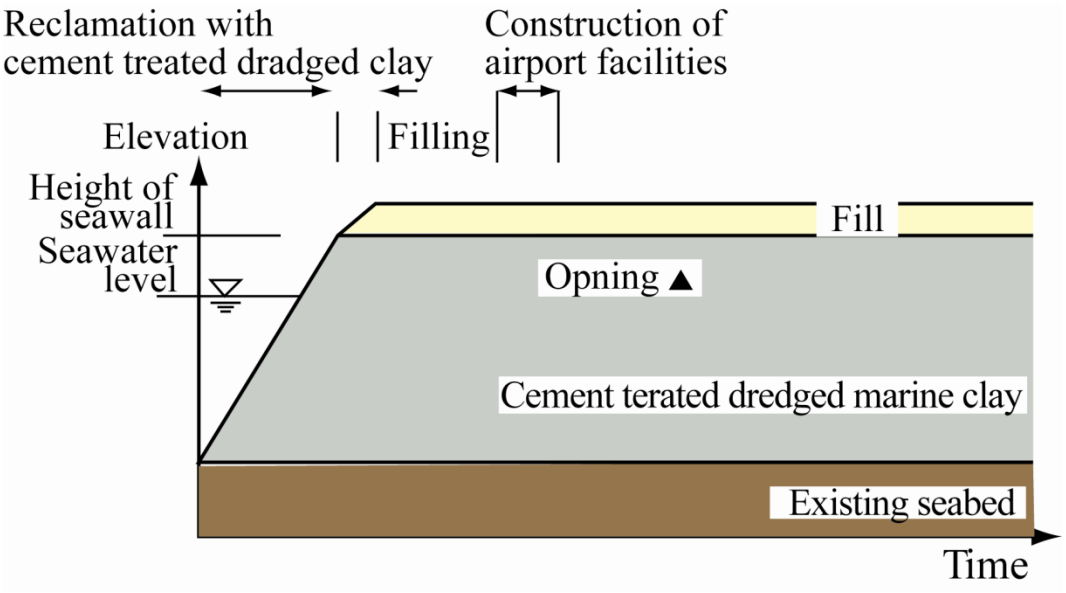


PNEUMATIC FLOW MIXING METHOD





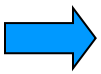
Cconstruction scheme



treated soil:

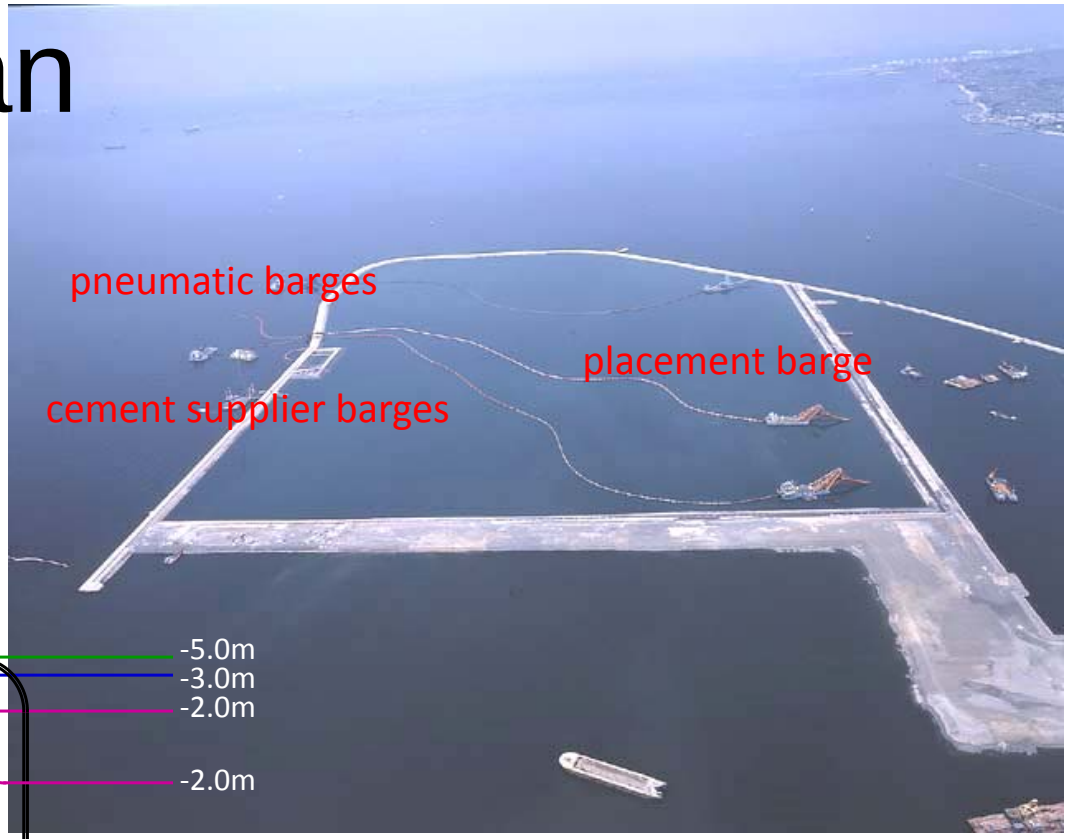
q_{uf} = 157 kN/m^2

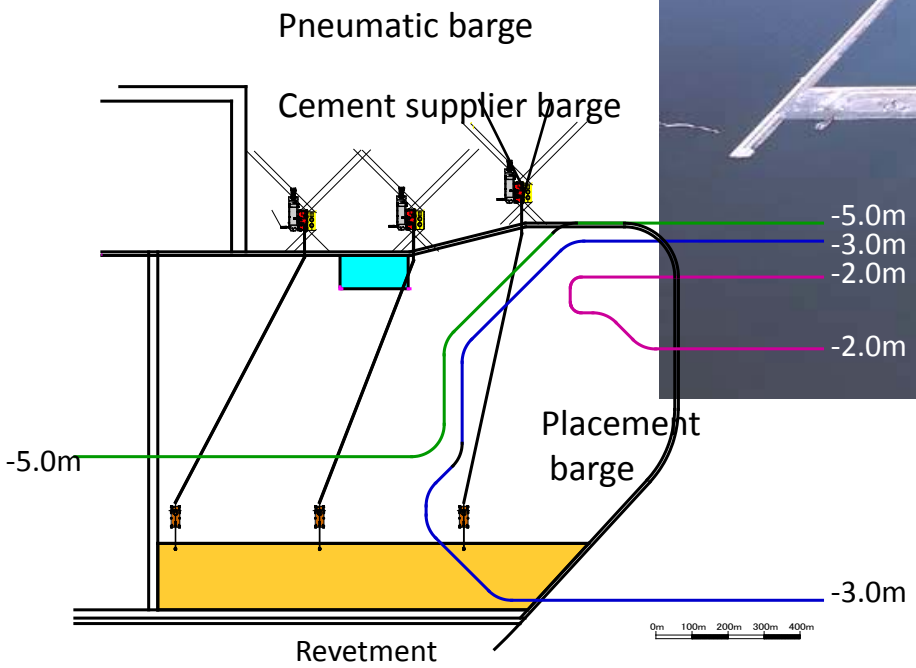
mixing ratio: 54 to 60 kg/m^3



no ground improvement is necessary

Execution plan





facility

soil transport barge, pneumatic barge & cement supplier barge

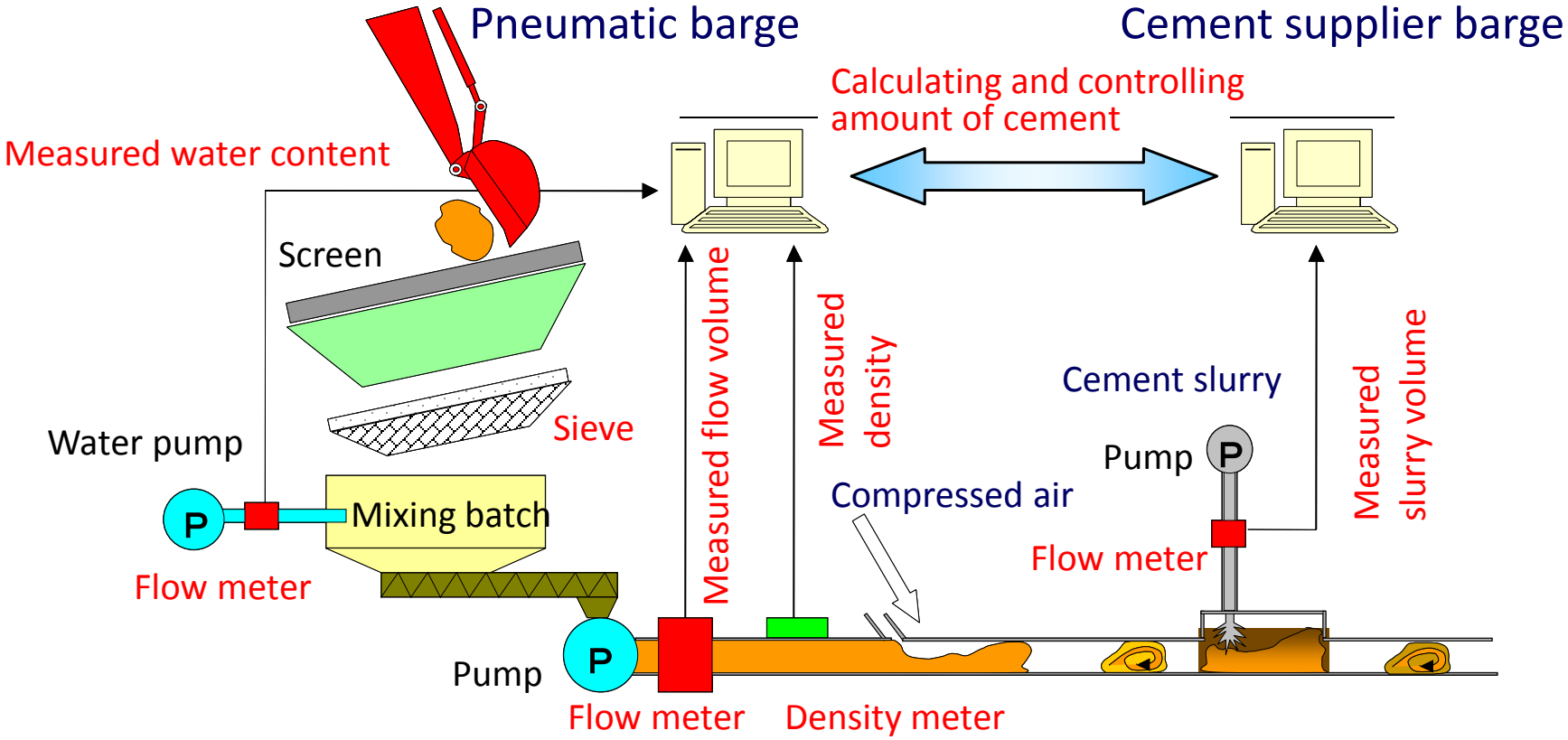
soil transport barge

facility

placement barge

placement barge

Mixing control system



Tokyo/Haneda International Airport

- Land Reclamation with cement treated dredged soil
- Sand drain method and Pneumatic flow mixing method

Tokyo/Haneda International Airport

- construction of fourth runway -

Runway Island : 150ha
D-runway: 2,500m by 60m
reclamation: 420m by 2,020m, 95ha
-12 to 20m deep
plat form: 520m by 1,100m, 52ha
-14 to 19m deep

The man-made island is located between the mouth of Tama River and the main sea route to Tokyo Port. In order to minimize the adverse influence to the water flow of Tama River, the west part of the runway is a steel-jacket-platform structure while the other is a reclamation land. As the east part of the reclaimed land is anticipated to obstruct a part of the main sea route, the main sea route has to move rotationally about 16 degree to the east, which requires additional dredging work. The dredged soil is stabilized with cement for reclamation of the island.

Land reclamation in C-runway

beneficial use of dredged soil

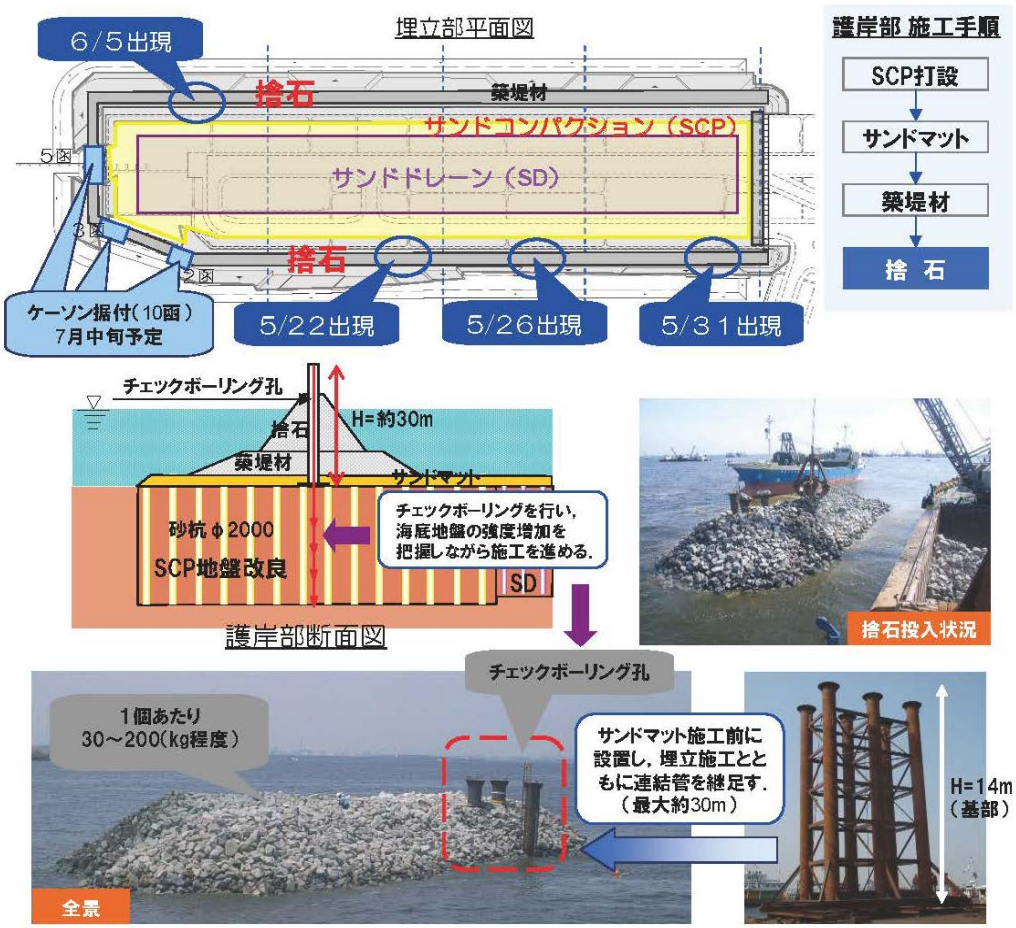
"Haneda Mayonnaise Layer"
water content > 150%

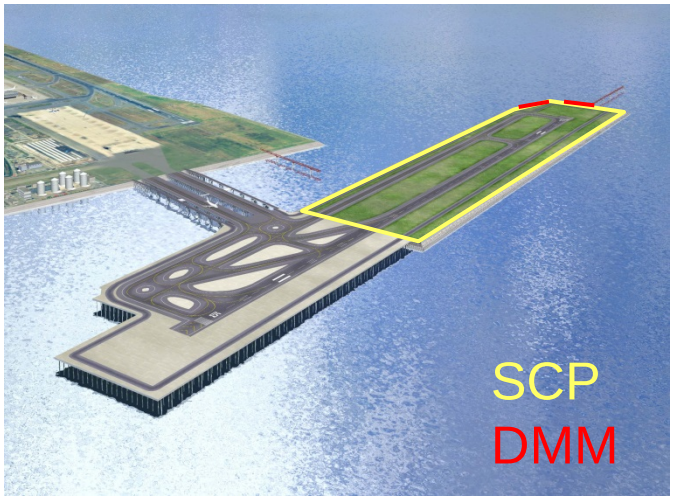
Fabri-packed sand drain method was applied for assuring stability of drain

PVD method was also applied for further speed up consolidation.

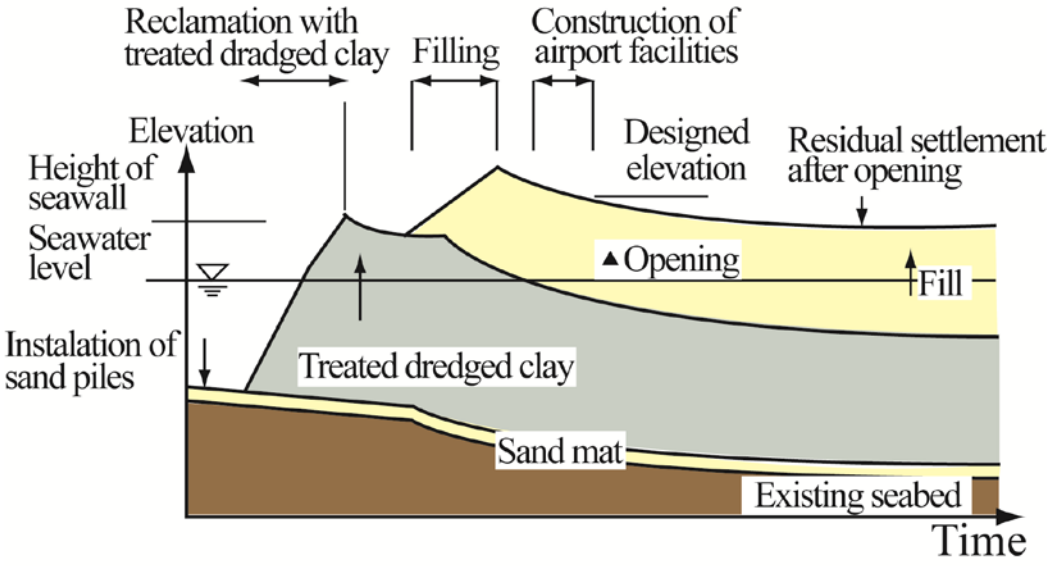
Land reclamation in D-runway

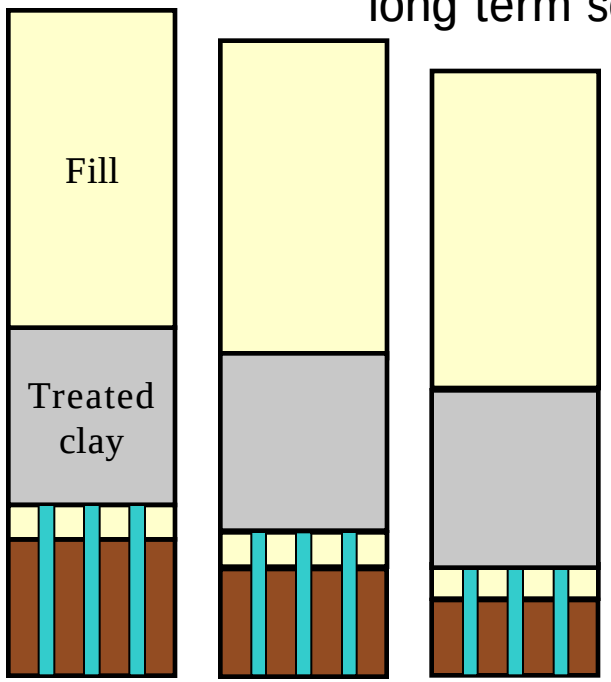
- construction of sea dike -





construction scheme





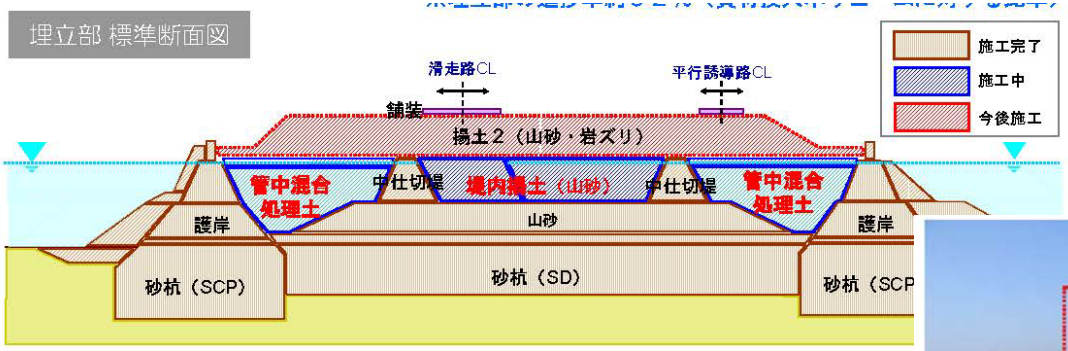
Land reclamation

- Pneumatic flow mixing method -

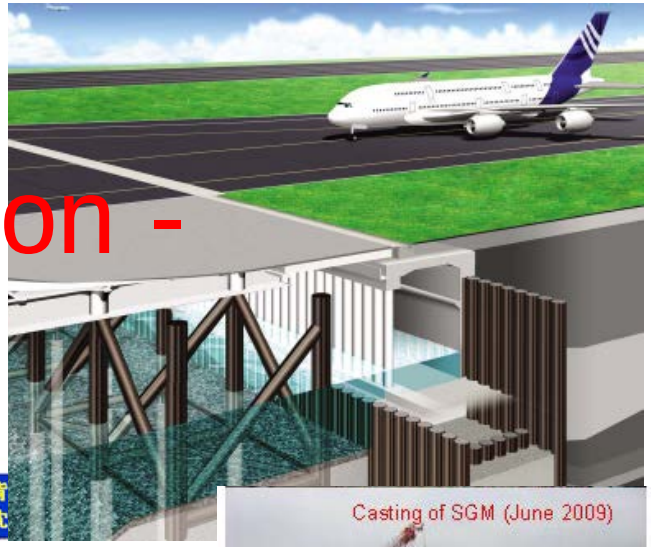
Pneumatic flow mixing method
mixing condition:
water content:
cement content
target strength:

Land reclamation

- Pneumatic flow mixing method -

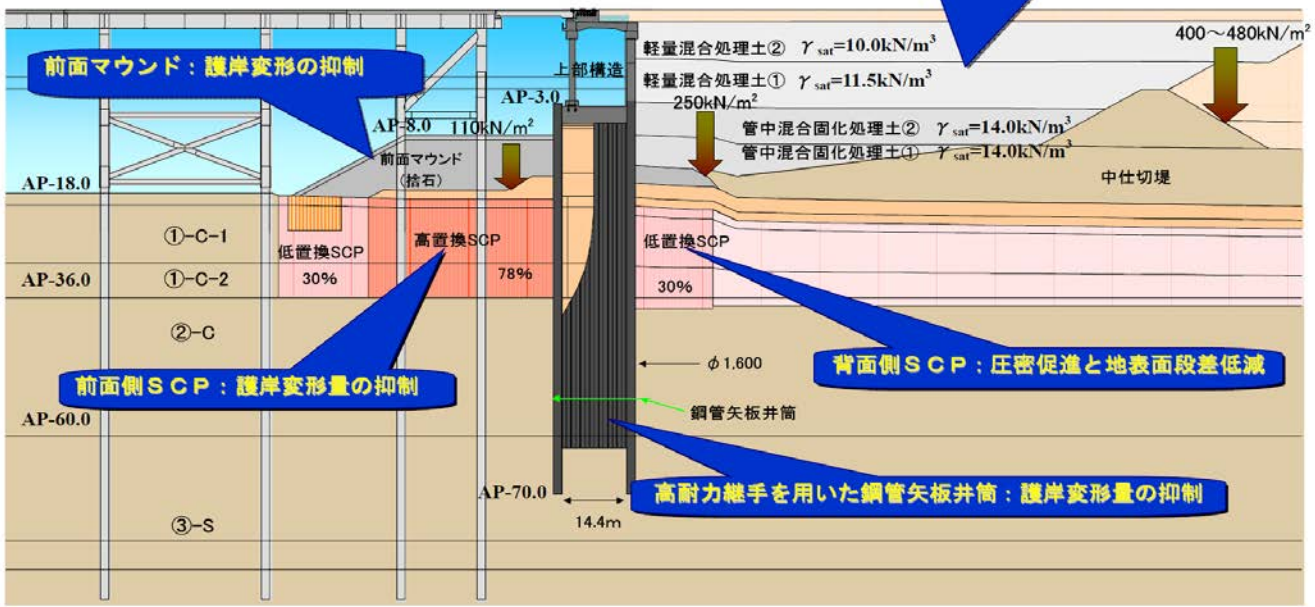


Land reclamation
- construction at junction -



接続部井筒護岸構造の特徴

厳しい施工工程の中で、鋼管矢板井筒、背面埋立構造、前面マウンド構造の最適化により最大限の変形抑止を実現



Land reclamation

- construction of steel jacket -

※1 船舶航行用に外周護岸に開口部を設置
※2 資材投入ボリュームに対する比率
※3 1基目のジャケット据付は，H20.1.9

・平成20年9月16日に総数198基のうち，66基の据付を無事に完了．
・引き続き，ジャケットの据付・床版の設置を急ピッチで進めていく．

CONCLUDING REMARKS

- Several ground improvement techniques are briefly introduced for different materials: mountainous soil, dredged soil and cement treated dredged soil.
- Many land reclamation constructions will be conducted with various types of reclamation material in future.
-
- I expect that this lecture will be useful and helpful for you reclamation projects.