

## Effect of Coarse Aggregate Quality on Drying Shrinkage Strain of Concrete

Okayama University Student member ○AHMADIGHADIKOLAEI MOHAMMADMAHDI  
 OHMOTO GUMI CO., LTD Takashi Taniguchi  
 Okayama University Regular membe Takashi Fujii  
 Okayama University Fellow Toshiki Ayano

### 1. Introduction

The performance of concrete varies depending on the type, quality, and origin of the coarse aggregate used. In this study, 44 types of crushed stones were used. This study investigated the effect of the quality of crushed stone on the drying shrinkage strain of concrete.

### 2. Experiment Summary

In this study, 44 types of coarse aggregates of different origins and rock types were used for coarse aggregate as shown in Table 1.

Ordinary Portland cement (density: 3.15 g/cm<sup>3</sup>, Blaine value: 3,350 cm<sup>2</sup>/g) was used as the binder, and crushed sand (surface dry density: 2.65 g/cm<sup>3</sup>, water absorption: 1.53%, fineness modulus: 2.93) as the fine aggregate. After the concrete was placed, it was cured in the formwork for 18 hours. The drying shrinkage test was conducted using 100×100×400 mm square column specimens using the method with a contact-type strain gauge. After underwater curing until 7-day material age, the test was conducted in an environment with a temperature of 20°C and humidity of 60%.

### 3. Test results and discussion

Fig.1 shows the experimental values of drying shrinkage strain for three different water absorption, No. 24 (water absorption Q = 0.49%), No. 26 (water absorption Q = 0.73%), and No. 29 (water absorption Q = 2.23%) from 44 types of coarse aggregates were compared. This figure shows that the larger the water absorption of the coarse aggregate, the larger the drying shrinkage strain. Fig. 2 shows the relationship between the water content in the aggregate and the drying shrinkage strain characteristic values calculated from the experimental results for a drying period of 182 days for all rock types. The moisture content  $\Delta\omega$ <sup>1)</sup> was calculated using the following equation.

$$\Delta\omega = \frac{\omega_S}{100+\omega_S} S + \frac{\omega_G}{100+\omega_G} G \quad (1)$$

$\omega_S$  and  $\omega_G$  : Water absorption of fine and coarse aggregate (%)

S and G: Unit content of fine aggregate and unit content of coarse aggregate (kg/m<sup>3</sup>)

Table 1 Coarse Aggregate Physical Properties

No.	Aggregate type	Dry density (g/cm <sup>3</sup> )	Water absorption (%)	Mass loss fraction in soundness test (%)		
1	Igneous rock	Andesite	2.66	0.83	1.1	
2			2.64	0.47	8.9	
3			2.71	0.46	6.6	
4			2.61	1.14	6.5	
5			2.62	0.56	10.2	
6			2.88	0.68	2.3	
7			2.67	1.18	24.2	
8			2.73	0.84	11.1	
9			2.62	0.74	2.0	
10			2.72	1.51	6.2	
11			2.66	1.50	3.1	
12			Rhyolite	2.52	2.44	12.6
13				2.58	1.36	3.5
14				2.61	0.76	13.5
15			Gabbro	2.75	0.77	2.0
16			Diorite	2.67	1.47	3.7
17			Porphyrite	2.59	1.02	6.7
18	Sedimentary rock	Sandstone	2.72	0.56	9.0	
19			2.68	0.58	7.7	
20			2.60	0.69	8.1	
21			2.73	0.54	10.1	
22			2.78	0.71	6.9	
23			2.68	0.56	9.1	
24			2.67	0.49	6.4	
25			2.68	0.46	5.9	
26			2.68	0.73	1.5	
27			2.69	0.84	7.2	
28			2.70	0.57	4.9	
29			2.54	2.23	18.6	
30			Limestone	2.70	0.19	10.4
31				2.70	0.24	5.5
32				2.70	0.32	1.1
33				2.60	0.97	3.8
34				2.71	0.35	4.0
35	2.72	0.51		2.7		
36	2.69	0.49		1.6		
37	2.72	0.34		1.2		
38	Slate	2.69	0.87	11.7		
39		2.64	1.11	20.4		
40	Shale	2.67	0.97	3.4		
41		2.72	0.62	10.8		
42	Metamorphic stone	Tuff	2.60	0.85	2.9	
43			2.60	0.95	3.0	
44			Hornfels	2.73	0.44	4.6

**Key Words** drying shrinkage strain, coarse aggregate, water absorption, soundness test of aggregate

Contact address 〒700-8530 3-1-1 Tsushimanaka, Kita-ku, Okayama city, Graduate school of environmental and life science, Okayama Univ. Ayano · Fujii Laboratory TEL 086-251-8920

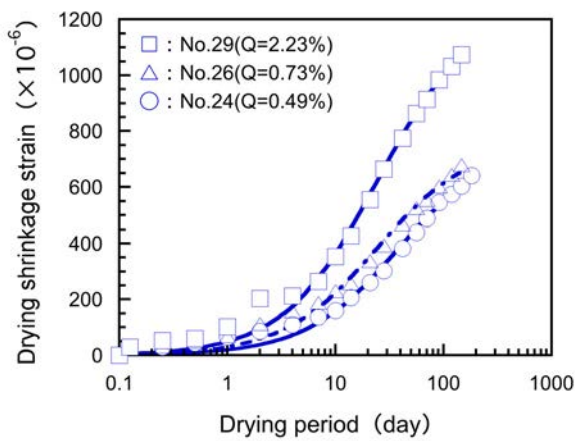


Fig.1 The relationship between water absorption rate and drying shrinkage strain

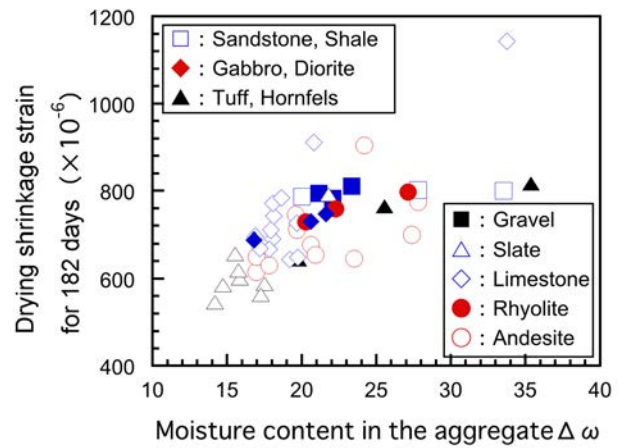


Fig.2 The relationship between moisture content in the aggregate and the drying shrinkage strain for 182 days

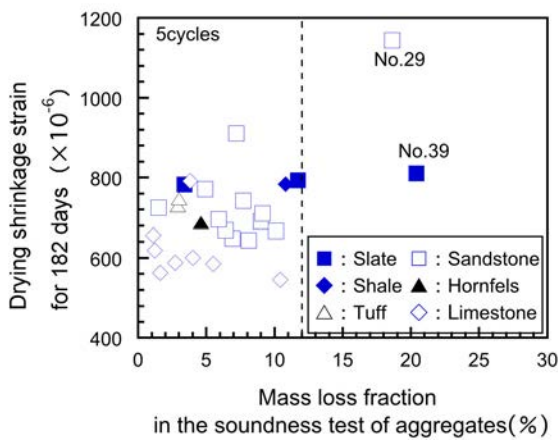


Fig.3 The relationship between mass loss fraction and drying shrinkage strain for 182 days (Sedimentary and metamorphic rock)

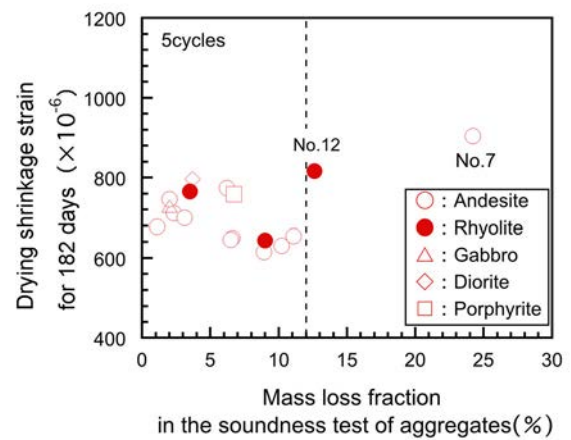


Fig.4 The relationship between mass loss fraction and drying shrinkage strain for 182 days (Igneous rock)

The higher the moisture content in the aggregate, the greater the drying shrinkage strain of the concrete. However, there is some difference in the drying shrinkage strain of concrete with the same moisture content in the aggregate.

Fig.3 shows the relationship between aggregate mass loss fraction from the soundness test and dry shrinkage for 182 days for sedimentary and metamorphic rocks. This figure shows that for sedimentary rocks, if the mass loss fraction of the stability test is greater than 12%, the drying shrinkage strain of the concrete using the sedimentary rock is large. Fig.4 shows the relationship between aggregate mass loss fraction from the soundness test and dry shrinkage strain for 182 days for igneous rocks. From this figure, the drying shrinkage strain of concrete using No.7 and No.12, whose mass loss fractions from stability tests are greater than 12%, are not different from those of concrete using coarse aggregate whose mass loss fractions are less than 12%.

#### 4. Conclusion

- 1) The higher the water absorption and moisture content of the coarse aggregate, the greater the drying shrinkage strain of the concrete using it.
- 2) When sedimentary rock is used, the drying shrinkage strain of concrete increases when the mass loss fraction of the aggregate exceeds 12%, but when the igneous rock is used, the drying shrinkage strain of concrete is no different than when aggregate with a mass loss fraction of less than 12% is used.

#### 5. References

- 1) Japan Society of Civil Engineers: Standard Specification for Concrete Structures-2017 [Design], pp. 107-109, 2018.3