III-248   DURABILITY CHARACTERISTICS OF RIPRAP ROCKS

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1.INTRODUCTION

Durability of rocks for use as riprap of fill dams plays a significant role in the stability of rock fill dams. In this research for investigating the response of riprap materials during various environmental conditions different type of tests were performed, allowing to simulate in laboratory and in a short time the physical and chemical weathering processes that take place in the nature in a much longer time.

For durability classification of the tested rocks against physical agents multivariate analysis is used. Finally the riprap rocks were exposed to dissolution test to obtain their behaviour against chemical agents.

2.SAMPLES AND TESTS CONDITIONS

The samples were taken as quarry from three dam sites in Kyushu Island , west of Japan. The rocks type and their chemical compositions is given in Table.1 , in which A, C and E show weathering rate for the same kind of rock. This classification is based on evaluation of the rocks in the field.

Table.1 Chemical composition of riprap rocks

	SiO_2	Al_2O_3	Fe_2O_3	CaO	K_2O	MgO	Na_2O	MnO	TiO_2	BaO	Total
Slate A	63.85	17.46	8.88	3.53	3.76	0.42	1.03	0.15	0.68	0.34	100.00
Slate C	59.17	17.57	8.87	8.00	3.69	0.49	1.24	0.14	0.84	0.0	100.01
Slate E	66.23	17.16	9.67	0.81	3.77	0.38	0.88	0.11	0.72	0.29	100.02
Green R A	58.32	15.47	10.44	10.97	1.86	0.65	1.33	0.18	0.71	0.09	100.00
Green R C	58.28	19.09	15.02	1.53	2.92	0.16	0.89	0.27	1.51	0.33	100.00
Green R E	67.58	16.23	8.5	1.49	3.73	0.35	0.70	0.07	0.90	0.49	100.04
Sandstone	73.5	14.33	5.78	2.87	2.03	0.12	0.66	0.11	0.59	0.0	99.99
Green Sch	62.71	14.46	12.23	7.31	0.33	0.52	1.08	0.12	1.26	0.0	100.02
Black Sch	64.91	16.37	9.06	3.08	4.26	0.32	0.72	0.15	1.12	0.0	99.99
Aplite	80.74	12.42	0.96	0.82	3.34	0.10	0.42	0.20	0.0	0.06	100.00

In order to accelerate the deterioration of rocks, after measuring physical properties such as porosity, absorption and specific gravity the samples were subjected into three major accelerated tests which are freeze-thaw test, wet-dry test and sodium sulphate soundness test.

The tests type and conditions are summarized in Table.2. In the case of

Table.2 Type and conditions of accelerated tests

Test conditions	Kind of tests		
	Wet-Dry test	Freeze-Thaw test	Sulfate soundness test
Drying Temperature	110℃	—	110℃
Drying Time	6 ~ 8	—	4 ~ 6
Submerged time	16 ~ 18	—	16 ~ 18
Freeze Temperature	—	5±2~-17±2℃	—
Number of cycles	100	300	5

accelarated tests weight loss was calculated as the deterioration index.

3.CLASSIFICATION OF ROCKS USING MULTIVARIATE ANALYSIS

For classification of riprap rocks principal component analysis was used, for this purpose the result of the three accelerated tests (weight loss), porosity and absorption were used as variables. Because of scale changes standardized variables were used

The result of the principal component analysis is illustrated in Table.3. The first principal component account for more than 95 percent of the total variation, so we can represent most of the variation in the tests by using this axis. Fig.1 shows the Z1 scores for the above mentioned parameters. For reveal the similarity of the rocks cluster analysis was used. The result indicates that the riprap rocks can be clas-sified into four groups. First group including aplite, sand stone, green schist, black schist and green rock A are durable rocks, and slate C is the weakest rock. In general there is a good agreement between initial field classification of the rocksand those obtained using multivariate analysis.

Table.3 Result of principal component analysis

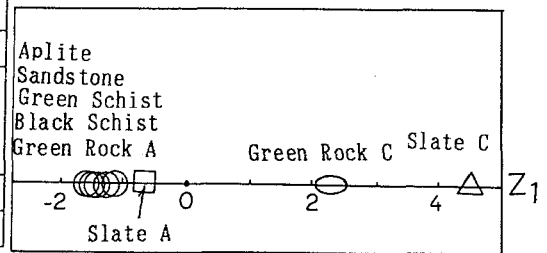| Variables	Average	Standared deviation	Z1		Z2	
			E.V	F.L	E.V	F.L
Porosity	2.505	1.916	0.45	0.98	-0.29	-0.13
Absorption	0.898	0.768	0.46	1.00	-0.17	-0.08
F-T.test	16.288	29.393	0.46	1.00	0.19	0.09
W-D.test	4.460	9.766	0.43	0.93	0.78	0.36
Cry.test	14.973	24.957	0.45	0.97	-0.49	-0.22
Eigenvalue			4.765		0.211	
Cumulative.P			0.953		0.995	

Fig.1 Z1 Scores for riprap rocks

4.CHEMICAL WEATHERING CHARACTERISTICS OF RIPRAP ROCKS

 For evaluating the effect of chemical agents on durability characteristics of riprap rocks, the ground samples were subjected to dissolution test.

Fig.2 shows the behaviour of one of the riprap rocks during dissolution test.For comparing the dissolution rate of dif-ferent rocks, the rate constant for all of the rock samples was calculated by applying an experimental equations.
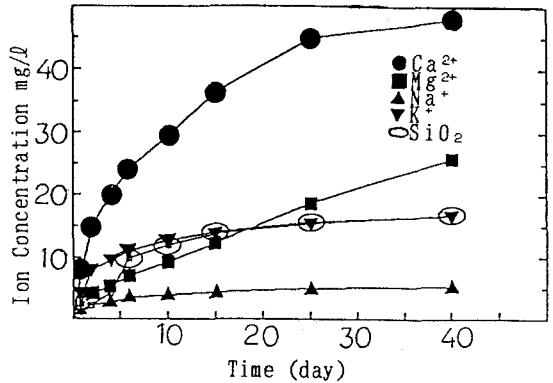

Fig.2 Dissolution characteristics of slate A

 The results approved that there is not much difference among dissolution rate of tested rocks and dissolution by itself will not be an effective factor for deterio-ration of riprap rocks during engineering time scale.

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