HYDRATION REACTION RATE AND UNCONFINED COMPRESSIVE STRENGTH OF FORMOSA GRANULATED BLAST FURNACE SLAG CURED IN SEAWATER

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ABSTRACT

Samples of Granulated blast furnace slag (GBFS) from Formosa steel plant (called as Formosa GBFS) were collected and used for several testing series regarding potential application as an alternative material in construction and civil works. Un-hydrated GBFS particle shows river sand-like shapes by all appearances with more angular and therefore, it shows higher shear strength than those of natural sand. In addition, GBFS has latent hydraulic characteristics affecting its physico-mechanical properties when working in wet conditions, especially alkaline ones. In this study, specimens were cured in seawater from 0 day to 280 days under the air temperature both in-room and outdoor. After curing, hydrated specimens were tested for unconfined compressive strength and hydration reaction ratio. It is shown from the experimental results that the unconfined compressive strength and the hydration reaction ratio of Formosa GBFS increase with curing duration and such a tendency is slightly affected by curing temperature between indoor and outdoor. An estimation method of the hydration reaction ratio and the hydration-induced strength was developed for Formosa GBFS cured in seawater.

Keywords: Construction material, Granulate blast furnace slag (GBFS), Hydration reaction, Unconfined compressive strength.

1. INTRODUCTION

Blast furnace slag (BFS) is a by-product with an average production of about 30% in a manufacture process of iron (*i.e.* about 300kg of BFS per ton of ion). Blast Furnace Slag is, furthermore, classified into Granulated blast furnace slag and Air-cooled blast furnace slag. Granulated blast furnace slag which is well-referred to as

GBFS is produced by quenching molten furnace slag with high-pressurized water. In Formosa steel plant and other plants in Vietnam, more than 95% of BFS is used to produce GBFS. Therefore, the production of this by-product increases rapidly with the development of the steel industry [1].

GBFS is a granular material having closed pores inside and open pores on the particle surface and the particle size is very similar to those of natural sand (river sand). GBFS has several advantages such as lightweight, high internal friction angle, high permeability and has already been used as a backfill material of the quay wall, landfill and lightweight embankment, etc [7,8,13]. In addition, GBFS has a latent hydraulic property by which its shear strength increases gradually with time in the natural wet condition without adding any additives and is expected to become a non-liquefied material after hardening [2-7]. After hardening, even if GBFS specimen or GBFS-used earth structure is collapsed by external factors such as strong motion during an earthquake or ocean waves, the strength of GBFS is confirmed to be recovered naturally regardless of the primary curing duration [8]. Furthermore, the physico-mechanical properties of GBFS during its hardening process have been clarified for various environmental conditions including the in-situ case studies [2-6, 8-12].

In port and harbor areas, soft clayey soils commonly distribute under thick layers and with shallow distribution depth and in such cases, soft ground improvements such as the sand compaction pile (SCP) are needed for constructing gravity structures like a quay-wall on it. When applying SCP method, a huge amount of natural sand is used, and recently, GBFS has been tried to use as an alternative geo-material [13]. Therefore, in this study, in order to show the applicability and advantages of Formosa GBFS to the SCP method for port and harbor construction, samples of Formosa GBFS were cured in the seawater under indoor and in-situ temperature with the curing duration from 0 to 280 days. Changes in unconfined compressive strength and hydration reaction ratio were observed, and an estimation method of such properties was then proposed.

2. MATERIALS AND TESTING METHODS

2.1. Sample and curing conditions

The material used in this study is fresh GBFS collect from Formosa steel plant. The index properties including the particle density, maximum and minimum void ratios, coefficient of permeability, loss of ignition, and the grain size distribution curves of Formosa GBFS in comparison with a Japanese product are shown in Table 1 and Figure 1, respectively. The results indicate that the index properties of Formosa GBFS

are mostly similar to those of Japanese products and that Formosa GBFS shows better initial permeability and also better agreement as a fine aggregate for mortar and concrete according to Vietnamese standards.

Table 1. Index properties of Formosa GBFS and a Japanese product

Properties	Formosa GBFS	Japanese GBFS
Particle density, ρ_s (g/cm^3)	2.790	2.722
Maximum void ratio, e_{max}	1.398	1.450
Minimum void ratio, e_{min}	0.881	0.939
Permeability coefficient, k (m/s)	28.6×10^{-4}	8.46×10^{-4}
Loss of Ignition, IL (%)	0.140	0.238

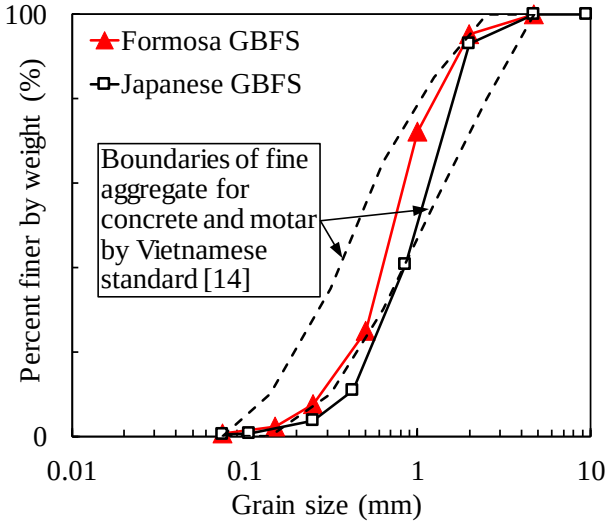

Figure 1. Grain size distribution of tested materials

(a) (b)

Figure 2. Specimens of GBFS were cured in seawater under indoor and outside temperature

In order to prepare the specimen, the mass of dried GBFS for a relative density of D_r = 80% was determined. Test specimens are prepared as follows: The seawater was firstly poured into the bottle containing a pre-determined mass of GBFS at the solid-liquid ratio of 1/1.4. The bottle was kept for one day with a lid and the seawater-mixed sample was poured into a plastic mold of 50mm in diameter and 100mm in height by the water pluviation method. The specimens were cured under the air temperature in the laboratory (Fig. 2a) and outside (Fig. 2b) and the curing duration was set from 0 to 280 days. After curing, unconfined compression test and hydration reaction test were carried out.

2.2. Hydration reaction test

Because GBFS has a latent hydraulic property leading to an increase in its shear strength and the changes in the strength of GBFS due to its hydration reaction has been confirmed on Japanese product [8]. So, in this study, in order to evaluate the solidification of GBFS, the hydrate was measured by the hydration reaction test proposed by Kondo and Ohsawa [15]. After the unconfined compression test, the sample was dried and used for the hydration reaction test. The procedure of hydration reaction test is as follows: 1 g of dried GBFS sample was firstly immersed into a liquid compound of salicylic acid 5 g, acetone 70 mL and methanol 30 mL by using the stoppered Erlenmeyer flask. The mixture of sample and compound solution was secondly agitated for an hour at 350 rpm by using a magnetic stirrer. The mixture is then left for 24 hours and separated by a suction filtration using quantitative filter paper with a pore diameter of 1.0μm. The residues obtained by filtration are put into a crucible together with the filter paper and heated at 850°C for about one hour in order to incinerate the filter paper. The weight of the residues was finally measured.

By this method, the rate of hydration reaction can be measured as a ratio of the mass of hydrates to the total mass of GBFS sample before immersed into the compound solution. The hydration reaction ratio denoting the hydration reaction rate of GBFS can be obtained by Eqs. (1) and (2) as follows [8]:

$$R_i = \frac{m_h}{m_d \times 1 - \left(\frac{IL}{100}\right)} \tag{1}$$

$$R = 100 - R_i \tag{2}$$

where R_i (%) is the un-hydrated ratio, m_h (g) is the mass of GBFS sample after heating, m_d (g) is the mass of GBFS sample before immersed into compound solution, IL (%) is the ignition loss of un-hydrated GBFS and R (%) is the hydration reaction ratio.

In this study, seawater was used as a curing solution and in this case, there is a possibility that the hydration reaction ratio obtained by Eqs. (1) and (2) is

overestimated due to the dissolution of salinity sticking to the surface of GBFS. Therefore, the un-hydrated ratio R_i is obtained by using Eq. (3) in which the effect of salinity is minimized, and then the hydration reaction ratio is obtained by Eq. (2).

$$R_i = \frac{m_h}{m_d \times 1 - \left(\frac{IL}{100}\right) - m_{sa}} \quad (3)$$

where m_{sa} (g) is the mass of salinity in tested sample.

3. RESULTS AND DISCUSSIONS

3.1. The hydration reaction rate of Formosa GBFS cured in seawater

By using the testing procedure and methods mentioned above, the hydration reaction ratio (R, %) of Formosa GBFS can be determined for each tested specimen. Changes in R are shown against the curing duration (T, day) in Fig. 3 for Formosa GBFS cured in seawater under the air temperature of indoor and outdoor. In this figure and other ones, GBFS specimens cured under in-room and outside temperature are symbolized as BP and BT, respectively.

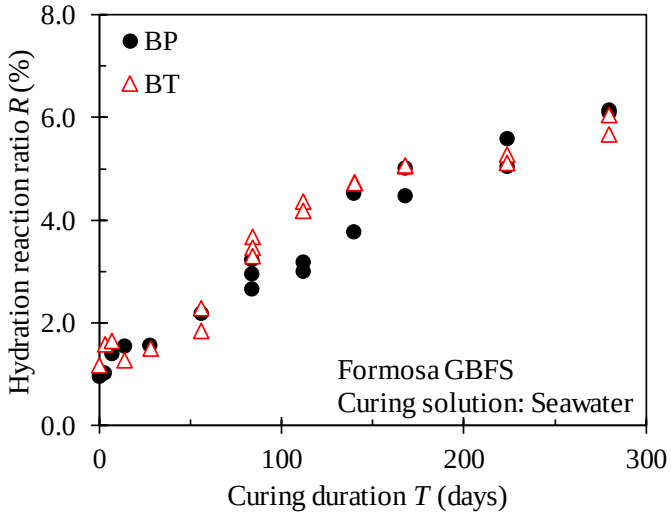

Figure 3. Changes in the hydration reaction ratio with the curing duration when Formosa GBFS cured in seawater under indoor and outdoor temperature

It is seen that R increases with T regardless of the curing temperature. When comparing the results for the case $T \leq 28$ days, the hydration reation of Formosa GBFS is slow and the increases in R and also the differences in R between indoor and outside temperature are negligible. For the longer curing duration ($T > 28$ days), R considerably increases with T, and several differences in R are seen on each curing duration suggesting a slight effect of the curing temperature between indoor and outdoor. After the production process, GBFS samples are maintained in the storage areas under

natural wet condition and consequently, the hydration reaction had initially occurred which is called as the initial hydration of GBFS. Therefore, in order to eliminate the initial hydration component of Formosa GBFS, increment of the hydration reaction ratio (ΔR, %) was used and defined as Eq. (4).

$$\Delta R = R - R_0 \tag{4}$$

where R_0 is the initial hydration reaction ratio (*i.e.* sample with T = 0 day).

The changes of ΔR with curing duration are shown in Fig. 4 for all specimens. It is seen that the tendency of ΔR in this figure is similar to those of R in Fig. 3, indicating the proportional increase in ΔR with T and that, when the curing duration is longer than 28 days, the hydration reaction of Formosa GBFS is started to accelerate in seawater.

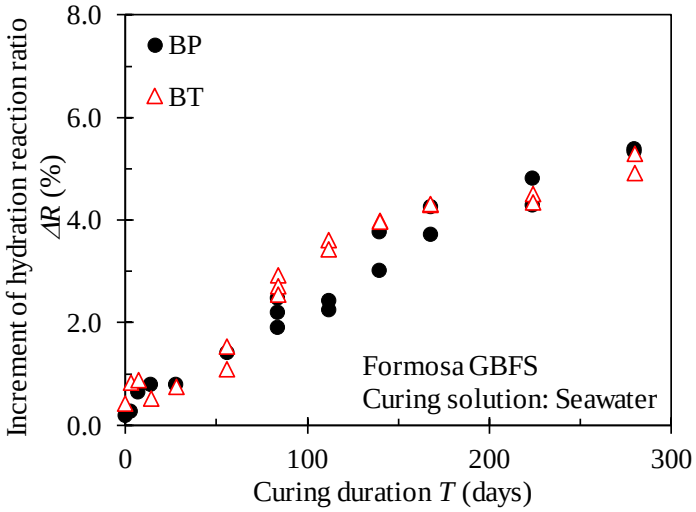

Figure 4. Changes in increment of the hydration reaction ratio with the curing duration on Formosa GBFS cured in seawater

In previous researches, un-hydrated and hydrated GBFS produced in Japan had been cured in various conditions in the laboratory (plain water at 20°C and 80°C, seawater at 20°C and 80°C, $Ca(OH)_2$ solution at 20°C) and in the natural condition as an in-situ test embankment. Consequently, the effects of these curing conditions on the physico-mechanical properties and hydration characteristics of GBFS have been clarified [2-6, 8-12], and potential application of GBFS as an alternative material in the SCP method has been confirmed [13, 16, 17]. Based on the observations, the changes in ΔR with the curing duration can be expressed as Eq. (5) as follows:

$$\Delta R = r \times \sqrt{T} \tag{5}$$

where r is the experimental constant related to the hydration reaction characteristics of GBFS under a curing arbitrary condition.

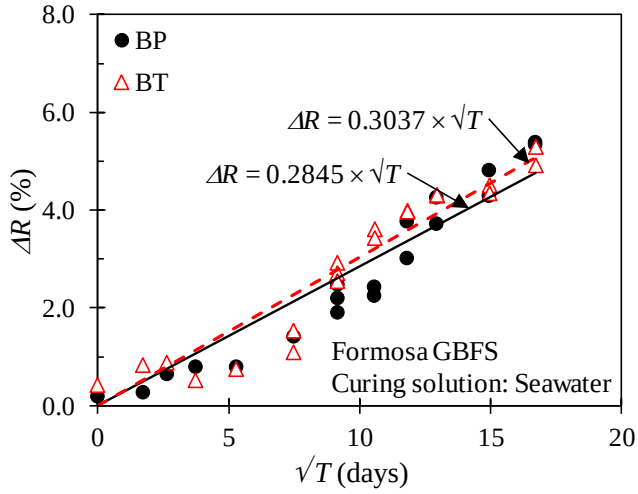

Figure 5. Relations between ΔR (%) and $\sqrt{T}$ (day) on Formosa GBFS cured in seawater under indoor and outdoor temperature

Therefore, in order to develop an estimation method of the hydration rate of Formosa GBFS, ΔR is plotted against the square root of curing duration ($\sqrt{T}$) as shown in Fig. 5. The observations in Fig. 5 suggest an applicability of Eq. (5) for evaluating the hydration rate of Formosa GBFS cured in seawater. Then, the experimental constants of r_{BP} = 0.2845 and r_{BT} = 0.3037 are obtained for in-room and outdoor temperature, respectively. In Fig. 6, comparisons between the calculated and experimental results on the hydration reaction ratio of Formosa GBFS are shown for the curing conditions used in this study. Despite several scattering on the observed data, reasonable agreements are seen, and therefore the validity of the developed method for estimating the hydration reaction rate of Formosa GBFS is confirmed.

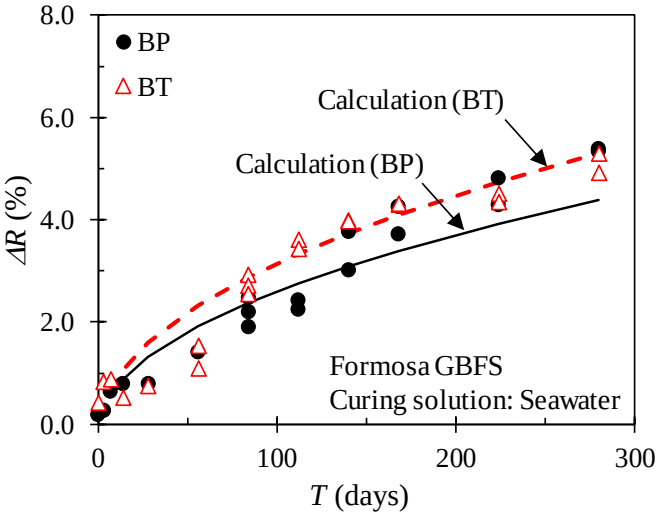

Figure 6. Comparisons between the calculated and experimental results of ΔR for Formosa GBFS cured in seawater under indoor and outdoor temperature.

2.2. Estimation of the unconfined compressive strength of Formosa GBFS concerning the effect of curing condition and duration

It has been confirmed that the hydrates generated on the surface of GBFS particle make the particle-bond increasing in the strength of GBFS [8, 17]. In Fig. 7, by curing the GBFS sample in seawater which is a slightly alkaline environment, the hydration reaction of GBFS seems to be accelerated and therefore, its hydration reaction ratio and strength increase with the curing time. The hydration reaction of Formosa GBFS occurs when the material is immersed into the curing solution (in Fig. 4). Meanwhile, in Fig. 7, the unconfined compressive strength (q_u, kN/m^2) of the specimen increases only when the curing duration T > 56 days. Thereafter, the strength increases continuously with T and approach 800 kPa after 280 days. Therefore, T = 56 days is considered as the threshold curing duration for the hydration reaction-induced strength of Formosa GBFS cured in seawater under the air temperature.

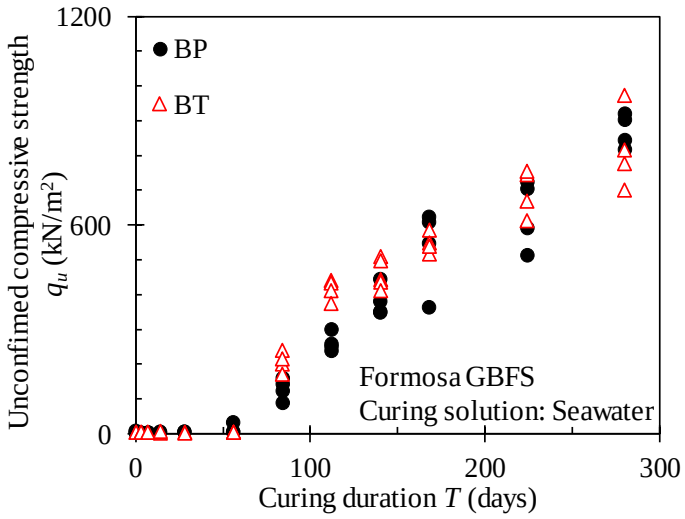

Figure 7. Changes in the unconfined compressive strength of Formosa GBFS with the curing duration for the curing conditions used in this study.

Un-hydrated GBFS particles show angular shapes based on which the shear strength of GBFS specimen is higher than those of natural sand (due to higher internal friction angle). Therefore, the strength of Formosa GBFS for the curing duration $T \leq 56$ days is considered as the initial component (defined as $q_u{}^o$) and the hydration reaction-induced strength (defined as q_{uR}) is generated only when T > 56 days. In other words, the increment of the hydration reaction ratio governing the formation of the hydration reaction-induced strength (defined as ΔR_{qu}) should be considered for T > 56 days. q_u and ΔR_{qu} are defined as Eqs. (6) and (7) as follows:

$$q_u = q_u{}^o + q_{uR} \tag{6}$$

$$\Delta R_{qu} = \Delta R - \Delta R_{56} = r \times \sqrt{T} - \Delta R_{56} \tag{7}$$

where ΔR_{56} is the increment of the hydration reaction ratio at T = 56 days.

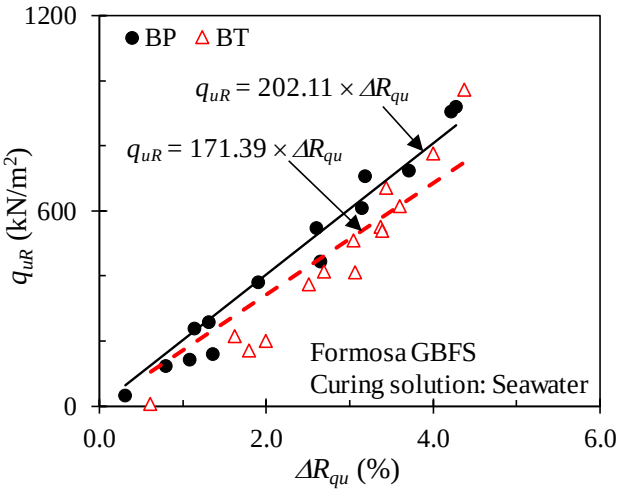

Figure 8. Relationship between q_{uR} (kN/m²) and ΔR_{qu} (%) on Formosa GBFS cured in seawater under indoor and outdoor temperature

In Fig. 8, relations between q_{uR} and ΔR_{qu} are shown for Formosa GBFS cured in seawater under indoor and outdoor temperature. The results indicate a linear relation and consequently, correlations following solid and dash lines are obtained for indoor and outdoor temperature, respectively. Then, q_{uR}-ΔR_{qu} relations are expressed as Eq. (8).

$$q_{uR} = A \times \Delta R_{qu} \quad (8)$$

where A is the experimental constant

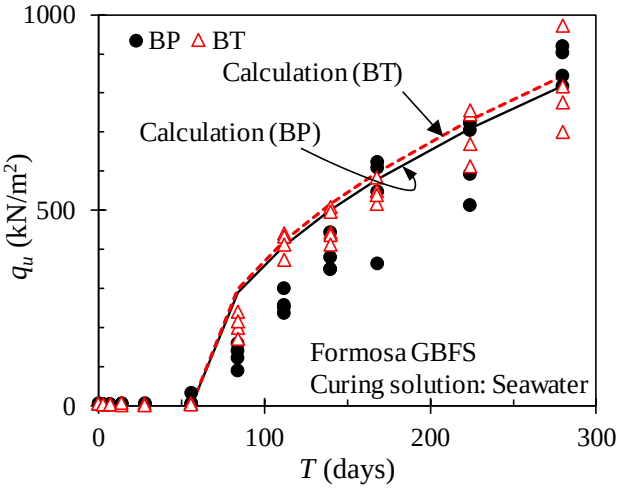

Figure 9. Comparisons between the calculated and experimental results of the unconfined compressive strength of Formosa GBFS cured in seawater under indoor and outdoor temperature

The experimental results in Fig. 7 are shown again in Fig. 9 in which the solid and dash lines correspond to the calculated results of the unconfined compressive strength of Formosa GBFS by using Eqs. (6) - (8). Reasonable agreements between the observations and calculations are seen and therefore, the validity of the estimation method of the unconfined compressive strength of Formosa GBFS can be confirmed for the curing conditions and duration used in this study.

4. CONCLUSIONS

In this paper, fresh samples of Formosa GBFS were used for preparing specimens at D_r = 80% which were cured in seawater under indoor and outdoor temperature and for the period from 0 to 280 days. The changes in the unconfined compressive strength and hydration reaction ratio were measured, and an estimation method of such properties was proposed for Formosa GBFS in terms of the effects of curing conditions and period. The main conclusions are as follows:

(1) The unconfined compressive strength and hydration reaction ratio of Formosa GBFS generally increase when cured in seawater and under the air temperature, both indoor and outdoor conditions.

(2) When curing in seawater under the air temperature, the hydration reaction of Formosa GBFS starts to accelerate after the curing duration of about 28 days, meanwhile the hydration reaction-induced strength is builtup after about 2 months. Thereafter, the hydration reaction ratio and the unconfined compressive strength of Formosa GBFS increase consecutively with curing duration.

(3) An estimation method of the hydration reaction rate and the unconfined compressive strength of Formosa GBFS can be expressed as a function of the curing duration.

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REFERENCES

[1]. L. V. Hung (2016). Current situation of the regulations and standards respect to slag application in Vietnam, *Conference on Application of Iron/Steel Slag in Construction Industry for Sustainable Development*, Hanoi, pp. 41-52.

[2]. Y. Kikuchi and K. Takahashi (1998). "Change of mechanical characteristics of granulated blast furnace slag according to age", *Technical note of the port and harbor research institute*, Ministry of transport, 915 pages.

[3]. H. Matsuda, N. Kitayama, Y. Ando and Y. Nakano (1998). Effective utilization of granulated blast furnace slag in geotechnical engineering, *Ground Engineering*, Vol. 16, pp. 33-40.

[4]. H. Matsuda, T. Koreishi, N. Kitayama, Y. Ando and Y. Nakano (2000). Engineering properties of granulated blast furnace slag, *Coastal Geotechnical Engineering in Practice (IS-Yokohama 2000)*, Yokohama, pp. 663-668.

[5]. H. Matsuda, N. Ohira, K. Takamiya, H. Shinozaki, N. Kitayama and M. Murakami (2003). Application of granulated blast furnace slag to light weight embankment, *Proc. of the international conference organized by British Geotechnical Association*, pp. 603-611.

[6]. H. Matsuda, H. Shinozaki, R. Ishikura and N. Kitayama (2008). Application of granulated blast furnace slag to the earthquake resistant earth structure as a geomaterial, *Proc. of the 14th World Conference on Earthquake Engineering*, Beijing, pp. 12-17.

[7]. H. Shinozaki, H. Matsuda, E. Sasaki, K. Ono, M. Suzuki and M. Nakagawa (2006). Hardening property of granulated blast furnace slag and its application to soil improvement, *Journal of JSCE, Division C*, Vol. 62, No. 4. pp. 858- 869.

[8]. H. Matsuda, H. Hara, N. Igawa and S. Nakamura (2015). Evaluation of self-restoration characteristics of GBFS by using hydration reaction, *The 15th Asian regional Conference on Soil Mechanics and Geotechnical Engineering*, Fukuoka, paper No. JPN-113.

[9]. H. Matsuda, R. Ishikura, M. Wada, N. Kitayama, W. Baek and N. Tani (2012). Aging effect on the physical and mechanical properties of granulated blast furnace slag as lightweight banking, *Japanese Geotechnical Journal*, Vol. 7, pp. 339-349.

[10]. M. Wada, H. Matsuda, H. Hara, N. Igawa and S. Nakamura (2015). Fundamental study on self-restoration characteristics of granulated blast furnace slag focusing on a hydration reaction, *Journal of the Society of Materials Science*, Vol. 64, No. 7, pp. 573-578.

[11]. M. Wada, H. Matsuda, H. Hara, S. Nakamura and N. Igawa (2016). Quantitative evaluation of strength and self-restorative capacity of granulated blast furnace slag, *Journal of the Society of Materials Science*, Vol. 65, No. 1, pp. 28- 33.

[12]. T. T. Nhan, H. Matsuda, T. X. Thach, N. D. Vien and H. T. Thanh (2019). Strength of granulated blast furnace slag during hydration reaction process, LNCE, Vol. 54, pp. 427-432.

[13]. H. Matsuda, S. Nakamura, T. T. Nhan, H. Hara, M. Wada and R. Ishikura (2016). Application of granulated blast furnace slag to the sand compaction pile method with low sand replacement area ratio, *Proc. of 69th Annual Canadian Geotechnical Conference (GEOVANCOUVER 2016).*, Vancouver, paper No. 3824 (6 pages).

[14]. Ministry of Science and Technology (2006). Aggregates for concrete and mortar - Specification, *TCVN 7570:2006*, Hanoi.

[15]. R. Kondo and S. Ohsawa (1969). Studies on a method to determine the amount of granulated blast furnace slag and the rate of hydration of slag in cements, *Ceramics Association Journal*, Vol. 77, pp. 39-46.

[16]. M. Kitazume (1994). The sand compaction pile method with the low sand replacement area ratio, *Tsuchi to Kiso - JGS*, Vol. 42, No. 1, pp. 45-46.

[17]. K. Mizuno and T. Tsuchida (2008). The finite element analysis on strength and deformation characteristics of improved ground by sand compaction pile method using the granulated blast furnace slag, *Journal of Geotechnical Engineering*, Vol. 3, No. 3, pp. 187-202.

TỐC ĐỘ THỦY HÓA VÀ ĐỘ BỀN NÉN MỘT TRỤC NỞ HÔNG CỦA XỈ HẠT LÒ CAO FORMOSA KHI THỦY HÓA TRONG NƯỚC BIỂN

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TÓM TẮT

Trong nghiên cứu này, mẫu xỉ hạt lò cao Nhà máy gang thép Formosa (gọi tắt là xỉ Formosa GBFS) được thu thập và thí nghiệm phục vụ nghiên cứu khả năng sử dụng làm vật liệu thay thế cát tự nhiên trong xây dựng. Hạt xỉ GBFS chưa thủy hóa có hình dạng giống với cát lòng sông nhưng góc cạnh hơn và do đó có cường độ kháng cắt lớn hơn cát tự nhiên. Ngoài ra, xỉ GBFS có đặc tính thủy hóa khi làm việc hoặc tiếp xúc môi trường ẩm tự nhiên, đặc biệt môi trường kiềm và đặc tính này có ảnh hưởng đến tính chất cơ lý của xỉ. Vì vậy, trong nghiên cứu này, mẫu xỉ Formosa GBFS được thủy hóa trong nước biển từ 0 đến 280 ngày và ở điều kiện nhiệt độ ngoài trời và trong phòng. Sau thủy hóa, mẫu được thí nghiệm nén một trục nở hông và thí nghiệm xác định hệ số thủy hóa. Kết quả thí nghiệm cho thấy độ bền nén và hệ số thủy hóa của xỉ Formosa GBFS tăng dần theo thời gian. Điều kiện nhiệt độ thủy hóa giữa trong phòng và ngoài trời ảnh hưởng không nhiều đến các tính chất này. Kết quả thu được cho phép phát triển phương pháp tính toán dự báo hệ số thủy hóa và cường độ kháng nén của xỉ Formosa GBFS khi làm việc trong môi trường nước biển.

Từ khóa: Độ bền nén một trục nở hông, phản ứng thủy hóa, vật liệu xây dựng, xỉ hạt lò cao (GBFS).

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Dương Phước Huy sinh năm 1996 tại tỉnh Thừa Thiên Huế. Ông tốt nghiệp đại học chuyên ngành Kỹ thuật Địa chất năm 2019. Hiện đang công tác tại công ty Cổ phần Nam Hòa.

Lĩnh vực nghiên cứu: Sử dụng xỉ gang và xỉ thép làm vật liệu xây dựng.

Nguyễn Thị Lệ Huyền sinh ngày 15/12/1988 tại Nghệ An. Năm 2011, bà tốt nghiệp cử nhân Địa chất tại Trường ĐH Khoa học, ĐH Huế. Năm 2013, bà tốt nghiệp thạc sĩ chuyên Địa chất tại ĐH Khoa học, ĐH Huế. Hiện nay, bà công tác tại trường ĐH Khoa học, ĐH Huế.

Lĩnh vực nghiên cứu: Địa chất, địa hóa, địa chất môi trường.

Trần Xuân Thạch sinh năm 1979 tại Hà Tĩnh. Ông tốt nghiệp đại học chuyên ngành Địa chất công trình năm 2001 và Thạc sĩ khoa học ngành Địa chất học năm 2007 tại Trường Đại học Khoa học, Đại học Huế. Hiện ông đang công tác tại Sở Xây dựng tỉnh Hà Tĩnh.

Lĩnh vực nghiên cứu: Gạch không nung, Chiến lược phát triển vật liệu tiên tiến, Cơ học đất; Sử dụng xỉ gang và xỉ thép làm vật liệu xây dựng.

Đỗ Quang Thiên sinh năm 1969 tại Quảng Nam. Ông tốt nghiệp chuyên ngành Địa chất công trình năm 1992 tại Đại học Tổng hợp Huế, Thạc sĩ kỹ thuật ngành Địa chất công trinh năm 2002 và Tiến sĩ chuyên ngành Địa chất công trình, đất băng học, thổ chất học năm 2008 tại Đại học mỏ - Địa chất, Hà Nội. Hiện ông là Phó Giáo sư liên ngành Khoa học trái đất - Mỏ, công tác tại Trường đại học Khoa học, Đại học Huế.

Lĩnh vực nghiên cứu: Địa chất công trình - Địa kỹ thuật và tai biến địa chất.

Nguyễn Thị Thanh Nhàn sinh năm 1978 tại Thừa Thiên Huế. Bà tốt nghiệp đại học chuyên ngành Địa chất công trình năm 2000 và Thạc sĩ khoa học ngành Địa chất học năm 2004 tại Trường Đại học Khoa học, Đại học Huế. Bà nhận bằng Tiến sĩ (Kỹ thuật) ngành Kỹ thuật đại chất tại Đại học Mỏ Địa chất Hà Nội năm 2015. Hiện bà giảng dạy tại Trường Đại học Khoa học, Đại học Huế.

Lĩnh vực nghiên cứu: Đất đá xây dựng, địa động lực công trình và vật liệu tái chế.

Hồ Ngọc Hậu sinh năm 1993 tại tỉnh Quảng Trị. Ông tốt nghiệp đại học chuyên ngành Địa chất công trình và địa chất thủy văn năm 2015 và Thạc sĩ khoa học ngành Kỹ thuật địa chất năm 2020 tại Trường Đại học Khoa học, Đại học Huế. Hiện ông đang làm việc tại Công ty TNHH Địa kỹ thuật xây dựng H2Tech trên địa bàn thành phố Đà Nẵng.

Lĩnh vực hoạt động: Khảo sát địa chất công trình và khảo sát địa hình công trình.