SLGS NEWSLETTER

SRI LANKAN GEOTECHNICAL SOCIETY

A Member Society of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)

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Message from the Editor

Dear Readers,

The SLGS Project Day and the Annual General Meeting was held on 23rd December 2020 on virtual platform. Ten undergraduate research projects were shortlisted for presentation at SLGS Project Day 2020.

In addition, this edition of the Newsletter features an article on Novel Geopolymer Based Binders for Soft Soil Stabilization by Dr. M. C. M. Nasvi, a senior lecturer at the Department of Civil Engineering, University of Peradeniya. You will also find details on sponsorship for ICGE Colombo 2020, which is scheduled to be held on 6 and 7 December 2021 in Colombo.

Dr(Eng). L. I. N. de Silva – Editor Newsletter Email: nalinds@uom.lk

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SLGS Executive Committee for the year 2021—2022

Details of the committee appointed for the year 2021-2022 is presented below.

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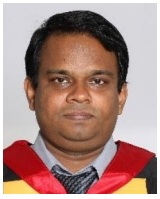

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ICGE Colombo 2020

Currently about 75 full papers have been received and the double blind review process of the already received papers is already completed. The authors were already informed on the review decision. The editorial committee decided to accept new abstracts to be considered for publication.

Organized by

Sri Lanka Geotechnical Society (SLGS)

Under the auspices of

International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE)

Keynotes

- **Prof Charles W.W. Ng**, President of ISSMGE, Hong Kong University of Science & Technology - Unsaturated Soils and Slope Stability
- **Dr Brian Simpson**, Honorary Professor, University of Nottingham, UK - Deep Excavations and Tunnelling
- **Distinguished Professor Buddhima Indraratna**, University of Wollongong, Australia – Ground Improvement for Rail and Road Infrastructure
- **Dr Chris Haberfield**, Principal Geotechnical Engineer, Golder Associates (Pty) Ltd, Australia – Soil-Structure Interaction
- **Prof Krishna Reddy**, University of Illinois, Chicago, USA - Modeling Coupled Dynamic Processes in Landfills: Holistic Long-Term Performance Management to Improve Sustainability

The proceedings will be published as a printed book and a USB/Online containing the full-length papers.

A Novel Geopolymer Based Binders for Soft Soil Stabilization

Dr. M.C.M. Nasvi, Senior Lecturer, Department of Civil Engineering, University of Peradeniya, Peradeniya.

1. Introduction

Soft soils are often encountered in Civil Engineering construction sites and they do not possess the required strength to support the loading either during the construction or throughout the service life. Chemical stabilization with cementitious materials has been widely used to improve the strength and stiffness of these soils. Most commonly used stabilizers include ordinary Portland cement (OPC), lime, etc. One of the key issues with the conventional stabilizers is their production is an energy intensive process. For an instance, production of one tonne of Portland cement releases about one tonne of $CO_2$to the atmosphere. In addition, readily available source materials have already been consumed in huge quantities and the construction industry is in search for sustainable construction materials. Therefore, it is essential to look for alternative materials for soil stabilization. Lakwijaya coal power plant in Norochcholai, Sri Lanka produces about 300,000 metric tons of fly ash (FA) and 25,000 metric tons of bottom ash annually, from which only about 30-40% is used for some industrial applications including brick and cement manufacturing. FA has been used successfully in many construction projects including base, subgrades, foundations soils, backfills, etc. to improve the strength characteristics of soft soils (Figure 1). However, use of geopolymers, which use alumina silicate materials like FA as the source material, is a recent new concept for soil stabilization. Therefore, the objective of this article is to provide an insight into the feasibility of adapting geopolymer based binders for soil stabilization work.

Figure 1: Soil stabilization using FA

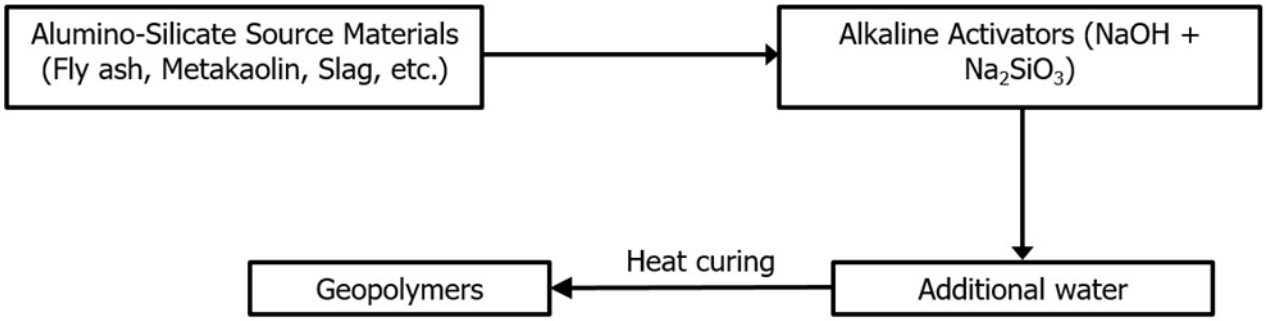
2. What are Geopolymers ?

Geopolymer is an alumina-silicate cementitious material, which can be synthesized by mixing source material (FA, metakaolin, slag, rice husk ash, etc.) with a strong alkaline solution (combination of NaOH and Na_2SiO_3). The chemical structure of geopolymers can be generally expressed as:

$$M_n[-(SiO_2)_z - AlO_2]_n.wH_2O$$

where ***M*** is the alkaline element such as potassium, sodium or calcium, ***n*** is the degree of polycondensation or polymerisation and ***z*** is ratio of Si/Al, which is 1, 2, 3, or higher.

Geopolymer can be prepared by mixing the raw materials with alkaline activators. The source materials can be artificial pozzolonas or alumina silicate-type industrial waste materials, or a combination of them. The source materials include metakaolin, FA, ground granulated blast furnace slag (GGBFS), silica fume, etc. The role of alkali is to activate the raw materials to take part in the polymerization process. The polymerisation process is very rapid in the presence of alkali solution. The alkali activator is most commonly an alkali hydroxide or alkali silicate solution and the most common activator used is a combination of sodium hydroxide (NaOH) and sodium silicate (Na_2SO_3). The schematic view of geopolymer preparation is shown below:



3. Applicability of Geopolymers for soil stabilization

To date, geopolymers have not been used in any large scale construction projects for soil stabilization as geopolymers for soil stabilizations is still in its infancy. However, there are very limited number of research findings (Cristelo et al., 2011; Zhang et al., 2013;Arulrajah et al., 2015; Phummiphan et al., 2015;Rios et al., 2016;Parhi et al., 2017; Murmu et al., 2018) on the applicability of geopolymers for soil stabilization. All these studies have found that alkali activated geopolymer based binders can be used as a sustainable binder to stabilize the soil and geopolymer based binders perform better than conventional OPC based binders. Table 1 summarizes geopolymers for soil stabilization and the improvements achieved after stabilization.

Table 1: Summary on the improvements achieved for soil stabilised with geopolymers

Soil type	Source material and alkaline activator used for geopolymer	Improvements achieved with geopolymer treatment	Reference
Low plasticity sandy clay	Class F FA; Mixture of NaOH+ Na_2SiO_3	Geopolymer stabilised soil showed significant time dependent unconfined compressive strength (UCS) development yielding strength values up to 11.4, 16.7 and 43.4 MPa at 28, 90 and 365 days.	Cristelo et al. (2011)
Low plasticity soft clay	Metakaolin; Mixture of NaOH+ Na_2SiO_3	UCS of soil samples increased from 0.75 MPa (untreated soil) to 3.75 MPa for 11% metakaolin geopolymer (MKG) addition. A stabiliser is effective when an increase in UCS of 345 kPa is achieved with the treatment (ASTM D469) and this indicates that MKG can be used as an effective stabilizer. MKG stabilised samples are more ductile compared to raw soil and Portland cement stabilized soil samples, which is beneficial for application in flexible pavements.	Zhang et al., (2013)
Spent coffee grounds (CG) – a landfilled waste	Class F FA; Mixture of NaOH+ Na_2SiO_3	Highest UCS of 1300 kPa and 4 days soaked CBR of 12% were achieved for the mix having FA = 30%, Alkaline liquid/fly ash ratio = 1.8 and Na_2SiO_3/NaOH ratio of 50:50. Increasing the FA content from 10% to 30% increased the UCS approx. from 300 to 660kPa.	Arulrajah et al. (2015)
Lateritic soil (LS) – marginal for road base applications	Class C FA; Mixture of NaOH+ Na_2SiO_3	The UCS values of LS-FA samples were in the range of 5,000 – 15,000 kPa for different curing periods (7 – 90 days). These strength values are higher than the strength requirement specified by national road authority in Thailand (UCS > 1724 kPa for light traffic and UCS > 2413 kPa for high traffic).	Phummiphan et al. (2015)
Non-plastic silty sand	Class F FA; Mixture of NaOH + Na_2SiO_3	Compared to the UCS of soil-FA mixture without alkaline activation (0.3 MPa), the UCS of alkaline activated specimen increased significantly to 2.4MPa at 28 days and to 4.8MPa at 90 days.	Rios et al. (2016)
Black cotton expansive soil	Class F FA; Mixture of NaOH+ Na_2SiO_3	The maximum 7 and 28 days UCS of geopolymer treated samples are 550 and 800 kPa respectively while the same for fly ash treated samples (without activation) were 275 and 360 kPa respectively.	Parhi et al. (2017)
High plasticity black cotton soil	Class F FA; NaOH solution	The UCS of FA-geopolymer treated samples were in the range of 1250 – 3250 kPa depending on the curing period (7 – 90 days) and the UCS values obtained are higher than the minimum strength requirement (750 kPa) of sub-base layer as per Indian RoadCongress (IRC). The treated specimens recorded an increase of 939 - 1178% in CBR values depending on the FA content (5 – 20 wt%).	Murmu et al. (2018)

Author conducted his own research to predict the feasibility of using geopolymers to stabilize expansive soil collected from Digana, Sri Lanka using ASTM class F FA based geopolymer activated with a combination of Na_2SiO_3 and NaOH as the activator. The maximum UCS value (1.02 MPa) obtained for geopolymer stabilised soil is higher than the minimum requirement of 0.75 MPa for subbase material specified by Institute for Construction Training and Development (ICTAD), Sri Lanka and IRC, India. The swell pressure of the soil reduces from 110 kPa to 82 kPa (25% reduction) with the geopolymer stabilization. When the microstructure and compaction of the geopolymer stabilised soil samples are considered, Ghadir and Ranjbar (2018) have found that geopolymers are uniformly distributed through the soil particles compared to untreated clayey soil and OPC stabilized samples (Figure 2). It was also found that geopolymer stabilised samples provide higher degree of compaction and strength compared to OPC treated samples.

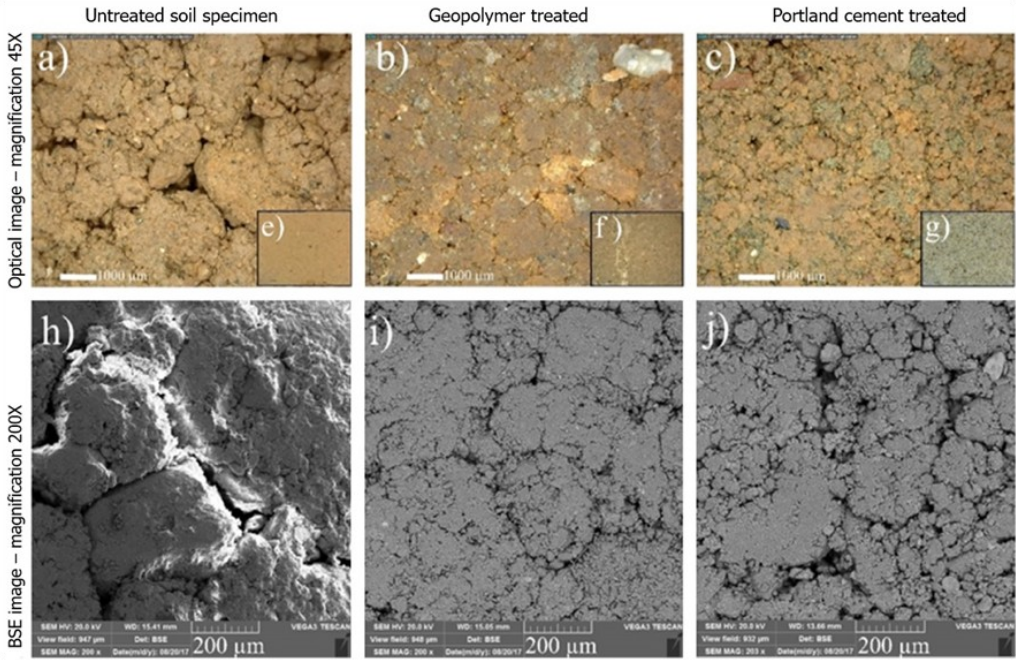


Figure 2: Optical and SEM image of untreated soil, 15% volcanic ash geopolymer treated soil and Portland cement treated soil (Ghadir and Ranjbar 2018)

Based on the findings, considering short and long term strength developments, the following ranges of the mix ratios are recommended for various soil types and source materials: geopolymer binder dosage (wt%) = 4 – 30%; Activator/solid ratio = 0.4 – 1.8; Na_2SiO_3/NaOH ratio = 80:20 – 50:50; NaOH molarity = 5 – 12M. On the whole, geopolymers can be successfully used as a soil stabilizerin construction application provided that the environmental and economic feasibility of this technique is verified prior to the field application.

4. Concluding Remarks

Geopolymers prepared with industrial by-products such as fly ash can be used to stabilise soft soils as it has been found that geopolymer stabilized soil exhibits better short and long term behaviour compared to Portland cement stabilised soil as maximum strength increase of 400%, swell pressure reduction of 25% and increase in CBR of 1178% have been reported with the geopolymer stabilisation. This can provide sustainable solution to the issues associated with the greenhouse gas emissions related to OPC, scarcity of the construction materials and landfilling of industrial by-products. However, economic and environmental feasibility of this techniqueneed to be predicted prior to making any firm conclusion on the real field application of these binders.

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SLGS Project day was successfully held on 23rd December 2020 on virtual platform. The abstracts of the joint winners of SLGS Project day are presented below. Shortlisted presenters are also presented herein.

Feasibility of using geopolymers to stabilize expansive soil

S. Kanjana, S. Sajiththijan and M.C.M. Nasvi
Department of Civil Engineering, University of Peradeniya, Sri Lanka

ABSTRACT: In the construction industry, ordinary Portland cement (OPC) based binders have been used to stabilize soft soils, and however the production of OPC emits significant amount of carbon dioxide to the environment. This study aims to use low calcium Class F fly ash (FA) based geopolymer as a novel binder to stabilize expansive soil. The effect of activator, binder and NaOH molarity on the strength and swell characteristics of expansive soil-geopolymer (ES-GP) were analyzed. ES-GP samples with different activator/binder (0.2-0.5), binder/soil (0.1-0.4) ratios and NaOH molarity (6M-12M) were prepared and the samples were cured under ambient temperature conditions. Unconfined compressive strength, swell pressure and scanning electron microscopy tests were conducted to analyze the strength, swell characteristics and to predict the microstructural changes. Based on the findings, the optimum mix ratios for high strength and low swell characteristics include activator/binder of 0.4, binder/soil of 0.3 and NaOH molarity of 8M. It is concluded that low calcium FA based geopolymers can be a promising alternative to OPC based binders to stabilize soft soils.

Investigation of the impact of the classification on integrity of bored and cast in-situ piles using Crosshole Sonic Logging (CSL®) test

A.G.K.P. Niwunhella and H.S. Thilakasiri
Department of Civil Engineering, Sri Lanka Institute of Information Technology, Sri Lanka

ABSTRACT: Integrity of bored and cast in-situ piles should be assessed thoroughly as tendency of occurring defects in such piles is higher due to improper construction methodologies. Crosshole Sonic Logging (CSL®) test is widely used in the industry to identify potential anomalies in order to ensure the quality and integrity of bored and cast in-situ piles. In this paper, several classification systems of bored piles based on CSL test results are identified and the effectiveness of each classification system is assessed towards the critical evaluation of pile integrity along with the assessment of anomalous regions, carried out using Tomography Analysis. The impact of the classification on the performance of piles using Tomographic Analysis is identi-fied towards the acceptability of piles and potential reasons for the occurrence of defects are studied in Sri Lankan context.

Shortlisted projects for SLGS Project Day 2020 award

- Feasibility of using Geopolymers to Stabilize Expansive Soil by S. Kanjana, S. Sajiththijan—Supervised by Dr. M.C.M. Nasvi
- Investigation of Strength Behaviour in Soft Peaty Clays stabilized with Calcium Carbide Residues, Fly Ash and Cement by A.K.G.M. Jayamal—Supervised by Dr. A.S. Ranathunga
- Reduction of Secondary Consolidation of Peaty Clay due to Preloading with Extended Periods by D.R.I.S. Dasanayake—Supervised by Prof. S.A.S. Kulathilaka
- Compressibility Characteristics of Unsaturated Soils by P.A.Y. Akalanka—Supervised by Prof. S.A.S. Kulathilaka
- Inv. of the Impact of the Classification on Integrity of Bored and Cast In-situ Piles using CHSL Test by A.G.K.P. Niwunhella—Supervised by Prof. H.S. Thilakasiri
- Accuracy of Commonly used Pile Integrity Testing Methods in Sri Lanka by T.V. Sanjula—Supervised by Prof. H.S. Thilakasiri
- Development of Local Rainfall Thresholds for Landslide Occurrence in Sri Lanka by H.T. Abeywickrama - Supervised by Dr. N.H. Priyankara
- Effect of Degree of Saturation on Pullout Resistance by K.A.S.N. Fernando - Supervised by Dr. N.H. Priyankara
- Comparison of Different Philosophies on Design of Geosynthetic Reinforced Piled Embankment by H.D.S. Mithila - Supervised by Dr. N.H. Priyankara
- Deformation Behaviour of Soil Cement Column Improved Ground by T.H.M.N Thenuwara- Supervised by Dr. N.H. Priyankara

Levels of Sponsorship and Respective Benefits for ICGE - COLOMBO - 2020

The Sri Lankan Geotechnical Society (SLGS) will be holding the 3rd International Conference on Geotechnical Engineering on 06 and 07 December 2021 in Colombo. Around 300 professionals in the field of Geotechnical Engineering from all around the world are expected to attend. A large number of projects on infrastructure development are in progress at present in the country with wide range of applications from the field of Geotechnical Engineering. As such, a conference of this nature that brings together experts from all around the world is of great importance to Sri Lanka.

There will be keynote addresses by eminent international experts in the areas of Unsaturated Soils and Slope Stability, Deep Excavations and Tunnelling, Ground Improvement for Rail and Road Infrastructure, Soil Structure Interaction and Holistic Long-Term Performance Management to Improve Sustainability. Current state-of-the-art in these key areas would be presented.

Around 150 papers will be presented on a number of themes that are very relevant to Sri Lanka. The conference would be conducted in two or three parallel sessions. If required, poster sessions would also be provided. An exhibition would be held in parallel with the conference.

We would like to invite your establishment to be a sponsor for this event. We need the generous support from the industry to make this very important event a success. You will be able to send your message across to a large gathering of Civil Engineers, Geotechnical Engineers, Engineering Geologists and Geologists of international repute.

Levels of Sponsorship	Available Number	Value SLR-Million
Platinum Sponsor	01	3.00
Gold Sponsor	03	2.00
Silver Sponsor	05	1.00
Bronze Sponsor	08	0.50

General Benefits for All Levels

Location for Logo in the conference website (the location differs with the category of sponsorship)
Opportunity to display banners in the conference hall
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A video presentation of 5 minutes duration at the inaugural session
A space for advertisement in the conference proceedings at the back page
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A space for advertisement in the conference proceedings at the inner front, inner first or inner back
Complementary registrations for 3 participants

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A space for advertisement in the conference proceedings at different locations inside
Complementary registration for 1 participant

Forthcoming Conferences

Information on upcoming international events and conferences related to geotechnical engineering are listed in the following official website of ISSMGE.

https://www.issmge.org/events?page=1

Forthcoming Events of SLGS

It was proposed to organize a half-a-day industry session on R&D activities related to Geotechnical Engineering on a quarterly basis. The industry representatives will be given the opportunity to present their work at the event. Any interested parties can contact the President of SLGS through the following email address.
athula.kulathilaka@gmail.com

SLGS and ISSMGE Membership Fees

SLGS members are kindly requested to pay the membership arrears at your earliest. A notice indicating due fees is attached.

Please inform any changes in the contact details.

Membership Admission Fee	Rs. 200/=
Annual Membership Fee	Rs. 700/=
ISSMGE Fee	Rs. 1500/=

The SLGS Newsletter comes to you in volumes of four fascicles issued in February, May, August and November each year. If you prefer to receive the newsletter by email, please send your email address to the editor, newsletter.

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