The 21st Global Joint Seminar on

Geo-Environmental Engineering

(GEE 2023)

Place | Seoul National University, South Korea

Date | May 11 - 12, 2023

GEE2023

SEOUL NATIONAL UNIVERSITY – MAIN GATE

Organization of GEE 2023:

1. ***Founder of GEE:***
   Prof. Em. Masashi Kamon (RIEG, Kyoto University, Japan)

2. ***Chairman of GEE 2023:***
   Prof. Junboum Park (Seoul National University, South Korea)

3. ***Organizing Committee Members:***
   Prof. Catherine Mulligan (Concordia University, Canada)
   Prof. Changwon Kwak (Inha Technical College, South Korea)
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   Prof. Mohamed Boutouil (ESITC Caen, France)
   Prof. Takeshi Katsumi (Kyoto University, Japan)
   Prof. Toru Inui (Osaka University, Japan)
   Prof. Toshifumi Igarashi (Hokkaido University, Japan)

TECHNICAL PROGRAM - *MAY 11th*					
Time	**Content**				
7:30 - 9:00	Registration **(Building 39, Room B103)**				
9:00 - 9:20	Welcoming Remarks / Lifetime Achievement Award to Prof. Masashi Kamon				
9:20 - 9:55	Keynote Lecture I (Prof. Junboum Park, Seoul National University)				
9:55 - 10:30	Keynote Lecture II (Prof. Iksuk Kim, California State University, LA)				
10:30 - 10:50	Photo Session / Breaking Time				
Oral Presentations (Parallel Sessions)					
Session A: Geotechnical (Room B103)			**Session B: Environmental (**Room B117)		
Presentation N°		**Presenter**	**Presentation N°**		**Presenter**
Geo. I 10:50 - 12:00 **Chairman: Prof. Kwak**	Geo. 01	Koji Yamamoto	**Env. I 10:50-12:00** **Chairman: Prof. Ilhwan Park**	Env. 01	Naohiro Nakahara
	Geo. 04	Yongjoon Choe		Env. 02	Ayaka Hashimoto
	Geo. 07	Riho Ogata		Env. 05	Keita Nakajima
	Geo. 12	Xiaochao Tang		Env. 06	Yuki Nagao
	-	-----		Env. 09	-----
12:00 - 12:30	Voting for Poster Presentations				
12:30 - 14:00	Lunch time / Campus Tour				
Geo. II 14:00 - 15:00 **Chairman: Prof. Takai**	Geo. 03	Sota Terano	**Env. II 14:00-15:00** **Chairman: Prof. Joo-Young Park**	Env. 16	Yuma Otsuka
	Geo. 06	Shinichiro Demachi		Env. 07	Tomohiro Kato
	Geo. 10	Shion Nishida		Env. 12	Kian Cho
	Geo. 02	Chikashi Koga		Env. 14	---
	Geo.13	-----		Env. 08	----
15:00 - 15:15	Coffee break				
Geo. III 15:15 - 16:15 **Chairman: Prof. Kato**	Geo. 11	Bechara Haddad	**Env. III 15:15-16:15** **Chairman: Dr. Rahim**	Env. 04	Ilhwan Park
	Geo. 08	Yoshizane Miki		Env. 10	Aneesu Rahman
	Geo. 05	Subin Yang		Env. 15	Shervin Hashemi
	Geo. 9	Zhexin Lin		Env. 13	-----
	-	------		Env. 11	------
16:30 - 17:00	Closing Remarks / Awards / Announcement for next GEE				
18:00 - 20:30	Gala dinner				

Note: Each presenter has 10 min for presentation and 2 min for discussion.

TECHNICAL PROGRAM - *MAY 12th*	
Time	**Content**
8:15	Meet at main gate of Seoul National University
8:30 - 10	Travel to the field trip site
10- 11:30	Field Trip at "*Han River* Tunnel Public Center"
11:30 - 13:30	Lunch and Group photo
13:30 - 14:30	Return to University

The Conference is partially supported by Korean Geotechnical Society (KGS), Institute of Engineering Research of Seoul National University (IOER), and Hyundai company engineering co., LTD. The committee members and GEE2023 Secretary members deeply appreciated for the cooperation.

KEYNOTE LECTURES			
Presentation Reference	**Title**	**Author(s)**	**University**
Keynote I	PFAS: The Most Emerging Contaminants in The World	Prof. Junboum Park	Seoul National University
Keynote II	ESG 2.0 in Construction Management	Prof. Iksuk Kim	California State University, LA

ORAL PRESENTATION			
GEOTECHNICAL SESSIONS			
N◦	**Title**	**Author(s)**	**University**
Geo. 01	Material Characteristics of Bamboo Chip Mixture for Sand Compaction Pile Method	Koji Yamamoto *et al.*	Fukuoka University
Geo. 02	Influence of Formation of Skeleton Structure on the Bamboo Chip Mixed Solidified Soil	Chikashi Koga *et al.*	Fukuoka University
Geo. 03	Swelling Property and Hydraulic Conductivity of Impervious Material Using Dehydrated Cake and Bentonite	Sota Terano *et al.*	Fukuoka University
Geo. 04	Experimental Study of Suffusion in Sand-clay Mixtures under Saturated and Unsaturated Conditions	Yongjoon Choe *et al.*	Korea University
Geo. 05	Longitudinal Dispersivity of Sand-Clay Mixtures under Unsaturated Conditions	Subin Yang, Jongmuk Won and Hangseok Choi	Korea University
Geo. 06	Evaluating Basic Geotechnical Properties of Pyroclastic Materials	Shinichiro Demachi *et al.*	Kyoto University
Geo. 07	Hydraulic Conductivity Tests for Soil Amended with Stabilizing Agent Using Ion Containing Solution	Riho Ogata *et al.*	Kyoto University
Geo. 08	Effects of Soil Modifiers on Separation of Soil -Wastes Mixtures on Disaster	Yoshizane Miki *et al.*	Kyoto University
Geo.09	Numerical Analysis of the Mechanical and Deformation Behavior of Deep Soil-Bentonite Cutoff Wall and the Surrounding Ground	Zhexin Lin *et al.*	Osaka University
Geo. 10	Fundamental Study on the Effects of Slaking on the Leaching Behavior of Geogenic Arsenic in Sedimentary Rock	Shion Nishida, Toru Inui and Sho Ogata	Osaka University
Geo. 11	Mitigating Urban Heat Island Effect with Eco-Friendly Flax Fiber Pervious Concrete	Bechara Haddad *et al.*	Comue Normandie University
Geo. 12	Stabilization of Soft Soil using Geopolymers Developed from Sewage Sludge Ash	Daniel Kane and Xiaochao Tang	Widener University
Geo. 13	Grain Size Distribution of Surface Sediment and its Contribution to Heavy Metal Pollution in Shallow Harbour in Quebec, Canada	Masoumeh Javid and Catherine N. Mulligan	Concordia University

ORAL PRESENTATION			
ENVIRONMENTAL SESSIONS			
N◦	Title	Author(s)	University
Env. 01	Material and Leaching Characteristics of Recycled Crushed stone using Woody Biomass Ash for Environmental Safety	Naohiro Nakahara *et al.*	Fukuoka University
Env. 02	pH-dependent Solubility of Calcium and Magnesium Released from Adsorbents Mixed with Excavated Rocks	Ayaka Hashimoto *et al.*	Hokkaido University
Env. 03	Evaluation of the Change of Zinc Concentration in Mine Drainage by Identifying its Source at the Sado Gold Mine	Taichi Matsusaki *et al.*.	Hokkaido University
Env. 04	Passivation of Arsenopyrite by Microencapsulation using Ferric-catecholate Complexes and Phosphate	Ilhwan Park *et al.*	Hokkaido University
Env. 05	Comparison of Arsenic Leaching Concentration from Excavated Rocks Between Pre-construction and Construction Phases of Hokkaido Shinkansen	Keita Nakajima *et al.*	Hokkaido University
Env. 06	Carbon Fixation and pH Decrease of Leachate in Coastal Landfills by Atmospheric Exposure of Wastes	Yuki Nagao *et al.*	Kyoto University
Env. 07	Column Sorption Tests Aginst Perfluorooctane Sulfonate (PFOS) on Silica Sand and Mahji	Tomohiro Kato *et al.*	Kyoto University
Env. 08	Evaluating the Stability of Arsenic Immobilized with Iron Oxides in Soil by using Diffusive Gradients in Thin Films	Juyong Bak,Jinsung An and Kyoungphile Nam	Seoul National University
Env. 09	Immobilization of Hexavalent Chromium by Dithionite Reduced Fe^{3+}-bearing Clay Minerals	Changyu Moon, Hee-sun Moon and Kyoungphile Nam	Seoul National University
Env. 10	Adsorption of PFAS from Subsurface using Montmorillonite Grafted Chitosan Beads	Aneesu Rahman, Rahim Shahrokhi and Junboum Park	Seoul National University
Env. 11	A Study on Long-Term Leaching Behavior of Cd and Zn from an Industrial Site and Its Effect on Groundwater Contamination	Hosub Lee and Kyoungphile Nam	Seoul National University

Env. 12	Effect of Cement Mineral Carbonation by CO_2 injection on the Stabilization of Cr(VI) in Cement Matrix	Kian Cho *et al.*	Seoul National University
Env. 13	Red Mud Modified Biochar as Adsorbent for Removal of Cd(II) from Aqueous Solution	Xiaofeng Liu, Jiashi Li and Xiaoqiang Dong	Taiyuan University of Technology
Env. 14	Evaluation of Lifetime of Calcium- and Magnesium-bearing Immobilizers for Waste Rocks Containing Arsenic	Ayaka Hashimoto	Iwata Chizaki Incorporated
Env. 15	Comparison Sustainability Analysis of Onsite Resource-Oriented Sanitation Systems versus Septic Tanks in the Republic of Korea	Shervin Hashemi	Yonsei University
Env.16	Utilization of Carbonated Incineration Bottom Ash from Municipal Solid Wste using Carbon Dioxide as Base-course Material	Yuma Otsuka et al.	Fukuoka University

POSTER PRESENTATION			
Presentation Reference	**Title**	**Author(s)**	**University**
P1	Soil Washing and Oyster Mushroom-based Bioremediation for the Munhak Mountain Petroleum Contamination	Minho Lee, Sungryul Kim, and Junboum Park	Seoul National University
P2	A Review of Physical and Chemical Remediation Technologies Concerning Southern California's Lead Contamination Case Study	Sadaf Shahaba *et al.*	Seoul National University
P3	A Suggested Modification of Thermal Desorption for Heat Reuse and Oil Recovery: Case study of Munhyeon Complex in Busan	Hyeong Seok Yun *et al.*	Seoul National University
P4	Exploring Biosorption as an ESG-aligned Solution for Contaminated Sites: A Case Study of Kabwe Mine Area in Zambia	Seok Hoon Kang *et al.*	Seoul National University
P5	Case Study of Busan DRMO Remediation Site and Application of ESG Method for Thermal Desorption	Da-eun Jo *et al.*	Seoul National University
P6	Application of ESG Concept to Landfarming technology for Sustainable Soil Remediation	Gi Heon *et al.*	Seoul National University
P7	Monitored Natural Attenuation at the Army Base in Yongsan	Gunwoo Shim *et al.*	Seoul National University
P8	A Next Generation of Soil Washing: The EcoWash ModuloRe	Adrien Ansaldi and Junboum Park	Seoul National University
P9	Development and ESG Aspects of In-Pile Thermal Desorption (IPTD)	Wonjin Lee *et al.*	Seoul National University

Presentations

Information

Keynote Lecture

Contents

Introduction

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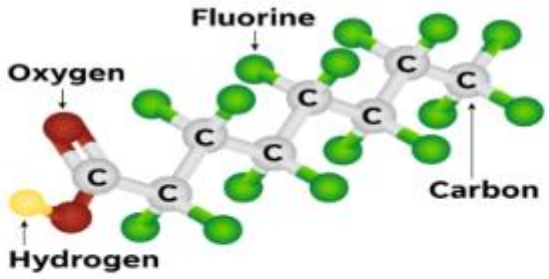
What are the PFAS?

- PFASs are **halogenated hydrocarbons**, where the hydrogen is either partially or fully substituted by ***fluorine*** and formed *fluorinated carbon* chains.

H ⟶ F



PFAS structure

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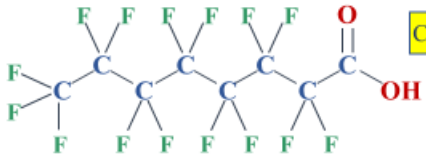
What are the PFAS?

1.Introduction

PFASs are Per- and poly-fluoroalkyl substances

- **Per-fluoroalkyl substances**: **fully** fluorinated alkyl tail
  - Perfluoroalkane carboxylates (or carboxylic acids): **PFCAs**

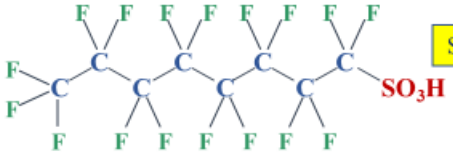
(PFOA)



PFAAs

  - Perfluoroalkane sulfonates (or sulfonic acids): **PFSAs**

(PFOS)



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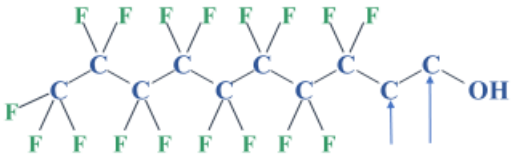
What are the PFAS?

1.Introduction

- **Poly-fluoroalkyl substances**: non-fluorine atom (typically hydrogen or oxygen) attached to at least one carbon atom

Fluorotelomer Alcohol (8:2 FTOH)



Non-fluorine atom on one or more carbons.

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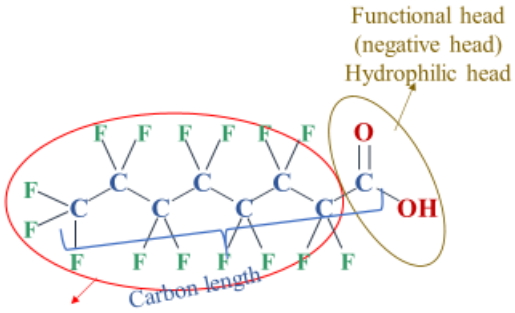
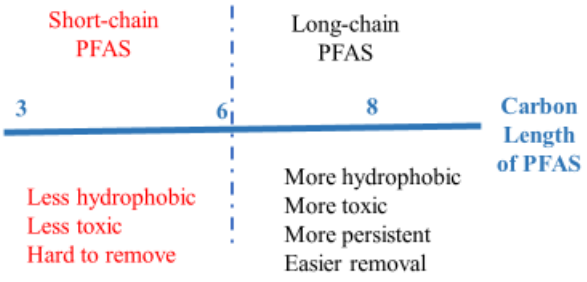
What are the PFAS?



Short and long chain PFAS



**Note:
Hydrophobicity means the property of not being easily combined with water molecules (repeal water) (ex. Oil)

Hydrophilicity means the property of being easily combined with water molecules (attract water) (ex. Salt, heavy metals)

PFCA≥ 8 carbon atoms → Long chained PFAS

PFSA≥ 6 carbon atoms → Long Chained PFAS

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What are the PFAS?

The most common short and long chain PFAAs (James O'Connor et al. (2022))

Short-chain PFCAs				Long-chain PFCAs				
PFBA	PFOeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA
PFBS	PFPeS	PFHxS	PFHpS	PFOS	PFNS	PFDS	PFUnS	PFDos
Short-chain PFSAs				Long-chain PFSAs				

Category	PFAS name	Acronym	Chain length	Log Kow	Molecular Weight (g.mol^{-1})	Density (g. cm^{-3})	Formula
Long-chain	Perfluorooctanic acid	PFOA	8	4.59	414.07	1.8	$C_8HF_{15}O_2$
	Perfluorooctane sulfonic acid	PFOS	8	5.26	538.22	1.85	$C_8HF_{17}SO_3$
Short-chain	Perfluorobutanic acid	PFBA	4	2.32	214.04	1.65	$C_4HF_7O_2$
	Perfluorobutane sulfonic acid	PFBS	4	2.73	338.19	1.82	$C_4HF_9SO_3$

Long-chain PFAS have more carbon length with higher molecular weight.

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Why we have PFAS; where PFAS are using?

- ❑ PFASs are a considered as the most recent group of man-made chemicals
  - ✓ Unique physico-chemical properties of PFASs

(resistant to grease, oil, water and heat)

- ✓ PFAS have been manufactured and used in a variety of industries around the world since the *1940s*.
- ✓ It has been reported that more than ***5,000*** types of PFAS have been used for various commercial and industrial applications (*US FDA, 2019*).

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What are the main source of PFAS?





- Fire stations
- Military bases
- Commercial and private airports
- **Landfills** (leaching from consumer products)
- **Chemical facilities**
- Textile/carpet manufacturers
- **Wastewater Treatment Plants**

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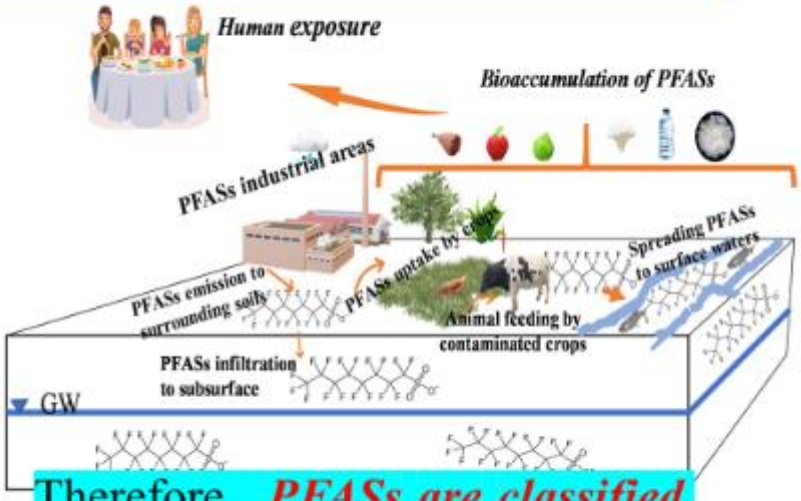
Why PFAS are important?

Concerns of PFAS:

- Extreme persistence
- Easily distributing/spreading
- Bioaccumulation in plants/animals
- Human exposure

Low infant birth weights,
Effects on the immune system,
Liver damage; high cholesterol level
Cancer (for PFOA), and
Thyroid hormone disruption (for PFOS

The detected PFAS in ***human's blood*** in Koreans has been reported as one of the highest level among the Asian countries *(Harada et al., 2010; Seo et al., 2018).*



Therefore, ***PFASs are classified as emerging threat for humans and environment***

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PFAS contamination and distribution is worldwide

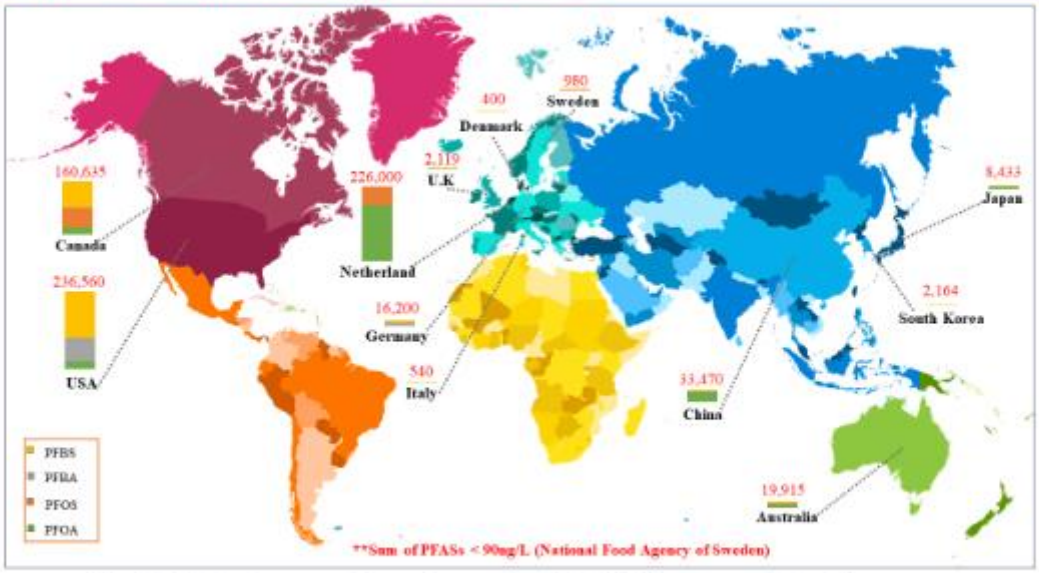

Fig. 1 PFASs in water sources from various countries (Total PFAS concentration in ng/L)

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PFAS contamination and distribution is worldwide

1.Introduction

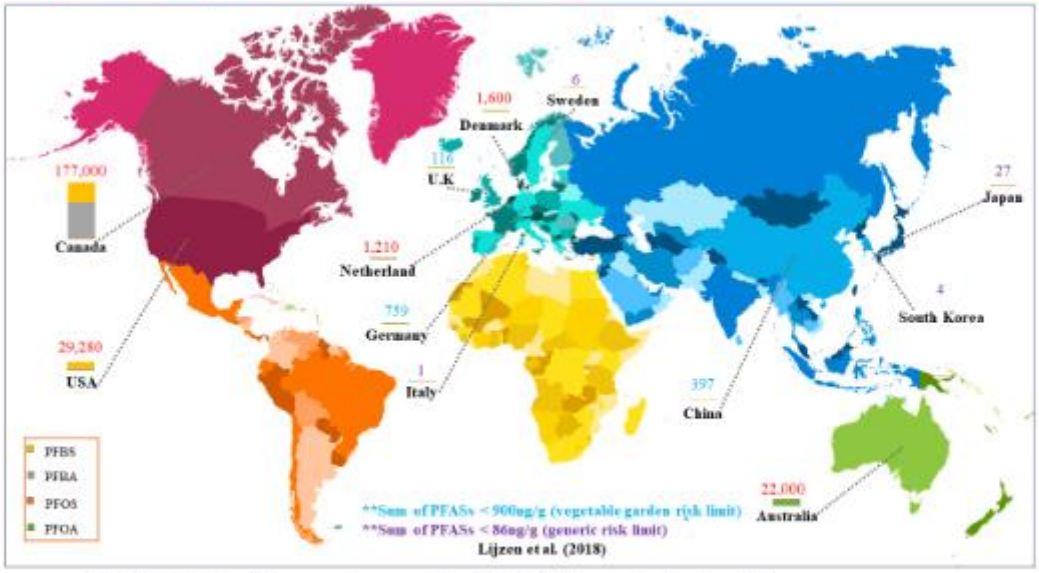

Fig. 2 PFASs in soil from various countries (Total PFAS concentration in ng/g)

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PFAS contamination and distribution is worldwide

1.Introduction

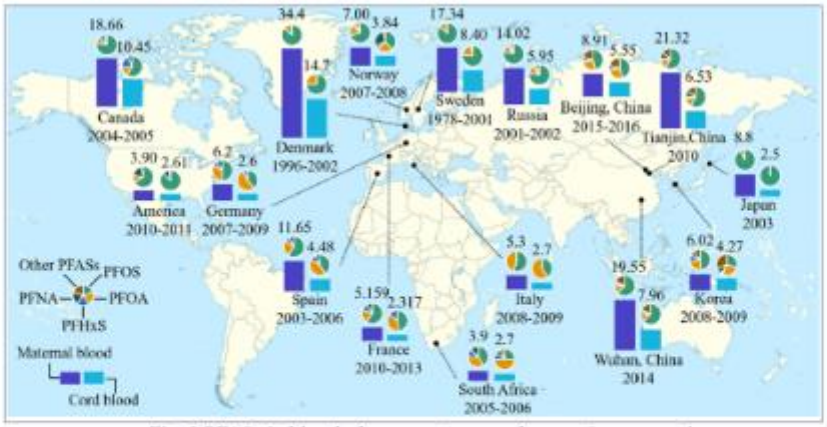

Fig. 3 PFASs in blood of pregnant women from various countries
(Total PFAS concentration in ng/L)

It has been confirmed that PFASs have been detected in human blood around the world at high levels of concentration, which can potentially lead to adverse effects on human health.

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PFASs distribution in S. Korea

1.Introduction

Sample	Location	Most detected PFASs	Detected concentrations	Reference
Waste Water	Upper midstream part of Nakdong River	PFOS,PFPeA,PFHxA, PFBA,PFPeS,PFBS,P FHxS	103-12500 ng/L	(Kim et. al; 2021)
Air, Water, Sediment, Soil, Fish	Asan Lake	PFOA, PFPeA, PFOS	0- 467 ng/L	(Lee et. al; 2020)
Effluents of waste treatment plants	Daegu & Gumi	PFBA,PFBS,PFOA, PFOS,PFHxA, PFHxS,PFPeA	38-1800 ng/L	(Choi et.al; 2021)
Human Serum	Cheongju-si & Chungcheongbuk-do	PFOA & PFOS	3.4 & 8.5 ng/mL	(Heo, et al; 2022).
Soil	Gyeonggi, Gangwon, Chungcheong, Geongsang & Jeolla	PFOA, PFOS	0.05- 1.573 ng/g	(Choi et. al; 2017)
Soil	Industrial, Landfill, Farmland & Mountain	PFBS,PFOS,PFOA, PFHxS	0.175-11.7 ng/g	(Wonjin et. al; 2021)

**Note: EPA water heath advisories level (70 ng/L)

**Note: German HBC(2 & 5 ng/mL for PFOA & PFOS)

**Note: Generic & vegetable garden risk limit by Lijzen et. al;2018(900 &86 ng/g)

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Treatment techniques

2. Remediation Technologies

The best treatment technique should be selected for PFAS removal!!!

Some possible treatment techniques

Ex-Situ Technologies

- Sorption
- Membrane filtration
- Thermal treatment
- Chemical treatment
- Soil washing

In Situ Technologies

- Phytoremediation
- Solidification/stabilization
- Soil Liquefractionation

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Treatment techniques

Pros	Technique	Cons
Efficient eco-design	Adsorption	Disposal of used adsorbents
All-PFAS effectiveness	Membrane Filtration	Complex mechanism
Full PFAS degradation	Thermal Treatment	Toxic byproducts
Short time for degradation	Chemical Treatment	Not effective for short chain
High removal	Soil Washing	Need secondary treatment
Low disruption & cost	Phytoremediation	Slow rate
Effective immobilization	Solidification/Stabilization	No toxicity reduction
High removal	Soil Liquefractionation	Need secondary treatment

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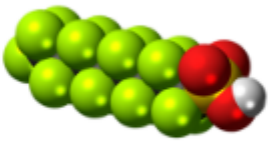
PFAS removal difficulties

Strong C-F bonds in PFAS



Forming dense hydrophobic C-F layer Preventing oxidative degradation

Strong dissociation energy of (C–F) Resistance against microbial cleavage

High melting point >600 °C Resistance against thermal treatment

Higher density than water Conventional remediation methods are not practical

Sorption has been known as one of the most promising methods for removing the PFAS contaminants

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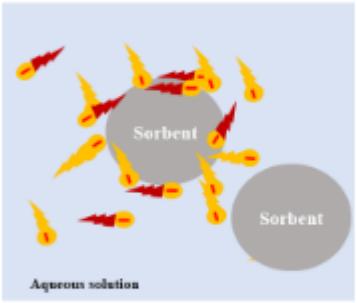
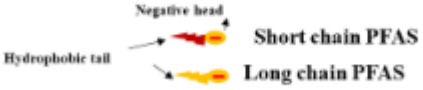
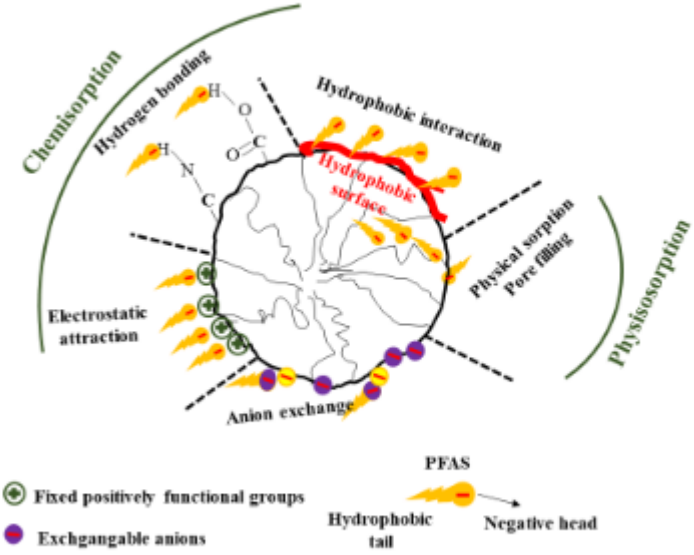
Sorption technique

How sorption technique works?
Sorption mechanisms







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Sorption technique

The most common sorbents for PFAS sorption
(Commercial sorbents)

Anion Exchange Resins (AER)

Activated Carbon (AC)

Zerovalent Iron (ZVI)

Biochar

Clays

AER and AC are the most efficient commercial sorbents for PFAS removal;

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Lab Research Overview

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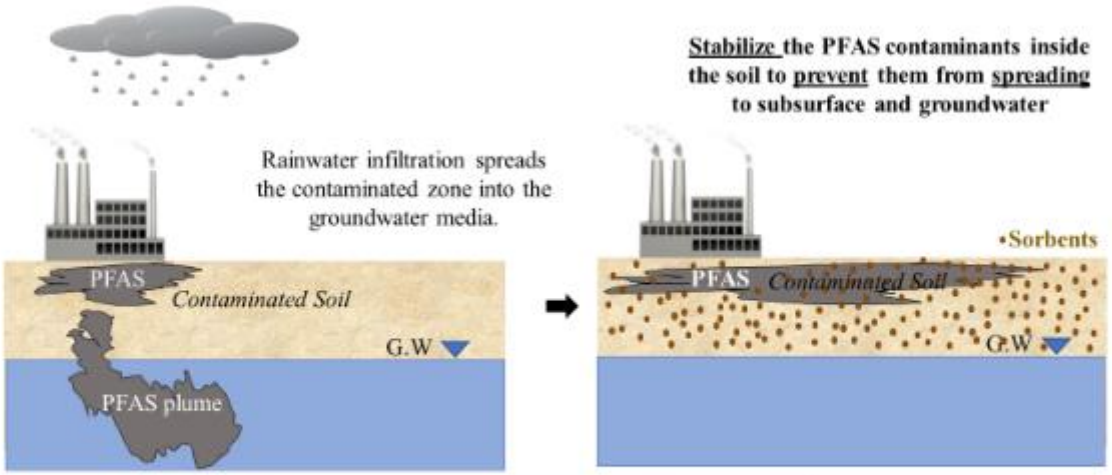
Our lab plan



Commercial sorbents (AC, AER) are expensive ;
Need to produce efficient and cost-effective sorbents

So what we did??

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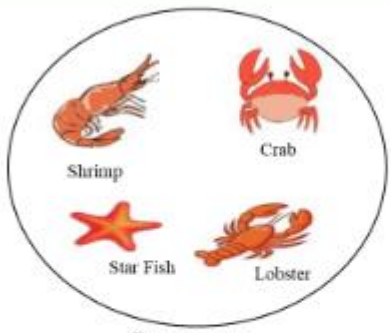
Making some sorbents form recyclable waste materials for PFAS sorption/stabilization



Crustaceans

Vegetables

Fungai

Chitosan

1) Chitosan is an abundant, cheap resource, which makes it economically viable.

(2) Abundant amino and hydroxyl groups

Chitosan has got attention for using as bio-sorbent for removing contaminates

Evaluate the efficiency of chitosan/modified chitosan for PFAS sorption

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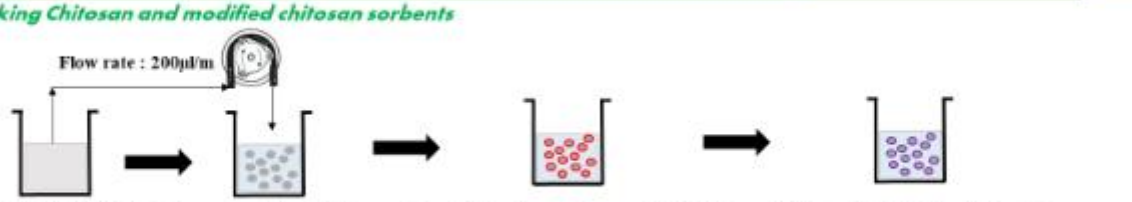
I) Making Chitosan and modified chitosan sorbents



Solve 1% chitosan powder in 2% acetic acid solution.

Dropwise adding of chitosan solution to 0.5 M NaoH

Crosslinking the wet chitosan with 2% ECH (Epichlorohydrin) (Time:12h; T= 40°C).

Grafting with PEI (polyethleneimine) (Time:24h; T= 30°C).

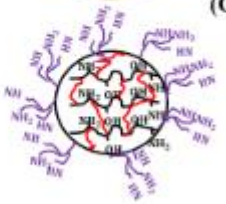
Vacuum dry

Vacuum dry

Wet chitosan beads

I) Chitosan beads (CB)

II) Grafted chitosan beads (GCB)



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3. Lab Research Overview

Selected the most common and efficient commercial sorbents as a reference sorbents (considering previous researches)

1. Carbonaceous sorbents groups

Pulverized Activated Carbon (PAC)

Granular Activated Carbon (GAC)

2. Polymeric sorbents groups

Anion Exchange Resins (AER)

AER efficiency based on their structure

- Macroporous beads > gel based- beads
- Polystyrene resin > Polyacrylic resins

A520E (Purolite)
Particle size Range: 300-1200µm
Strong Base Anion Resin

Selected PFAS at this study

Long chain PFAS

PFOA (Perfluorooctanoic acid)
PFOS (Perfluorooctane sulfonic acid)

Short chain PFAS

PFBA (Heptafluorobutyric acid)
PFBS (Potassium nonafluoro-1-butanesulfonate)

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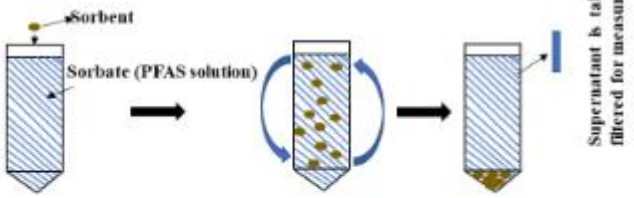
3. Lab Research Overview

Basic tests to evaluate the efficiency of each sorbents

1. Batch adsorption tests

Isotherm sorption tests
Determine the maximum adsorption capacity of sorbent

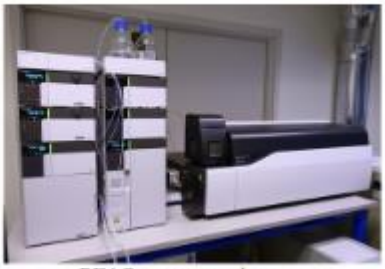
Kinetic sorption tests
Determine the sorption rate of sorbent
(how sorbent is quick to catch the PFAS)



Adding sorbent to the sorbate solution (initial concentration C*i*)

Agitation of solution

Centrifuge of solution (Remind concentration C*e*)



PFAS concentration were analyzed by LC-MS/MS

$$Cs = \frac{(Ci - Ce) \times V}{m}$$

Cs (mg/g): Amount of adsorbed PFAS
Ci: Initial Concentration
Ce: Equilibrium (remind) concentration
V: Volume of sorbate
m: Dry mass of adsorbent

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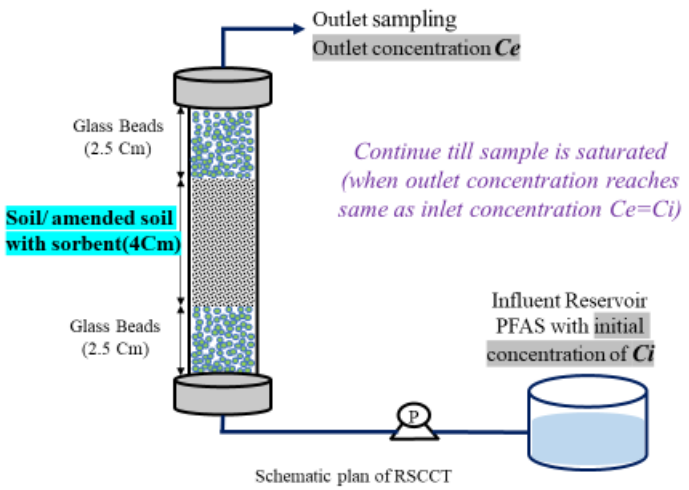
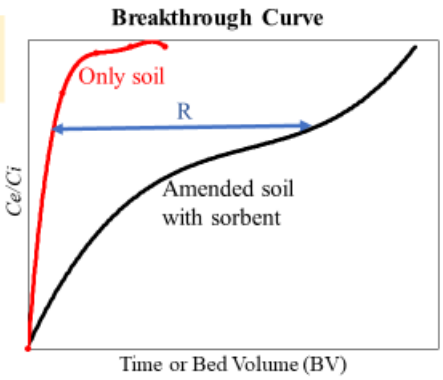
2. Rapid Small Scale Column Test (RSSCT)

RSSCT are conducted at small scale in the laboratory and can accurately simulate the performance of full scale columns, while using a relatively small volume of water and taking a fraction of the time required for pilot scale testing.



Schematic plan of RSCCT

Continue till sample is saturated (when outlet concentration reaches same as inlet concentration Ce=Ci)



R : Retardation factor determined from column tests
Difference between saturation time for soil and amended soil

R ↑ → **Sorbent is more efficient**

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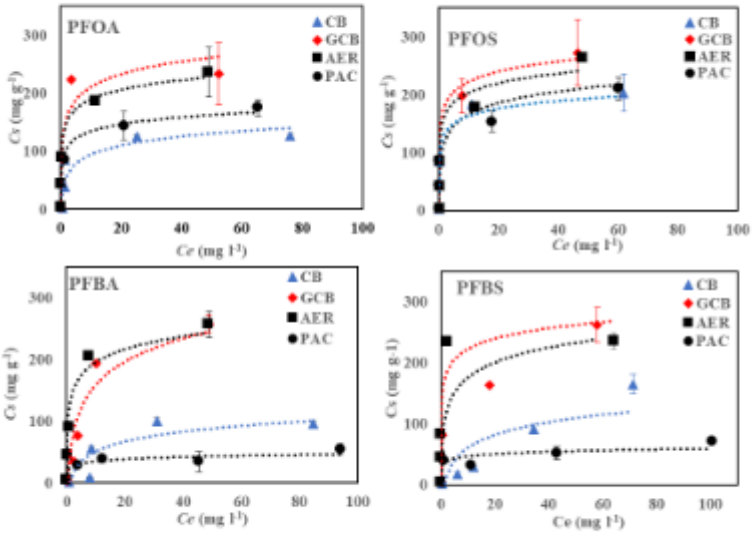
PFASs sorption results (Isotherm test- initial concentration 1- 100 mg.l^{-1})



- ✓ GCB and AER showed better sorption efficiency for all PFASs among the used sorbents.
- ✓ GCB showed adsorption capacity as high as AER.
- ✓ Non modified CB showed lower efficiency for removing the PFAS, which confirms adsorption capacity of CB is increasing by grafting process.

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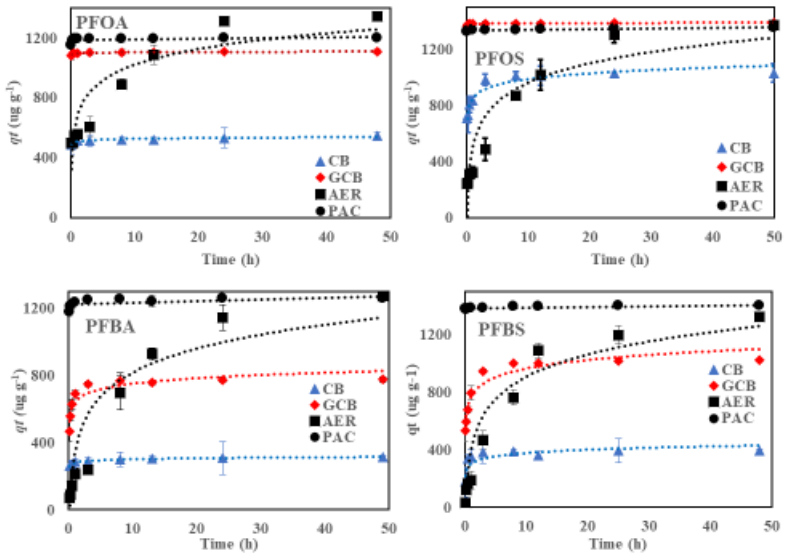
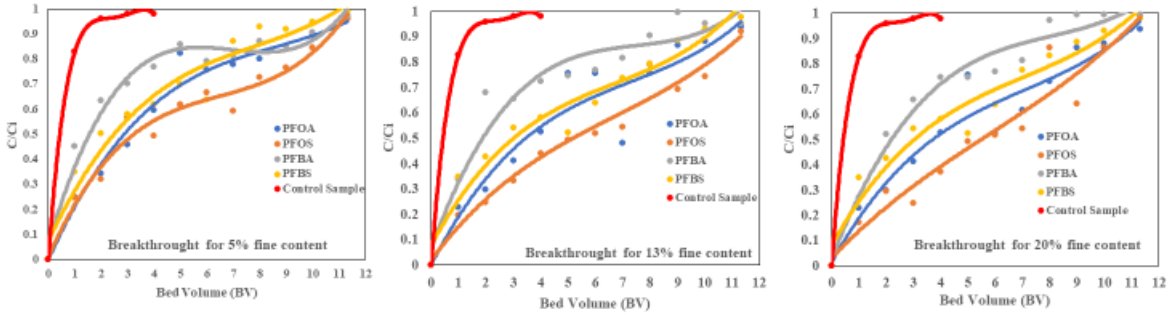
PFASs sorption results (Kinetic tests- initial concentration 100 µg. l^{-1})



- ✓ GCB showed adsorption rate as fast as PAC
  Their equilibrium phase is less than 5 minutes.
- ✓ AER needs more time (>48h) to reach to the equilibrium phase

Column tests results



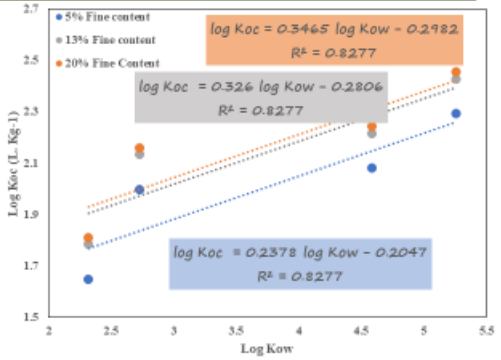
- ➢ The PFAS with shorter chains (PFBA, PFBS) exhibited earlier breakthroughs than the ones with longer chains (PFOA, PFOS).

  For example, PFBA (C4) showed almost complete breakthrough at ~4BV, whereas PFOS (C8) reached to complete breakthrough at higher BV (~9BV).

- ➢ This is due to the fact that the length of the PFAS chain affects their physicochemical properties. Longer-chain PFAS are more hydrophobic than shorter-chain PFAS, and can be more sorbet by soil particles *(Park et al. 2020)*.

Column tests results

Fine content of soil	PFAS	Present study (column tests) K_d (L. Kg^{-1})	Present study (column tests) Log K_{OC} (L. Kg^{-1})
5%	PFOA	0.712	2.078
	PFOS	1.161	2.291
	PFBA	0.263	1.646
	PFBS	0.588	1.995
13%	PFOA	0.976	2.215
	PFOS	1.591	2.428
	PFBA	0.360	1.783
	PFBS	0.806	2.132
20%	PFOA	1.037	2.242
	PFOS	1.691	2.454
	PFBA	0.383	1.809
	PFBS	0.857	2.159



Carbon chain of PFAS (Kow) ⬆ ⟶ K_d & K_{oc} ⬆

Almost identical breakthrough trends with the same K_{oc} values were obtained among soils with varying fine contents. It appears that the ***fine content of soil has not so much influence*** on the sorption of PFAS components.

The obtained low K_d and K_{oc} values for PFAS components demonstrated that PFAS breakthrough occurs immediately in soils, indicating that ***PFAS sorption by soil is not a significant factor for their fate and transport through soils (PFAS components are prone to rapid leaching through soil).***

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Summary

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4. Summary

- PFAS contamination is a global problem that requires immediate attention
- PFAS contamination in soil and water is a global issue, with levels in all countries studied exceeding the advisory limit of the national food agency of Sweden for the sum of 10 PFAS less than 100 ng/L in water. Countries such as the USA, Australia, and Canada are well above the risk limit in soil, highlighting the need for immediate action.
- It is crucial to take necessary measures to address this issue, including implementing remediation technologies based on the type of PFAS, sources, cost and sustainability.
- Our research has shown that adsorbents made from recyclable materials can provide comparable results with commercial adsorbents. However, long-term studies are needed, and how soil properties such as pH, organic content and soil mineralogy effects the adsorption.
- Overall, it is imperative to continue research and development efforts to find effective and sustainable solutions to tackle PFAS contamination.

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4. Summary

Is it possible to reduce exposure to PFASs??!!

PFAS do not have any taste, color, or odor. The best way to prevent exposure to PFAS is to avoid products and sources that may contain them:

- Use home water treatment systems or specific water filters that remove PFAS
- limit the use of waterproof and stain-resistant product
- Choose non-stick, PFAS-free cookware; use ceramic coated non-stick
- Try to avoid paper wrapping and coated cardboard boxes used at fast food restaurants
- Avoid "anti-aging" cosmetics containing PTFE (polytetrafluoroethylene)

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Thank you

Any questions?

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Phone: +82-2-880-8356

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ESG 2.0
in Construction Management

김 익석
Iksuk Kim
California State University Los Angles

Today's ESG:
ESG EVERYWHERE!!

Marketing Tactic ➡ Business Standard

U.S. Standard ➡ Global Standard

Stockholders' Interest ➡ Stakeholders' Interest

Today's ESG:
ESG is *RESOURCE* !! (and Responsibility)

For Investors:
Providing timely Non-Financial data related business activity with Financial Data

For Consumers:
Providing Evaluation Basics about Personal/Social Belief about Corporate Social Responsivity

BUT….
What is Next?

Strategic ESG Implementation for REAL BUSINESS!

Strategic ESG Implementation

ESG Background

ESG in CE Industry

ESG Rating

ENVIRONMENTAL, SOCIAL, AND GOVERNANCE BACKGROUND

Corporate Community **Involvement**

↓

Corporate Social **Responsibility**

↓

Corporate **Sustainability**

↓

ESG

ENVIRONMENTAL, SOCIAL, AND GOVERNANCE MARKETING EXAMPLES

- **Green Marketing**

94% of Consumers would Buy a product that has an Environmental benefit; 76% have already Purchased an Environmental Product in the past 12 Months.

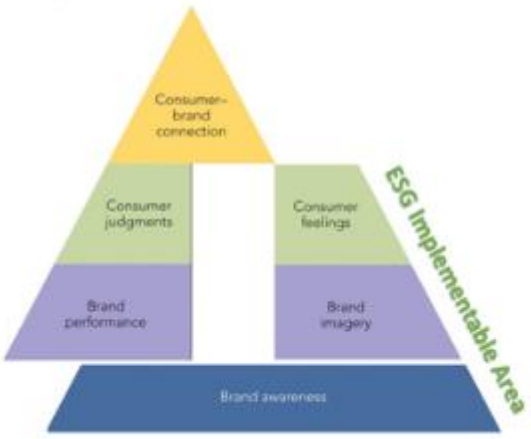
- Kerin, et al. Marketing, 14th ed.

- 2011 Cone/Echo Global CR Opportunity Study

- **Cause Marketing**

93% of Consumers would buy a product associated with a Cause Marketing; 65% have already purchase as a Cause Marketing product in the past 12 Months.

ENVIRONMENTAL, SOCIAL, AND GOVERNANCE BRAND VALUE APPROACH



- Kerin, et al. Marketing, 14th ed.

-Keller, Strategic Brand Management, 4th ed.

ENVIRONMENTAL, SOCIAL, AND GOVERNANCE
BRAND VALUE APPROACH

Foundation of Corporate Image >> Long Term Brand Setup

- Expertise (전문성)
- Trustworthiness (신뢰성)

↘ *ESG Access Areas*

↗

- Likeability (호감도)

3 BOTTOM LINES:
PEOPLE, PLANET, PROFIT

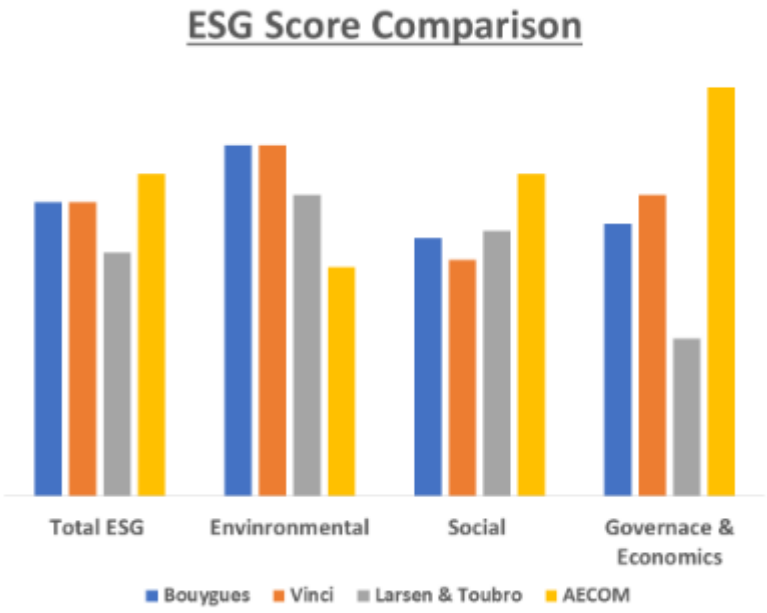
- Keramida.com

Are We Balanced?

Corporate MUST be the Center of ESG Activity.

ESG Score Comparison

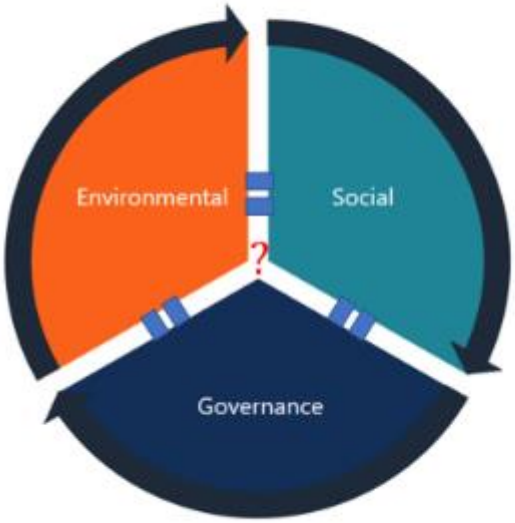
Construction & Engineering Industry



ESG Score Comparison

Construction & Engineering Industry

Are E. S. G Equally Important in the CE Industry?



ESG Rating Overview

- 600+ ESG Rating product over the world
- SPGlobal, MSCI, FTSE, Sustainalytics(Morningstar), Bloomberg, ISS (Institutional Shareholder Services), Moody's, CDP

ESG Rating Comparison

	MSCI	SP Global
Hyundai E&C	BBB	75
AECOM	AA	45
Bouygues	AA	41
Vinci	A	41
Larsen & Toubro	B	34

ESG Rating Comparison: Hyundai E&C

ESG Rating Comparison: Bouygues SA

WHICH ESG RATING?

TOMS

One for One

TOMS donates a pair of shoes for every pair sold and has donated of over *60 million pairs* of shoes to children in need. Profits are used to assist the visually-impaired by providing prescription glasses and medical treatments, provide safe drinking water and build businesses in developing countries to create jobs. They are also strong anti-bullying advocates and work with several non-governmental organizations and nonprofits to set examples of ethical behavior.

-Digital Marketing Institute

Lego invests *$150 million+* on climate change and reducing waste. It has reduced their packaging as well as investing in an alternative energy source and plans to source 100% renewable energy by 2020. To accomplish this the company hires a team to support its commitment to using sustainable materials and plans to reach a 90% recycling rate.

-Digital Marketing Institute

The brewing company owned entirely by its employees through a stock ownership plan is focused on sustainability.
Its Fort Collins brewery produces *18%* of its own electricity through solar panels and wastewater. It also contributes to bicycle and eco-focused organizations.

-Digital Marketing Institut

BOSCH

BERN (Bosch Energy Research Network) invests in creating environmental protection technology.
By 2021 the company will have invested €50 million to support universities and research programs that are focused on the environment, energy and mobility in Germany, India, the U.S and China.

-Digital Marketing Institute

Do we REALLY need ESG Ratings?
ESG Kings without ESG Ratings

TOMS One for One

LEGO

NEW BELGIUM BREWING

BOSCH

KEY FACTORS FOR SUCCESSFUL ESG IMPLEMENTATION

"For brands of all sizes, it's key to pay attention to the issues that your *customers* are interested in and the impacts your company can make at a community and global level. "

- Top Management's Official Attitude about ESG.
- Adjusting/Evaluating Business Strategy and ESG Adaptability
- Setting Comm. Ch. between (CEO and CFO) and ESG Unit.
- Understanding core Customers, Stakeholders, and Suppliers.
- Periodic Review Process with Clear Goal and Performance.
- Organizational Performance Sharing and Feedback Process.

Question?

Oral Presentations

Material Characteristics of Bamboo Chip Mixture for Sand Compaction Pile Method

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Eiji Watanabe[5], Naoya Nunokawa[6]

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Abstract

Sand compaction pile method, one of the liquefaction countermeasure methods, has a long history, and its design, construction, and materials have been improved according to the needs of the times for more than half a century. Sand and gravel are the most common filling materials used in the sand compaction pile method. However, due to the depletion of high-quality materials and environmental considerations, alternative materials such as steel slag, blast furnace slag, recycled crushed stone, and sand mixed with shells have been used. On the other hand, in recent years, various civil engineering technologies have been developed using biomass materials that incorporate carbon for a decarbonized society that aims to curb global warming. In this study, we focused on bamboo, which grows faster than other trees and is becoming a problem in neglected bamboo forests due to its fertility. Therefore, it is considered necessary to develop new filling materials that can meet the needs of the age of decarbonization in sand compaction pile construction methods. The objective is to develop a new material for carbon sequestration in the ground by mixing bamboo chips with conventional filling material in the sand compaction pile method. This paper reports the results of a study on the compaction and mechanical properties of the bamboo chip mixed material with the conventional filling material.

Influence of Formation of Skeleton Structure on the Bamboo Chip Mixed Solidified Soil

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Abstract

In western Japan, damage to mountain forests caused by bamboo propagation has been reported. Bamboo is one of the materials responsible for achieving the SDGs, from effective utilization of bamboo waste by solving the problem of neglected bamboo forests. On the other hand, improvement of soft ground containing a lot of organic matter has revealed problems such as increased costs due to the use of special solidifiers and increased pH of the ground. The authors have shown that the improvement effect of bamboo chip mixed solidified soil with dredged soil with high water content ratio is effective because of the high-water absorbency and the toughness of bamboo chips. In this study, we focused on the formation of bamboo chip skeletal structure in bamboo chip mixed solidified soil and examined the strength development by the arrangement and structure of bamboo chips. The results showed that the skeleton was not formed when the addition rate of bamboo chips was low, and that the skeletal structure of bamboo chips was formed with increasing addition rate, contributing to strength development. The formation of the bamboo chip skeleton structure was most effective in developing strength when the addition rate of bamboo chips was B=30~40%.

Swelling Property and Hydraulic Conductivity of Impervious Material Using Dehydrated Cake and Bentonite

Sota Terano[1], Kenichi Sato[2], Takuro Fujikawa[3], Chikashi Koga[4],

Yuji Inamoto[5], Masayuki Mizuno[6], Yuki Sakoda[7], Yasunori Arai[8] and Tsutomu Saito[9]

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Abstract

In Japan, the function of embankment bodies has been impaired in the aging of small earth dams because of the piping phenomenon of the small earth dams' bodies caused by torrential rain or cracking caused by earthquakes. In general, natural impervious soil, such as viscous soil, is used as a part of a small earth dam body. However, the shortage of natural impervious soil and destruction of nature by excavation have recently become major issues. Therefore, this study focuses on dehydrated cake generated from the treatment of turbid water in the process of crushed stone production as an alternative material to viscous soil of impervious material. Dehydrated cake is treated as waste material in Japanese law, thus effective utilization is required to prolong the landfill capacity. In general, grain size distribution is important for impervious materials used small earth dam in Japan. If the small earth dam body is composed entirely of clay, drying shrinkage might occur. Therefore, the impervious material are prepared by mixing decomposed granite soil containing sand and gravel with dehydrated cake containing fines. In addition, bentonite is added to the impervious material to improve its swelling and impervious performance. Previous studies have shown that bentonite mixed soil has low permeability and self-sealing property. However, there are few research reports on the permeability and self-sealing of impervious materials using waste material such as dehydrated cake. This study aims to investigate the swelling property and hydraulic conductivity of the impervious material of different grain size distribution using dehydrated cake and bentonite.

Experimental Study of Suffusion in Sand-Clay Mixtures Under Saturated and Unsaturated Conditions

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Abstract

Suffusion is defined as detachment of small particles in the soil matrix with no volume change, caused by the hydrodynamic force and the alternation of pore fluid chemistry. This study investigated the ionic concentration (IC)-induced suffusion of sand-clay mixtures under unsaturated conditions, which was not investigated in previous studies. Three clay types (kaolinite, illite, and bentonite) were selected to prepare sand-clay mixtures and to investigate the impact of clay mineralogy on the suffusion of sand-clay mixtures. At a given clay or sand type, the observed breakthrough curves (BTCs) obtained from soil-column experiments for the unsaturated conditions were compared to those for the saturated conditions. In both saturated and unsaturated conditions, the suffusion of sand-clay mixtures resulted from a decrease in IC. The observed BTCs in this study demonstrated more significant suffusion in the saturated than unsaturated conditions for the kaolinite and illite (non-swelling clay)-sand mixtures, whereas less substantial suffusion in the saturated than unsaturated conditions was observed in the sand-bentonite mixtures. This can be attributed to the dominance of interparticle double-layer repulsion over capillary and van der Waals attraction at high degree of saturation for non-swelling clay. In constrast, the more substantial suffusion of bentonite in unsaturated condition can be attributed to lower degree of saturation at bottom of the column than the top of the column, which led to formation of more significant preferential flow for sand-bentonite mixtures in unsaturated than saturated condition. The results of this study indicate the need for incorporating the saturation state for a comprehensive understanding of the suffusion of sand-clay mixtures.

Longitudinal Dispersivity of Sand-Clay Mixtures Under Unsaturated Conditions

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Abstract

The longitudinal dispersivity of soils is one of the key properties in predicting contaminant transport through soil. However, the longitudinal dispersivity of clay-containing soils is a less understood aspect even though they are abundant in subsurface environments. Therefore, this study investigated the longitudinal dispersivity of sand-illite mixtures under unsaturated conditions using laboratory soil-column experiments. Using sodium bromide (NaBr) as a non-reactive tracer, the longitudinal dispersivity of sand-illite mixtures was evaluated from the observed breakthrough curves (BTCs) as a function of illite content, initial volumetric water content, and travel length (controlled by the column length). The Richards' equation was adopted to back-calculate longitudinal dispersivity from implementing HYDRUS-1D. In addition, the change in water content during the injection of the NaBr solution was monitored by weighing the soil column. It was observed that the evaluated longitudinal dispersivity increased as the illite content, initial water content, and travel length increased. The high coefficient of determination obtained in this study indicates that the Richards' equation well described the water flow through the sand-clay mixtures under unsaturated conditions. The higher longitudinal dispersivity at higher illite content indicates the more tortuous flow path at higher illite content under both saturated and unsaturated conditions. Moreover, there is higher possibility of forming preferential flows at higher values of the final water content.

Evaluating Basic Geotechnical Properties of Pyroclastic Materials

Shinichiro Demachi[1], Tomotaka Yoshikawa[2], Atsushi Takai[3], Tomohiro Kato[4], Takeshi Katsumi[5]

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Abstract

Large-scale eruptions have resulted in the widespread deposition of pyroclastic materials, causing significant economic and social impacts as well as posing a threat to public safety. The treatment and disposal are not easy due to the limitation of land space. Therefore, utilization for them is important to reduce the disposal amount. In this study, the possibility of using such pyroclastic material as ground material was investigated, and pyroclastic material deposited in the Nojiri river basin of Sakurajima was used. The basic properties of the pyroclastic material and its suitability for use as a subgrade/base course material were evaluated. Compaction tests evaluated friability of the pyroclastic materials. Since pyroclastic materials are friable, the friability should be evaluated from a view of generated soil utilization. In addition, California Bearing Ratio (CBR) was examined to discuss the applicability of the material as a subgrade/base course material for road embankments. Batch leaching tests using water were conducted to evaluate the arsenic (As) and boron (B) leaching from pyroclastic material. The results confirmed the friability of pyroclastic material, with an increase in fracturing and dry density observed with an increase in applied energy. Bearing capacity was increased by applying pre-crushing treatment. Regardless of the presence or absence of crushing, it satisfies the standards for roadbed materials and lower roadbed materials for railway pavement. The leaching of As and B met the soil environment standards. The pH met the standards for discharge into the sea.

Hydraulic Conductivity Tests for Soil Amended with Stabilizing Agent Using Ion Containing Solution

Riho Ogata[1], Lincoln W. Gathuka[2], Tomohiro Kato[3], Atsushi Takai[4], Takeshi Katsumi[5]

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Abstract

Large amounts of excavated soils containing geogenic contaminants are generated. Since such excavated soils should be utilized as geomaterials, proper countermeasures should be taken. An attenuation layer method has been increasingly used at construction sites to prevent the contamination. The attenuation layer is usually installed beneath the geogenically contaminated soils. When leached contaminants permeate into the attenuation layer, contaminants are sorbed. Since pore water infiltrates in the layer, the hydraulic conductivity of the attenuation layer should be investigated. However, distilled water was generally applied for hydraulic conductivity tests for attenuation layer. The electrolytes leached form geogenic contaminated soils could cause pore-clogging of the attenuation layer. Considering such background, the permeability of the attenuation layer was evaluated under distilled water and two types of electrolyte solutions. The attenuation layer was simulated using mixtures of the decomposed soil and stabilizing agent. The agent was mainly composed of magnesium/calcium (Mg/Ca) substances. Hydraulic conductivity tests were conducted using acrylic columns (ϕ 5 cm × h 10 cm). Five different solutions, i.e., distilled water, calcium chloride ($CaCl_2$) solution (Ca^{2+} = 10 and 1000 mg/L), and iron(III) sulfate ($Fe_2(SO_4)_3$) solution (Fe^{3+} = 10 and 100 mg/L) were permeated. The permeability coefficients decreased from 5×10^{-6} m/s to 3×10^{-7} m/s by increasing pore volumes of flow (PVF), in distilled water and $CaCl_2$ solution cases. For Ca^{2+} 1000 mg/L cases, the hydraulic conductivity decreased faster than distilled water. On the other hand, $Fe_2(SO_4)_3$ solution affected the hydraulic conductivity more significantly than other solutions. The permeability coefficients of $Fe_2(SO_4)_3$ solution decreased from 3×10^{-7} to 6×10^{-8} m/s by increasing PVF. The result of permeability test and analysis of concentration of leachate showed that $Fe_2(SO_4)_3$ solution effected on permeability, while $CaCl_2$ solution had little effect.

Effects of Soil Modifiers on Separation of Soil -Wastes Mixtures on Disaster

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Abstract

Natural disasters occur frequently in Japan, which results in a substantially large amount of disaster waste that requires separation for proper disposal and recycling. Separating soil from soil-wastes mixtures (SWM) is particularly important for soil reuse and disposal of other materials. The high water content and high fines content soil in the soil-wastes mixtures (HWF-SWM) can increase the difficulty of separation. In such cases, soil modifiers are added to separate the soil from the SWM. However, the study on the effect of soil modifiers on the separation of SWM is insufficient. This study evaluated the effects of adding soil modifiers on separation of SWM. For that laboratory sieving tests were conducted using simulated HWF-SWM. Simulated HWF-SWM were prepared by mixing decomposed granite soil, Tochi-clay or Kasaoka clay, and wood chips. Two types of modifiers were used, namely quicklime and MgO-based neutral modifiers. Two sieving methods, rotary and vibrating screen which are imitating a real machine were compared. The addition of soil modifiers had a significant impact on the mass of the sieved fraction obtained from the SWM. Laboratory tests conducted on a rotary screen revealed that the addition of quicklime at a mass ratio of 1% in the dry state resulted in an increase in the sieved fraction from less than 20% to 80%. Similarly, the addition of MgO-based neutral modifiers at a mass ratio of 5% resulted in a 60% increase in the sieved fraction. The overall water content of the sample was not significantly affected by the addition of modifiers. The increase in the sieved fraction might be due to flocculation or a decrease in viscosity resulting from the reduction in moisture on the soil surface. Moreover, the purity of the residual wood chips was also observed to increase proportionally with the sieved fraction.

Numerical Analysis of the Mechanical and Deformation Behavior of Deep Soil-Bentonite Cutoff Wall and the Surrounding Ground

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Abstract

Soil-bentonite (SB) slurry trench cut-off wall, one of the commonly used contamination barriers in environmental geotechnical engineering, has the advantages of low permeability, strong flexibility, and low construction cost. However, the hydraulic conductivity of the wall is greatly affected by the stress state of the SB cut-off wall. Moreover, the deep excavation is involved in construction process, inevitably leading to stress releasing, lateral squeezing of the wall, and affecting the surrounding ground. Therefore, it is particularly essential to study the mechanical properties and consolidation properties of SB cut-off walls during construction and after the construction. In this study, the stress state of the SB cut-off wall in a full-scale cutoff wall construction field during the construction and consolidation was simulated by a finite element model. The simulating procedures include trench cutting with slurry, re-mixing the bentonite powder in the trench and consolidation. The stress state and consolidation characteristics of the wall, the lateral pressure and deformation of the interface between the wall and the soil ground after construction are solved. Then, the model was applied to assess the changes of effective stress of the wall in terms of the distribution of lateral squeezing pressure, the dissipation of excess pore pressure during the consolidation period. The result show that 1) the stress state of the SB cut-off wall is influenced by both lateral squeezing and vertical fiction from the sidewall. Thus it is inaccurate to simply consider the geostatic stress to calculate the effective stresses. 2) In the case of a wall with a large depth-to-width ratio, lateral squeezing effect is more apparent than expected, resulting to a redistribution of water pore pressure. 3) the primary consolidation was completed approximately one month after wall construction.

Fundamental Study on the Effects of Slaking on the Leaching Behavior of Geogenic Arsenic in Sedimentary Rock

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Abstract

In Japan, surplus soils and rocks excavated during construction works are reused and recycled as earthen embankment and reclamation materials for promoting resource recycling. If the excavated material consists of sedimentary rocks with slaking potential, it may result in reduced strength and compressive settlement. Additionally, Japan has abundant naturally occurring heavy metals such as arsenic (As) and lead. Leaching behavior of these naturally derived heavy metals in sedimentary rocks can be affected by slaking, leading to changes in adsorption/desorption equilibrium. While several past researches have studied the leaching behavior of heavy metals from soil samples, focusing on factors such as maximum particle size and particle size distribution, there are limited studies that investigate the impact of drastic changes in particle size caused by slaking. This research, specifically focusing on geogenic As, assessed the correlation between the progression of slaking and the amount of As leached from sedimentary rocks through serial batch tests. The results indicate that As concentration tends to increase with the progression of slaking, reaching a peak and then decreasing slowly (i.e. tailing). Chemical factors such as the leachability of As, pH, and leaching concentrations of Fe and Al were observed to have some influences, but not identified as dominant factors governing the leaching behavior of As. In addition, the correlation with the surface area of the rock sample and the leaching mass of As is not subjected to a linear relation. It suggests that existing leaching models of toxic heavy metals that considers only adsorption/desorption equilibrium do not simulate the actual behavior of As, and that the influence of diffusion in the solid phase should be considered.

Mitigating Urban Heat Island Effect with Eco-Friendly Flax Fiber Pervious Concrete

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Abstract

Urban heat island (UHI) is a well-known phenomenon in which urban areas experience significantly higher temperatures than their surrounding rural areas. This effect is caused by a combination of factors, including reduced vegetation cover, increased building density, and the use of heat-absorbing materials such as concrete and asphalt. Various strategies have been proposed to mitigate the UHI effect, including the use of green infrastructure, such as trees and green roofs, and cool roofs and pavements that reflect more sunlight and absorb less heat. However, one promising approach that has been gaining attention in recent years is the use of pervious or draining concrete. Draining concrete allows water to pass through and be absorbed into the ground, reducing surface runoff and heat absorption. This type of concrete is a sustainable solution for managing stormwater runoff in urban areas, but it can also contribute to the UHI effect due to its high albedo and low thermal mass.To address this issue, this study focuses on the use of flax fibers in draining concrete to enhance its hydric properties capacity and mitigate the UHI effect. Three different mixes of draining concrete were prepared, each containing different percentages of flax fibers. The mixes were tested for compressive strength, water absorption capacity, and water retention capacity. The results showed that the inclusion of flax fibers up to 10% by volume improved the water absorption capacity of the draining concrete without compromising its compressive strength. Additionally, flax fiber draining concrete retained water up to 30% more than conventional draining concrete. In conclusion, the use of flax fibers in draining concrete provides a sustainable solution for managing stormwater runoff and mitigating the UHI effect in urban areas.

Stabilization of Soft Soil Using Geopolymers Developed from Sewage Sludge Ash

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Abstract

Soft soils often contain high content of clay and lack desired mechanical properties to support infrastructures such as roadways. A common practice is to use Portland cement or lime to stabilize the soft soil and enhance its mechanical properties. However, these traditional stabilizers have a high carbon footprint due to their energy-intensive production process. Geopolymer cement is a sustainable alternative as it can be synthesized at room temperature from various waste or byproduct materials with little carbon emission. Sewage sludge ash is a byproduct of incinerating dewatered sewage sludge from wastewater treatment. This project's goal is to utilize sewage sludge ash (SSA) from the Delaware County Regional Waste Quality Control Authority (DELCORA) in southeast Pennsylvania of the U.S. to develop a geopolymer for stabilizing soft soils. The SSA was first utilized to develop a geopolymer mortar in conjunction with an alkaline solution consisting of sodium hydroxide and sodium silicate. Factors that influence the geopolymerization and strength gain of geopolymers were examined, including molar ratio between silicon dioxide and sodium oxide and activator/binder ratio. A set of parameters leading to optimum performance of the geopolymer was identified. A series of specimens consisting of a soft soil and the geopolymer at various dosages were created and tested for compressive strength on day 3, 7, and 28 of curing. An optimum dosage of geopolymer was determined to yield the maximum strength of the stabilized soil.

Keywords: Soft soil, stabilization, geopolymer, sewage sludge ash, compressive strength, sustainability.

Grain Size Distribution of Surface Sediment and Its Contribution to Heavy Metal Pollution in Shallow Harbour in Quebec, Canada

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Abstract

Anthropogenic activities related to antifouling paint particles and the runoff entering the harbour were the main sources of pollution in the harbours. Trace metals such as Cd, Cu, Cr, Ni, Pb, As, Zn, Mn, are among a wide variety of contaminants having an affinity for sediments. Here, we analyzed the grain size distribution and its potential impact on heavy metal pollution in surface sediment in the shallow harbour in Quebec, Canada. In this study, experiments were performed simulating sediment resuspension in the four stations, using a vertical plexiglas cylinder reactor.

The resuspension process was carried out in reactor for 2 hours, by using 1:10 (v/v) of sediment sample to tap water in suspension. Sediment with smaller grain size had a higher metal concentration. Specifically, particles with the smallest grain size (<39 μm) had the highest metal concentration in most areas (unit: mg/kg): Mn 370–911, As 2.1–7.7 Cd 0.33–1.07, Cr 48–85, Cu 8.9–149, Ni 3.3–46.0, Pb 20.36–69 and Zn 118–523. The 523 mg/kg concentration of Zn found at the station four exceeded the PEL (probable effect level) value of 310 mg/kg, which represents an environmental hazard to aquatic organisms.

Material and Leaching Characteristics of Recycled Crushed Stone Using Woody Biomass Ash for Environmental Safety

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Abstract

Currently, the effective utilisation of soot and dust as industrial waste is becoming increasingly important. However, it is difficult to manage its production due to its heavy metal content and variations in particle size and other properties. Therefore, it is desirable to clarify its properties and promote the effective utilisation of dust. Therefore, in this study, the properties of recycled crushed stone using dust are determined by unconfined compression tests and CBR tests in order to understand its properties. The environmental safety of the recycled crushed stone to the surrounding ground was also determined by leaching tests. It was considered that the strength of the initial solidified soil and the strength properties of the recycled crushed stone were both influenced by the number of curing days and the ash type. The leaching tests conducted to determine the environmental safety of the recycled crushed stone suggested that the amount of heavy metals leached was significantly affected by the ash type and combustion material, suggesting that it is necessary to focus on the mixing conditions of the initial solidified treated soil.

pH-dependent Solubility of Calcium and Magnesium Released from Adsorbents Mixed with Excavated Rocks

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Abstract

Large-scale tunnel excavation has been conducted in Hokkaido. Excavated rocks from hydrothermally altered areas and sedimentary rocks in marine origin often contain hazardous elements such as arsenic (As). Thus, the adsorption layer and insolubilization are used as reasonable countermeasures against reducing leaching concentrations from the rocks containing As. In this study, dolomite or magnesia was used for an immobilizer of As, and the solubilities of magnesium (Mg) and calcium (Ca) of major components of the adsorbents were evaluated by batch leaching experiments with and without rocks releasing As. The geochemical model PHREEQC was also applied to evaluate the solubilities. The results showed that the solubilities were sensitively dependent on pH and not on the existence of rocks, and that the solubilities were reduced in the alkaline region. The pH-dependent solubility of Mg was evaluated by brucite whereas that of Ca was evaluated calcite and dolomite, according to the simulation by PHREEQC. These results indicate that PHREEQC can be applied to evaluate the dissolution of the major components of the adsorbents.

Evaluation of the Change of Zinc Concentration in Mine Drainage by Identifying its Source at the Sado Gold Mine

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Abstract

A water treatment plant is planned at the Sado gold mine because zinc (Zn) concentration in mine drainage has been increasing recently and exceeded the effluent standard (2 mg/L). One of the countermeasures before construction is to reduce the flow rate of the drainage from the mine since it is less than 2.5 L/min. Therefore, the objective of this study was to identify the origin of the mine drainage by measuring the quality of river water located on the mine and groundwater around the mine. Not only Zn and co-existing major ions concentrations but also environmental isotopes such as δD and δ^{18}O values were analyzed. The result showed that although Zn concentration in the river water was lower than the detection limit (<0.1 mg/L), Zn concentration in the mine drainage exceeded the effluent standard. The isotopic data showed that the δ^{18}O values of the mine drainage agreed with the values of the surface water at around 400 m above sea level. This indicates that the drainage originates from the surface water at the same elevation. This implies that surface water percolation at around 400 m above sea level should be prevented to reduce the flow rate of the drainage.

Passivation of Arsenopyrite by Microencapsulation using Ferric-catecholate Complexes and Phosphate

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Abstract

Arsenopyrite (FeAsS), one of the most common arsenic (As)-bearing sulfide minerals in nature, is often found in auriferous sulfide ores. Typically, gold (Au) exists as metallic Au nanoparticles incorporated in the crystal structure of arsenopyrite (or pyrite (FeS2)). The general processing of Auriferous sulfide ores is as follows: (i) crushing/grinding to expose gold from sulfide matrix, and (ii) cyanidation to extract gold from the ground ore. After cyanidation, arsenopyrite-rich leaching residues are generated, and its weathering results in the release of toxic arsenic into the environment. The authors developed a new passivation technique called carrier-microencapsulation (CME) using ferric-catecholate complexes that forms ferric-oxyhydroxide coatings on the surface of sulfide minerals like arsenopyrite. Although this technique is effective in suppressing arsenopyrite oxidation, the coating formed is relatively instable when pH decreased to < 4. In this study, thus, we investigated the effect of the addition of phosphate ion in CME using ferric-catecholate complexes to form ferric phosphate coating having stronger acid-resistance than ferric-oxyhydroxide.Ferric ion and catechol (1,2-dihydroxybenzene, C6H4(OH)2) form three types of complexes depending on the pH: mono-catecholate complex ([Fe(cat)]+) at pH 3.0–5.5, bis-catecholate complex ([Fe(cat)2]–) at pH 5.5–9.0, and tris-catecholate complex (Fe(cat)3]3–) at pH > 9.0. In the presence of phosphate ion, mono-catecholate complex became unstable due to the formation of FePO4 precipitate, while bis- and tris-catecholate complexes remained stable. The complex should be decomposed on the surface of arsenopyrite to selectively form the coating, so bis-catecholate complex was chosen for passivating arsenopyrite. When arsenopyrite was treated by bis-catecholate complex and phosphate ion, arsenopyrite oxidation was suppressed due to the formation of FePO4 coating that limit the reaction of arsenopyrite with water and oxygen.

Comparison of Arsenic Leaching Concentration from Excavated Rocks Between Pre-Construction and Construction Phases of Hokkaido Shinkansen

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Abstract

Sedimentary rocks of marine origin and volcanic rocks excavated by tunnel construction projects may have risks of contamination by naturally occurring arsenic (As) to the surrounding soil and groundwater. Thus, appropriate management and/or countermeasures against the hazardous element are often required by understanding the leaching characteristics from the rocks. Vertical boreholes from the ground surface are drilled in pre-construction phase whereas horizontal boreholes from the inside of excavated tunnels are drilled in construction phase in Hokkaido Shinkansen. Although only sparse data of leaching concentration are available by boring from the surface, continuous data are available by boring from the tunnel. In this paper, the distribution of As leaching concentration from the bored cores is compared to confirm the validity of the distribution of As leaching concentration obtained before tunnel excavation. The distributions were evaluated for two sedimentary rock formations and one volcanic rock formation. The results showed that the distribution of As leaching concentrations followed a log-normal distribution, irrespective of the type of rock and the phase. The distributions of the concentrations from sedimentary rocks in the pre-construction phase and construction phase were almost the same. On the other hand, those from volcanic rocks were different. These results suggest that As in sedimentary rocks is homogeneously distributed whereas As in volcanic rocks is heterogeneously distributed. This may be due to the localization of volcanic activities. Therefore, in volcanic rock areas, more leaching tests are required to closely evaluate As distribution in pre-construction phase.

Carbon Fixation and pH Decrease of Leachate in Coastal Landfills by Atmospheric Exposure of Wastes

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Abstract

In recent years, the operation time of a coastal landfill has been extended. One of the reasons is the pH of the retained water showed an increase during the reclamation progress, and the pH does not decrease even though the criteria for decommissioning are met. The long-term leaching of calcium (Ca) and other ions is challenging in the control of leachate pH. Unless the waste itself is cleaned up, the problem of leachate pH will remain. To solve this problem, this study proposed exposing waste to the atmosphere for a certain period at a coastal landfill to lower the leachate pH by fixing CO2 to Ca ions and other substances contained in the waste. Four kinds of wastes were subjected to atmospheric exposure for CO2 fixation, and 4 exposing times were designed (1, 3, 7, and 28 days). Then the stabilization level of waste was evaluated by the CO2 mass fixed to the unit mass of the waste. Since CO2 is fixed in the waste as CaCO3, the mass of fixed CO2 was calculated by measuring the pressure of CO2 gas generated by the reaction of CaCO3 and HCl. As a result, a maximum of 75 kg and an average of 30 kg of CO2 were fixed per ton of dried waste after 28 days of exposure to the atmosphere.

Column Sorption Tests Against Perfluorooctane Sulfonate (PFOS) on Silica Sand and Mahji

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Abstract

Perfluorooctane sulfonic acid (PFOS) is a type of organic fluorine compound (PFASs). Since PFOS has unique physical properties, such as high thermal and chemical stabilities, water and oil repellency, and chemical resistance, PFOS is used in various applications, such as industrial, household, and military products. However, the toxicity of PFOS to living organisms and accumulations of the harmful effect of PFOS is revealed. Also, soil contamination caused by PFOS is gradually found with increased surveys. Therefore, sorption tests should be conducted to predict the soil contamination of PFOS precisely. Batch tests are often conducted to evaluate the sorption behavior of PFOS, while column tests need to be conducted more. This study evaluated the sorption behavior of PFOS using column tests. Two types of soils, i.e., silica sand and Mahji, were used in this study. Since soil contamination of PFOS in Okinawa is severe, Mahji, the unique soil in Okinawa, is applied. Sorption-desorption column tests using acrylic columns (5 cm × h 10 cm) were employed to evaluate the sorption performance against PFOS. The PFOS solution (C_0 = 0.01 or 0.1 mg/L) was applied in the sorption phase, while the distilled water was applied in the desorption phase. The breakthrough (C/C_0 > 0.05) occurred in PFOS solutions with initial concentrations of 0.01 earlier than 0.1 mg/L. The saturation of the sorption performance (C/C_0 > 0.9) occurred after approximately 8 and 11 PVF for silica sand and Mahji, respectively, for the initial concentration C_0 = 0.1. Since the total organic carbon concentration (TOC) of Mahji is 10 times larger than silica sand, the sorption performance of Mahji may be larger than silica sand.

Evaluating the Stability of Arsenic Immobilized with Iron Oxides in Soil by using Diffusive Gradients in Thin Films

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Abstract

Stabilizing arsenic (As) in contaminated soil through *in situ* synthesis of iron oxides has been shown to be more effective in reducing its biological accessibility than the *ex situ* amendment method of injecting pre-synthesized iron oxides. In this study, we investigated the effectiveness of *ex situ* amendment and *in situ* synthesis methods for stabilizing As in artificially contaminated soil. DGT-induced fluxes in soils (DIFS) were conducted to evaluate the dissociation kinetics of solid-phase As which has the potential to be re-released into porewater. Diffusive gradients in thin films (DGT) is a passive sampler that accumulates metal ions present in soil porewater through diffusion. The concentration gradient around the device induces the desorption of solid-phase metals into the porewater, allowing us to predict the rate constants for metal association and dissociation (k_1 and k_{-1}) and the distribution coefficient of labile metals ($K_{d\ labile}$). The concentration of As in the porewater was reduced by 76% in *ex situ* amended soil and 99% in *in situ* synthesized soil. The kinetic stability evaluation using DIFS showed that As immobilization with *in situ* iron oxide synthesis exhibited higher durability over the long-term compared to *ex situ* iron oxide amendment. The dissociation rate constant (k_{-1}) was 4.16×10^{-4} s^{-1} in *ex situ* amended soil and 3.03×10^{-5} s^{-1} in *in situ* synthesized soil, while the release rate was 0.093mg kg^{-1} day^{-1} in *ex situ* amended soil and 0.022mg kg^{-1} day^{-1} in *in situ* synthesized soil. These results suggest that solid-phase As was in a more stable state in the *in situ* synthesized method, which could have important implications for remediation of arsenic-contaminated soil.

Immobilization of Hexavalent Chromium by Dithionite Reduced Fe^{3+}-bearing Clay Minerals

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Abstract

Hexavalent chromium Cr(VI) is a carcinogenic inorganic, which is found in contaminated areas such as metal plating plants, and leather tanning plants. Cr(VI) usually exists in form of oxyanions (i.e., CrO_4^{2-}, $Cr_2O_7^{2-}$) in natural environment, which are not easily adsorbed on soil, leading to leaching into groundwater. Promoting a reduced environment in aquifer by using a reductant (i.e., dithionite) results in reduction of Cr(VI) to Cr(III), which can be an effective remediation technology. Structural iron (Fe^{3+}) in clay minerals is a key reaction medium, mediating electron transfer between dithionite and the Cr(VI) through Fe^{3+}/ Fe^{2+} coupling reaction. This study investigate the feasibility of utilizing Fe-bearing clay minerals as an electron shuttle for the immobilization of Cr(VI). The redox behavior of structural Fe^{3+} in three types of clay minerals including kaolinite (total Fe, 0.01 wt%), montmorillonite (total Fe, 2.3 wt%), and nontronite (total Fe, 22.3 wt%) was confirmed through the reduction by dithionite. The efficacy of utilizing reduced structural Fe^{2+} for the immobilization of Cr(VI) was also assessed. Results showed that the reduction ratio (Fe^{2+}/Total Fe) increased as pH increased except for pH 11, showing the highest in kaolinite, following montmorillonite and nontronite. Calculated standard redox potential (Eh_0) of structural iron shows that it differs depending on the types of clay minerals and environmental pH, and reduction of structural iron prefers when the environmental redox potential is lower comparing the Eh_0. Although kaolinite showed the highest reduction ratio reaching up to 100%, the mass of structural iron reduced was the highest in nontronite (i.e., ca. 112 mg/g of clay mineral, whereas 16.78 mg/g in montmorillonite and 0.03 mg/g in kaolinite). The results of reduction Cr(VI) at different pH using the reduced structural Fe^{2+} in demonstrated a decrease in both Cr(VI) and total aqueous chromium (i.e., Cr(VI), Cr(III)), with a more rapid decrease observed at lower pH. The concentration of Fe^{2+} remaining after the reaction suggested an effective reaction of Fe^{2+} with Cr(VI). Furthermore, considering the pH-dependent behavior of the chromium species, Cr(III) adsorption onto clay minerals occurs at acidic pH, while precipitation in the form of $Cr(OH)_3$ takes place at alkaline pH.

Keywords: Hexavalent Chromium, Iron bearing clay mineral, Structural iron

Adsorption of PFAS from Subsurface Using Montmorillonite Grafted Chitosan Beads

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Abstract

Per- and polyfluoroalkyl substances (PFAS) are a class of persistent organic pollutants that have been widely used in industrial, commercial, and consumer products due to their unique properties, but their toxicity and persistence in the environment pose significant risks to human health and the ecosystem. In this context, the development of effective and sustainable adsorbents for PFAS removal is crucial. However, the currently available commercial adsorbents have limitations, such as the lack of studies on their performance in soil, and the use of non-renewable materials. To address these issues, a novel adsorbent based on montmorillonite grafted chitosan beads (MT-GCB) is developed that combines the advantages of both natural materials and engineering design. The study aimed to compare the performance of MT-GCB with that of a commercial adsorbent (granular activated carbon, GAC) in batch sorption and leaching tests for four types of PFAS (PFOA, PFOS, PFBA, and PFBS) which is more commonly seen PFAS in environment. The results demonstrated that MT-GCB showed comparable removal efficiency to GAC for all four PFAS in both water and soil samples. Specifically, MT-GCB exhibited a removal efficiency of over 90% for PFOA and PFOS in water, and showed less leaching in soil at 10% of addition compared to 2% and 5%. Furthermore, MT-GCB was more effective in removing long-chain PFAS, especially PFOS. Importantly, MT-GCB did not affect the shear strength of soil, indicating its safety and potential for use in remediation efforts. This study provides a novel and sustainable solution for PFAS removal that has promising potential for both water and soil remediation. The development of MT-GCB as a natural-based adsorbent offers an eco-friendly and effective alternative to commercial adsorbents for environmental cleanup.

Keywords: PFAS, Adsorption, Natural Adsorbent, Remediation, Sustainable

A Study on Long-Term Leaching Behavior of Cd and Zn from an Industrial Site and Its Effect on Groundwater Contamination

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Abstract

Soil investigation was conducted at a smelting factory, revealing serious degrees of heavy metals contamination such as Cd and Zn, up to 15 m below the surface. According to depth-weighted average, the representative concentrations of Cd and Zn are 436 and 28,597 mg/kg-soil, respectively. A five-step sequential extraction method demonstrates that significant amounts of the total Cd and Zn can be desorbed from the soil by 0.04 M hydroxylamine hydrochloride (NH_2OH•HCl, pH 2), indicating that the site can act as a potential source for groundwater contamination. To predict the extent of leaching of Cd and Zn into the groundwater, three soil samples, designated A, B, and C, were collected from the site and long-term leaching test was carried out. The long-term prediction was followed by the method proposed by ISO, 2019, which generates leaching rate (first-order kinetic constant k, kg/L) and cumulative leaching amount of a heavy metal per unit area until time t (I_t, mg/m^2). It is found that leaching rates of Cd were 531 for A, 32 for B, and 2.6 for C and those of Zn were 443 for sample A, 76 for sample B, and 2.4 for sample C, respectively. The results are consistent with the extents of Cd concentration in the soil samples. In addition, cumulative amounts of Cd and Zn after 100 years at the site ($I_{100\ years}$) were calculated, yielding 3,000 and 24,000 mg/m^2 for Cd and Zn in

Effect of Cement Mineral Carbonation by CO_2 Injection on the Stabilization of Cr(VI) in Cement Matrix

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Abstract

Reducing CO2 emissions generated in the cement manufacturing process is an international challenge, and research on technology to fix carbon in cement is actively being conducted. As the background of CCUS (Carbon Capture and Utilization and Storage), "In-situ carbonation technology", a mineral carbonation technology in which CO_2 is injected into the mixing process of cement materials, was examined. In recent years, the Korean cement industry has reported that the amount of hexavalent chromium (Cr(VI)) eluted in cement paste exceeds the standard value, which has become a social problem. The purpose of this study was to evaluate the leachability of Cr(VI) by injecting CO2 into Ordinary Portland Cement (OPC), and to contribute to both the international CO2 emission reduction issue and the reduction of Cr(VI) leachability in the cement industry. As a result, it was found that the amount of Cr(VI) eluted from the cement was reduced by mineral carbonation with In-situ carbonation technology. Besides, as the sealed air curing time got longer, the leaching amount of Cr(VI) has decreased in tank leaching test. Especially the specimen of 28 days air curing with CO2 injection was measured almost zero leaching of Cr(VI). The analysis of the microstructure of the cement suggested that the increase in cement hydrates due to mineral carbonation contributed to the fixation of Cr(VI).

Red Mud Modified Biochar as Adsorbent for Removal of Cd(II) from Aqueous Solution

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Abstract

The aim of this study was to develop a cost-effective method for Cd(II) removal from aqueous systems. To this end, a pristine biochar (BC) and red mud modified biochar (RMBC) were prepared using peanut shells as raw material. The adsorption effect of Cd(II) in aqueous solution under different conditions (adsorption time, pH, and initial concentration) was investigated. The red mud increased the specific surface areas of BC. The adsorption capacity of the adsorbent increased with the increase of adsorption time, pH, and initial concentration. At a system temperature of 25 °C and pH 6, the maximum adsorption capacity of RMBC reached 63.25 mg/g, which is 2.9 times of the maximum adsorption capacity of BC (21.70 mg/g). All the adsorption processes can be well described by Langmuir isotherm and Freundlich isotherm. The adsorption process follows Pseudo-second-order reaction kinetics. The results suggest that the adsorption of Cd(II) by RMBC is based on chemisorption. The adsorption mechanism includes mineral precipitation, complexation with surface functional groups and cation exchange. Thus, the RMBC could be potentially used as an effective adsorbent for Cd(II) removal from aqueous solutions. Red mud is a feasible means of modification.

Evaluation of Lifetime of Calcium- and Magnesium-Bearing Immobilizers for Waste Rocks Containing Arsenic

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Abstract

Batch leaching experiments of arsenic contained in mudstone samples and a hydrothermally altered rock sample were conducted with and without an immobilizer such as calcite, periclase, and half-burnt dolomite. The results showed that the immobilizers reduced the leaching concentrations of arsenic from the rock samples although the removal ratio depended on the immobilizer. The leaching concentrations of calcium and magnesium as major components in the immobilizers primarily depended on pH, and not the existence of rock samples. The calculated results of calcium and magnesium leaching concentrations by PHREEQC agreed with the results obtained by the experiments. This means that the solubility of calcium and magnesium is mainly controlled by leachate pH, and not coexisting ions. This indicates that the lifetime of the calcium- or magnesium-bearing immobilizers can be evaluated by their leaching concentrations controlled by their solubilities, assuming that the performance of those cases when all of the major components are leached out. The calculated lifetime of the immobilizers ranged from several thousand years to tens of thousands, which are significantly longer than the life of structures. This implies that the lifetime of an immobilizer can reasonably be estimated using the method based on the solubility of major components in it.

Comparison Sustainability Analysis of Onsite Resource-Oriented Sanitation Systems Versus Septic Tanks in the Republic of Korea

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Abstract

With two billion people having no access to safe and sustainable sanitation systems, achieving The sixth sustainable development goal (SDG6) is yet challenging. Shortcomings in defining the technical, social, and economic sustainability of an implemented sanitation system are barriers to developing sustainable solutions to sanitation challenges. Onsite resource-oriented sanitation (ROS) systems are developed in different technical ways to provide systems with lower water and energy consumption, along with providing economic benefits with boosted accessibility. This study uses the recently developed Sanitation Sustainability Index (SSI) along with a lifetime cost-benefit analysis to compare the overall technical, economic, and social sustainability of an onsite ROS system with a septic tank. Real-scaled data are provided from a one-year pilot implementation and operation of both systems in an urban farming center located in the suburban residential area of Nowon district, Seoul to offer public hygiene services. To cover uncertainties, the Monte-Carlo simulation with one million trials was used to provide forecasted distributions for SSI and cost-benefit probability. Results yielded SSI distributions with averages of 0.36 (95% CI = 0.24–0.50) and 0.67 (95% CI = 0.55–0.75) for septic tank and ROS systems, respectively, which indicates notably higher sustainability for the ROS system. Nevertheless, it has a lower social sub-index score compared to the septic tank. The cost-benefit analysis predicts that for the ROS system after approximately six years, all the costs can be covered through the obtained economic benefits. When the ROS system is functioning beneficially, there will be less than a five percent probability of economic failure.

Utilization of Carbonated Incineration Bottom Ash from Municipal Solid Waste Using Carbon Dioxide as Base-Course Material

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Abstract

In Japan, approximately 80 % of municipal solid waste (MSW) is processed at incineration facilities, and approximately 3.4 million tons of incinerated ash is generated discharged every year. The incineration ash is classified into incineration bottom ash (IBA) and fly ash (FA), which account for 80 % and 20 %, respectively. This study focused on IBA that is disposed from the bottom of the incinerator. Currently part of IBA is effectively utilized as molten slag and cement material, but the utilization of that doesn't really proceed due to high lead leaching concentrations. As a result, the utilization rate of total incineration ash is only 30 % in Japan. Incinerated ash that is not used effectively is landfilled at final disposal sites, but the capacity of these sites is not adequate. The entire quantity of final disposal sites in Japan is equivalent to only about 20 years' landfilling amount, and it is currently difficult to construct new final disposal sites. Therefore, further promotion of effective utilization of IBA is required. To immobilize of lead from IBA, carbonation of IBA by venting carbon dioxide applied in this study. Also, to account for ash variability, experiments were conducted using two ashes discharged different years. In addition, focusing on the effective use of IBA as a base-course material, CBR tests were conducted on the carbonated IBA to evaluate its bearing capacity as a base-course material. As a result, it was revealed that carbonation treatment contributes to reducing lead elution of IBA, and carbonated IBA met the strength criteria for the subbase-course material.

Posters

A Review of Physical and Chemical Remediation Technologies Concerning Southern California's Lead Contamination Case Study

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Abstract

Heavy metal contamination poses significant risks to human health and the environment. This paper reviews Southern California's lead contamination case study instigated by battery recycling plants. Despite a $750 million clean-up budget, concentrated regions of toxic lead persisted sporadically across soils due to the inadequate removal and substitution with clean soil: threatening the livelihood of thousands of residents within a 3.5-mile radius of the plant. Landfilling was the ex-situ technique used to remediate polluted soils. Although landfills are cost-efficient, the possibly of secondary contamination heightens, as a result, the elevated environmental footprint must be lessened. Hence, this paper seeks to examine the applicability, efficiency, and limitations of remediation methods offering alternatives to landfilling.

In the case of lead, a metal which strongly affiliates with residual soil fraction, we found that soil washing could be a successful physio-chemical method in the removal of the heavy metal pollutant. Treatment procedures on excavated sediments are further discussed. Whereby stabilisation or solidification of sediments were noted to be sustainable and highly efficient processes. Therefore, this paper evaluates and compares the implementation of various remediation systems for Southern California's contaminated site.

Keywords: Lead Contamination, Landfilling, Soil Washing, Stabilisation, ESG.

A Suggested Modification of Thermal Desorption for Heat Reuse and Oil Recovery: Case study of Munhyeon Complex in Busan

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Abstract

The Munhyeon district in Busan, South Korea has been used for military purposes in recent years and has suffered from severe oil contamination. To address this issue, several methods such as Landfarming, Thermal Desorption, and Bio-pile have been applied, showing successful results. However, there is a growing need for more efficient and environmentally sustainable remediation processes. Therefore, this study focuses on thermal desorption, specifically analyzing its processes and types. In consideration of the environmental, social, and governance (ESG) factors, the study aims to develop more efficient method for the remediation of oil-contaminated soil, based on the reuse and recycling of materials. Two possible options are presented: a regenerative thermal desorption (RTD) and modified condensation system. Based from a regenerative thermal oxidizer (RTO) that stores and reuses heat using ceramic media, the RTD uses the stored heat in the preprocessing stage. A modified condensation system is proposed to convert the resulting mixed oil condensates into usable oil by classified heat temperatures and pressures. The study concludes that these approaches show promising potential for efficient and sustainable remediation in the Munhyeon district and beyond.

Keywords: Oil-contaminated soil, Thermal Desorption, ESG, Heat Reuse, Oil Recovery, Regenerative Thermal Oxidizer, Oil condensation system

Exploring Biosorption as an ESG-aligned Solution for Contaminated Sites: A Case Study of Kabwe Mine Area in Zambia

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Abstract

For the case study for contaminated site, we researched about mine area in Kabwe in Zambia. Its waste was never cleaned up, and lead dust continues to blow to nearby residential areas polluting homes, yards, schools, and play areas. Recently, in March 2023, the Zambian government is trying to clean up the contaminated site using a technology called "capping“. Unfortunately, this reaction did not really work well. Therefore, we suggest biosorption. Biosorption is reducing the movement of heavy metals by adsorbing heavy metals in soil to microorganisms and there are two types of biosorption (‘passive biosorption’, ‘bioaccumulation’) Today, it has developed to ‘nano-biosorbent’ which is sustainable, eco-friendly, renewable materials. To improve biosorption align with ESG, there are two ways to apply ESG to biosorption. One is re-using waste materials (citrus peel waste, tire waste) and the other one is re-using biosorbents(microalgae) after applying the technique.

Keywords: Biosorption, Nano-biosorbents, ESG, Bioaccumulation, Stabilization

Case Study of Busan DRMO Remediation Site and Application of ESG Method for Thermal Desorption

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Abstract

The ESG concept includes environment, social, and governance, and is in the spotlight in the modern era because it pursues sustainable development through eco-friendly and social responsibility and transparent management for sustainability and is no exception to soil restoration. Busan DRMO site was utilized by army base until 2008 and remained contaminated until 2020. The main contaminants were dioxin, TPH and heavy metals. For remediation, high temperature thermal desorption(HTTD) was used to remove dioxin and soil washing was used for other contaminants. Ex-situ and direct heating were applied to the case. HTTD is a useful and quick way to treat contaminated soil. However, it uses large amount of energy compared to other methods such as soil vapor extraction or bioremediation. So, it is important to control energy utilization of HTTD. In our study, we propose to apply variable condition mode(VCM) and heat returning mode(HRM) to HTTD. We can lower energy consumption by using VCM which is operating 3 heating process, increasing burner temperature of each stage. HRM extracts heat from purified gas or thermal treated soil after remediation process. So, HRM enables to save energy by reusing the heat. Furthermore, we can gather excavated soil at soil bank system and improve energy utilization.

Keywords: Thermal Desorption, ESG, Variable Condition Mode, Heat Returning Mode, Soil Bank

Application of ESG Concept to Landfarming Technology for Sustainable Soil Remediation

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Abstract

Landfarming is a soil remediation technology for removing organic contaminants by using agricultural practices to promote biodegradation. In this research, the ESG (Environmental, Social, and Governance) concept was applied to the landfarming method, one of the soil remediation techniques, to ensure sustainability for long-term operation. In terms of E (Environmental), post-combustion carbon capture technology was employed to reduce carbon emissions during microbial decomposition of organic compounds. We applied a carbon capture process using calcium and lithium hydroxide sorbent to a small-scale landfarming remediation site by benchmarking the post-combustion carbon capture technology. For S (Social), the Polyurethane Biofilter was used to eliminate odors generated during the remediation process, and regular meetings with the local community and residents were held to minimize their discomfort and complaints. Regarding G (Governance), the financial soundness of the project was secured by selling carbon credits and receiving government subsidies based on the carbon reduction achieved to offset the increased project costs resulting from the application of the ESG concept.

Keywords: Landfarming, ESG, Carbon capture, Polyurethane biofilter, Carbon credit

Monitored Natural Attenuation at the Army Base in Yongsan

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Abstract

Monitored Natural Attenuation (MNA) decreases the concentration, mass, toxicity, mobility, or volume of pollutants by the mechanism of natural media such as plants. With this, purification can be achieved so that it does not harm humans and nature in the desired time period at a low cost. MNA alone is limited in purifying contaminate areas, but it is of high value as follow-up process. From a long-term perspective, it is expected that MNA can reduce pollutants to an acceptable level. considering above characteristics of MNA, this research work suggests its implication and possible results for oil contaminated sites. In addition, when purifying oil-contaminated areas, we would like to suggest which purification technology should be used to purify the area first to effectively use the monitored natural attenuation. For case study the Army Garrison return base in Yongsan was chosen. This paper proposes a contaminant remediation plan using MNA as a follow-up process with predicted results.

Keywords: MNA(Monitored Natural Attenuation), Phytoremediation, Phytotranspiration, TPH(Total Petroleum Hydrocarbon), Oil-Contamination

Development and ESG Aspects of In-Pile Thermal Desorption (IPTD)

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Abstract

Soil remediation using TD (Thermal Desorption) has advantages in cost, time, efficiency, and can be applied to various environments (In-situ, Ex-situ). The technology researched in this study is IPTD (In-Pile Thermal Desorption), which excavates contaminated soil and heats it at a high temperature to breakdown organic contaminants into non-toxic components. Although there are limitations on the particle size and that it requires a large area, it is highly applicable in large-scale areas. Among IPTD cases, we focused on the Danang Airport site cleanup project. Since Danang airport site was contaminated by dioxin (TCDD) throughout a large space and was needed to be remediated quickly and efficiently, IPTD was adopted as the remediation method for the site. Prior research was conducted on the operating parameters of temperature, heating time, heating rate, and carrier gas after extraction, as well as on the properties of the soil, for IPTD. To study on the development of IPTD site and technology, we reviewed the cases of Saipan and Corina. Also, by researching ISTD cases, we also learned similar construction methods. Lastly, unsustainability characteristics of TD and core elements of ESG was also reviewed to study TD in the aspect of ESG. Then, we came up with ideas to make this technology sustainable such as optimization of temperature, reuse of waste heat, microbial diversity increase by microbial insert, etc. In addition, the elements of Social and Governance, which emerged in the Incheon Bupyeong military base return site cleanup project, were also reviewed to seek the ultimate development direction of IPTD.

Keywords: TD, HTTD, Ex-situ, IPTD, Dioxin, Unsustainability, Optimization, Organic method

A Next Generation of Soil Washing: The EcoWash ModuloRe

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Abstract

At a time when the heavy industry tends to curb its irreversible environmental aftereffects implementing new techniques and regulations, the French AZF plant still used to employ hazardous chemicals in their processes to produce nitrogen fertilizers and chlorine derivatives for the food-processing industry. But a sudden explosion occurred on September 21st, 2001, releasing many heavy metals (Pb, As, Hg) and organic pollutants (HNO_3) in the soil. The remediation technique implemented several years later was soil washing, an ex-situ process in which the soil is first excavated to be then washed with chemical and physical processes. In this case, 2 years of in-site remediation (a unit was directly set up on the explosion site) were required to hamper the contamination of 450 000 m3, even if no data was released about its efficiency. Therefore, this study delves into the soil washing method through a green and sustainable prism exploring several technological improvements. Soil washing hinders the resilience of biosystems because it requires excavating and adding hard chemicals as EDTA into the soil, killing all bacteria, whereas in-situ methods could be more resilient. Hence, soil washing is to be combined with bioremediation and other methods to provide less extreme washing conditions. While research is ongoing, bioremediation can indeed allow using an environmental-friendly washing framework by replacing EDTA as the main washing chemical by GLDA, EDDS or IDS. Moreover, not only does the core of the washing technology need to be improved but also the whole process following both the ESG principles and each case features. The energy, water, land, and material use must be addressed to create a green soil washing method. These findings suggest that implementing a modular, mobile, and reusable soil washing unit can be a sustainable response to the hitherto waste issues. It includes a closed-loop water use, energy-saving features as a regenerative braking system, and flows management thanks to IoT sensors communicating real-time data which can be released to the citizens in the light of the AZF case.

Keywords: Soil Washing, Heavy metals, Organic pollutants, Modularity, Green remediation

Soil Washing and Oyster Mushroom-Based Bioremediation for the Munhak Mountain Petroleum Contamination

Minho Lee[1], Sungryul Kim[2] and Junboum Park[2]

[1] Department of Civil and Environmental Engineering, Seoul National University
[2] Professor, Department of Civil Engineering, Seoul National University

Abstract

The soil in the Munhak Mountain area was contaminated by fuel used at a military base and the purification project began in the early 2000s using soil washing and cultivation methods, which took about 20 years to complete. This paper proposes a new approach to improve the purification project. Even after performing the commonly used soil washing method, the contaminants in the fine-grained soil still remained contaminated. To solve this problem, bioremediation using mushrooms is then performed. Oyster mushrooms are used due to their excellent ability to decompose various types of contaminants, especially organic substances, and their relatively flexible cultivation conditions compared to other mushrooms. Oyster mushrooms can remove TPH and PAHs, which will accelerate the purification process. However, the cultivation of mushrooms requires various specific conditions such as temperature, humidity, and light, which can be challenging to maintain. To overcome this limitation, the paper proposes the installation of solar panels above the cultivated mushrooms. The installed solar panels will provide shade and supply electricity to devices that control humidity and temperature. This will maximize the efficiency of the contaminated area. In addition, for even soil purification, the soil will be overturned in a vertical direction, and the purification process will take place in a greenhouse to prevent the odor of contaminated soil from spreading and to maintain a suitable level of humidity and temperature.

Keywords: Soil washing, Bioremediation, Oyster mushroom, Solar panel

Conference Venue

General Information

Place: Seoul National University, College of Engineering (Building 39)

Map URL: https://goo.gl/maps/tNNnq8wisKVTXwfG8

Seoul National University Main Gate

Campus map

Access from stations

I) Seoul National University Station of Line 2

(1) From Exit 3, find the bus station.

Bus stop of Soul National University Station

(2) Take green city bus **5511** or **5513** to "College of engineering" stop.

Green city bus 5511 and 5513

(3) From the bus stop "College of engineering", go straight and pass Bld. 38.

View from the bus stop

Bld. 38

(4) Across the crosswalk, you can see Bld. 39.

Bld. 39

Conference rooms

II) Nakseong-dae Station of Line 2

(1) From Exit 4, find the bus station.


Way to the Nakseong-dae bus station

(2) Take green city bus "관악 **02**" to "Energy Research Institute" stop.


Green city bus "관악 **02**"

(3) From the bus stop "Energy Research Institute", go down a hill


View from the bus stop Hill

(4) Turn your left and go down a hill.

Bld. 39 Conference rooms

Lunch / Campus Tour / Gala Dinner

Lunch

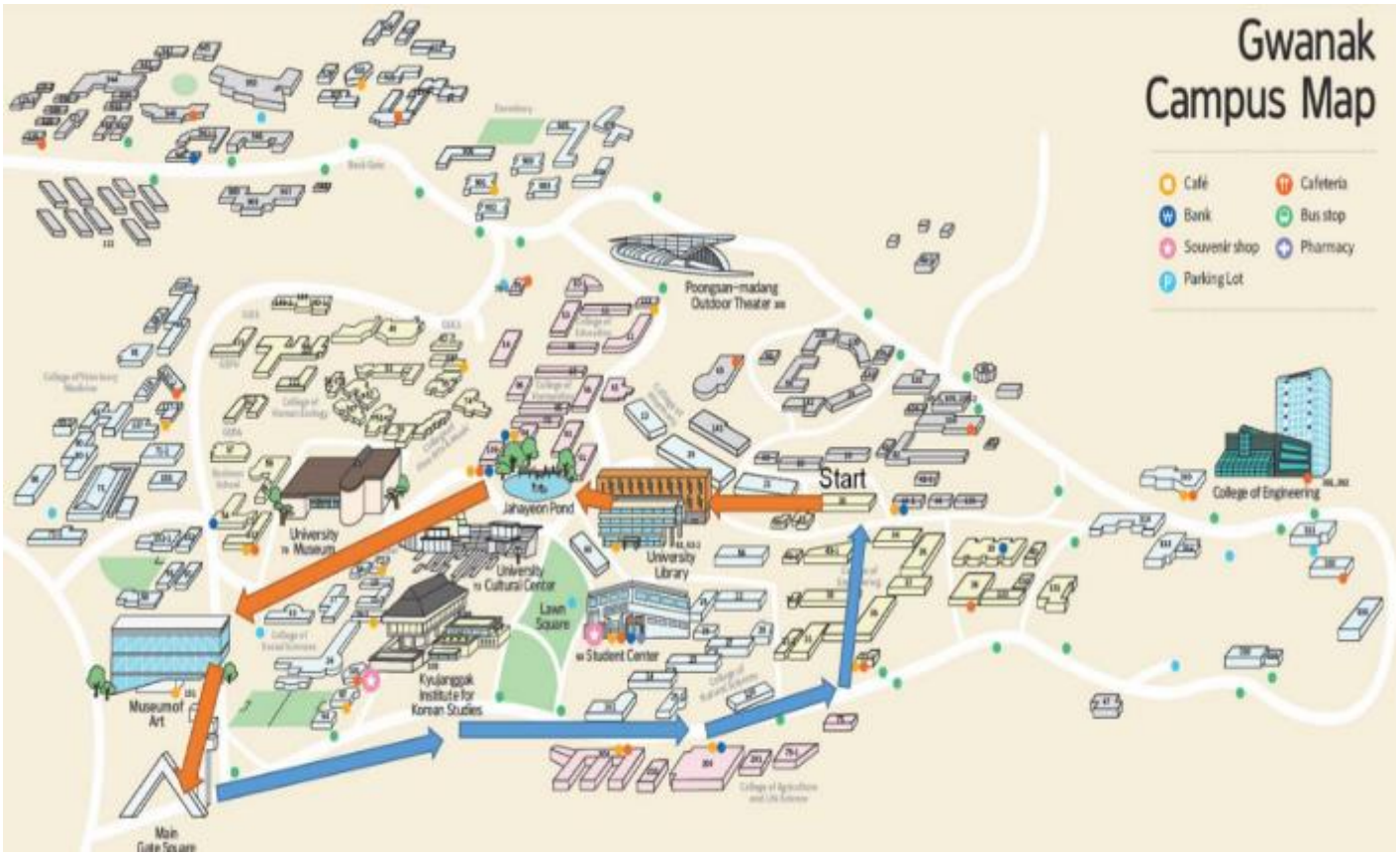
Place: *Rakgujung* / Korean Resturant

Location: Seoul National University Building 38 Global Engineering Education Center B1 floor, *http://www.rakgujung.co.kr/*

Campus Tour

Rout:

1. Library
2. Lawn square
3. *Jahayeon* Pond
4. Museum of Art
5. Main gate square
6. Back to Bld. 39



Contents of Campus tour:

Library

Symbol of University's academic passion

Lawn square

Complex cultural space

Jahayeon Pond

Pond reflecting a purple sunset

Museum of Art (MoA)

Current Exhibition:
Time States – Contradiction and Accordance
YOU & ME who portrait us

Main Gate Square

"샤 (sha)" sculpture

Gala Dinner

Place: Haibo / Chinese Restaurant

Location: 134 Gwanak-ro, Bongcheon-dong, Seoul, South Korea

https://goo.gl/maps/45RYwTEQsWhQhyep7

Field Trip
(May 12)

Place: *Han* river public center and construction site

Han river public center

Construction site

Han river tunnel project (*Hyundai* construction company)

https://newsroom.hdec.kr/en/newsroom/news_view.aspx?NewsSeq=711&NewsType=LATEST&NewsListType=news_clist#.ZEiw6HbP2Uk

Han river?

The Han River is one of Korea's longest rivers, running through three provinces (Gangwon-do, Chungcheongbuk-do, and Gyeonggi-do) and through Seoul.

On top of its beauty, the Han River surprisingly gives a tranquil peacefulness away from the city bustle. It is well-known for being the filming location for numerous popular Korean dramas and variety shows (for example, Running Man).

Han river park