

Optimum Backfilling Material into Over-cutting Area Surrounded by Acid Sulfate Soils in East Asian Countries


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Outline

- Introduction
- Objective
- Materials and Methods
- Results and Discussions
- Conclusion

Introduction

In Southeast Asian Countries, the demand for infrastructure constructions has increased.



Most of area is occupied by structures.

The social infrastructure has to be established under the ground.

Introduction


Established infrastructure under the ground.

Open Cut Method


Low cost and the simplicity are strong points.
This method causes traffic jams and regulation of traffic in the large cities.

Trenchless Construction Method

These method allows us to directly construct infrastructure underground.
Construct the infrastructure under the ground without the traffic problems.



Shield Method



Pipe Jacking Method

It is widely used for underground construction in Japan.

Introduction

Pipe Jacking Method

Pipe jacking is a technique for installing underground pipes. After the thrust and the reception pits are constructed, the pipelines are installed by some jacks.

(Attandana and Vacharotavan, 1986).

Excavator, Face, Pipe, Thrust, Reception pit, Overcutting area, Over-cut space, filling materials are injected

Introduction

Filling Material

The main material is cement.

- ✓ Reducing the friction between pipes and soils
- ✓ Filling through the over-cutting areas
- ✓ Securing the space of the over-cutting area
- ✓ Sustaining against the overburden pressure

The function of reducing friction, The function of filling over-cutting areas, The function of against the overburden pressure, The function of securing the space

Introduction

Climatic division in Southeast Asian Countries

Af: Tropical Rainforest Climate
Am: Tropical Monsoon Climate
Aw: Savannah Climate

Southeast Asian countries are in Tropical climate. Acid sulfate soil spreads in tropical climate region.

Acid Sulfate Soil has the negative impact on filling materials.

Introduction

The mechanism of deterioration of filling materials.

$\text{CaO (main material of Filling Materials)} + \text{SO}_4 \rightarrow \text{Ettringite}$

Ettringite causes the swelling, resulting in the formation of vacant space.

(Yamaji, Mohammed, and Hamada, 2007).

In order to reduce the durability of cement material, fly ash and slag are used in some cases according to past studies.

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Objective

In Southeast Asian Countries

- ✓ Large-scale improvements of infrastructure with pipe jacking method will be conducted.
- ✓ Acid sulfate soil spreads, and it has negative impacts on the filling materials used for pipe jacking method.
- ✓ Fly ash and slag can control the deteriorations.

(QCL Group Technical Note, 1995 and Slag Cement Association, 2002).

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The objective of this study was to obtain fundamental knowledge about filling materials for constructions in Southeast Asian Countries.

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Materials and Methods

Materials

		Standard				
The amount of fly ash (kg / 1 m ³ filling materials)		0	5	10	15	20
The amount of slag (kg / 1 m ³ filling materials)		30	50	70		
Standard	...	The filling material added no fly ash and slag				
FA	...	The filling material added 10 kg of fly ash				
SL	...	The filling material added 30 kg of slag				

Gelling Time Measurement
Setting appropriate gelling time is important for pipe jacking constructions.

Uniaxial Compressive Strength (UCS) Test
The filling materials injected into the Tail-void have to support overburden and it has to be strong enough to keep the space of the Tail-void.

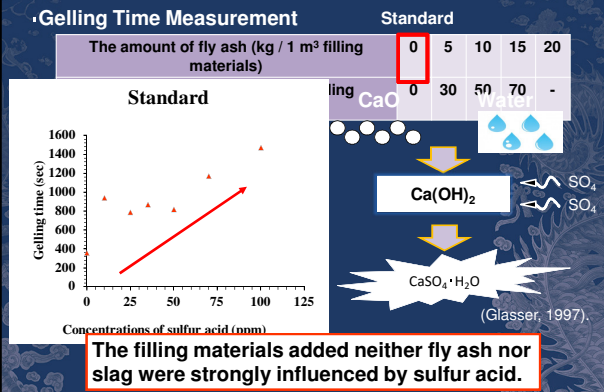
Coefficient of Friction Measurement
The smaller the coefficient of friction of the filling materials is, the less thrust is necessary, leading to reasonable construction.

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- Gelling Time Measurement
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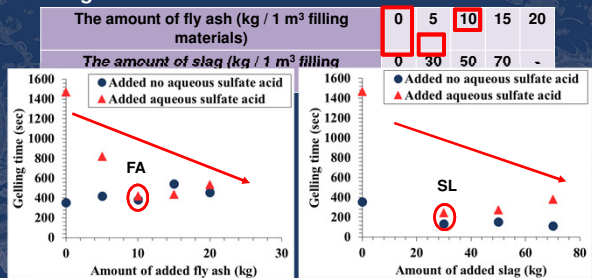
Results and Discussion

Gelling Time Measurement



Results and Discussion

Gelling Time measurement



(Dimitris and Xiaoguang, 2003 and Manso, Polanco, Losanez, and Gonzalez, 2006).

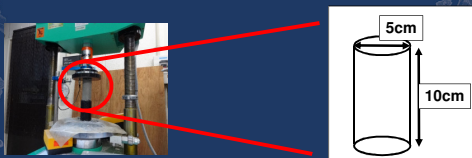
Fly ash and slag could control the sulfate attack, since they are alkalinity.

Uniaxial Compressive (UCS) Test

Results and Discussion

Uniaxial Compression Test

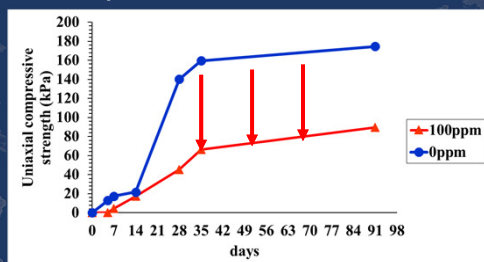
- ✓ The samples of filling materials were immersed in sulfur acid during their curing times.
- ✓ Curing times were set 5, 7, 14, 28, 35, 91 days.
- ✓ The concentration of sulfur acid were set 0 ppm and 100 ppm.



The effect of sulfur acid to filling materials from the aspect of strength.

Results and Discussion

Uniaxial Compression Test

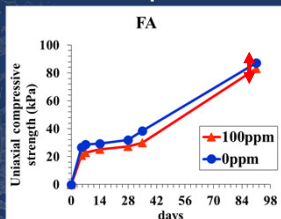


(Grubesa, Barisic, Fucic, and Bansode, 2016)

The strength of the filling materials did not show potential strength in sulfuric acid environment.

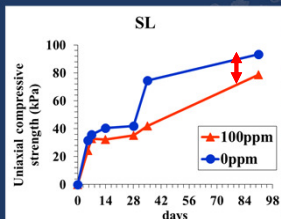
Results and Discussion

Uniaxial Compression Test



Because of fly ash, durability and water-tightness increased.

(Yamamoto and Kanezu, 2007).



The pores inside the filling materials decreased, leading to block the penetration of sulfur acid.

(Slag Cement Association, 2002).

Fly ash and slag can control deterioration of strength from sulfur acid.

Coefficient of Friction Measurement

Results and Discussion

Coefficient of Friction Measurement

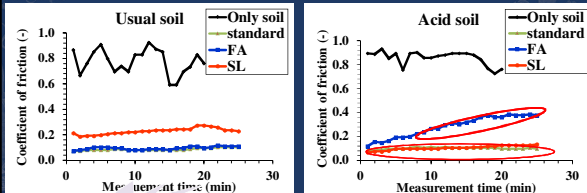
- ✓ Rotational friction meter was used.
- ✓ 2 types of soil were prepared, **Usual Soil** and **Acid Soil (pH: 4)**.
- ✓ The water content was 10 % (water and sulfur acid).
- ✓ The coefficients of friction of soils were measured.
- ✓ The filling materials were set on the soils.



The effect of sulfur acid to filling materials from the aspect of friction.

Results and Discussion

Coefficient of Friction Measurement



However, Acid filling materials can function as lubricant.

The coefficient of friction of FA gradually increased with time.

The coefficient of friction of SL was smaller than one in usual soil.

Filling materials added slag are better than filling materials added fly ash.

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Conclusion

- ✓ Sulfur acid causes increasing the gelling time and deterioration of strength of the filling materials.
- ✓ The new filling materials added fly ash and slag could control the effect of sulfur acid.
- ✓ The new filling materials were able to function as lubricant in sulfur acid environment.
- ✓ Adding slag is better than adding fly ash from the aspect of reducing friction.

Filling materials used for future constructions in Southeast Asian Countries should be added slag.

