EFFECTS OF THE TAILINGS POSITION IN TAILINGS POND ON THE STRENGTH OF FILL①

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ABSTRACT The effects of the tailings position in tailings pond on the strength of the fill have been investigated on the basis of the physical assay and strength experiment of the tailings, referring to the filling experiences in Kangjiawan Zone, Shuikoushan Mineral Burean. The research work is important to crude tailings cemented fill.

Key words: tailings position tailings pond strength of the fill

1 INTRODUCTION

A series of economic and social problems resulting from the use of classified tailings with slit removed can be solved by crude tailings cemented fill. What is called crude tailings are the tailings applied for the aggregate of the fill directly without any treatment. When discharged from the dressing plant, the coarseness of grading and physical characteristics of the tailings vary with their positions in the pond due to natural classification, which exerts different impacts on the strength of the fill.

2 EXPERIMEINTAL MATERIALS

Three types of the tailings sampled in the scrap tailings pond of Shoukoushan Lead-Zinc Minc are as follows:

(1) The coarse tailings at the center of the pond, about 150 m away from the discharge point;

(2) The fine tailings near the end of the pond, about 30 m from the drainage shaft;

(3) The classified tailings in which the particles less than 0.03 mm are excluded by a cyclone.

Potland cement No. 425 acts as the cementing material.

3 COARSENESS AND PHYSICAL ASSAY OF TAILINGS

From the grades of the tailings (Table 1) and their physical characteristics, as listed in Table 2, it may be found that the tailings near the discharge point can be used directly as the fill materials because of their coarse grades and little amount of slit (only 5.83% grains less than 0.03mm in dia). On the other hand, they are fine (51.46% particals less than 0.03

Table 1 The coarseness of different tailings

Coarseness /mm	Coarse tailings /%	Fine tailings /%	Classified tailings /%
+0.15	59.97	4.63	63.68
−0.15～+0.106	22.39	5.79	23.78
−0.106～+0.075	3.48	2.24	3.69
−0.075～+0.045	7.26	29.76	7.71
−0.045～+0.030	1.07	6.12	1.14
−0.30	5.83	51.46	
Total	100.00	100.00	100.00

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Table 2 The physical characteristies of different tailings

Physical characterstic	Coarse tailings	Fine tailings	Classified tailings
Average grade /mm	0.134	0.0585	0.137
Unit weight /t·m^{-3}	1.28	1.38	1.53
Porosity/%	55.2	52.7	46.7
Seepage factor /cm·h^{-1}	14.10	2.04	27.61
Settling rate /mm·min^{-1}	62.25	53.80	45.75

mm) and difficultly seepy (seepage factor is 2.04 cm/h), but the other physical aspects of the tailings next to the drainage shaft, such as porosity, setting rate, are superior to the coarse tailings and beneficial to the long-term compressive resistances of the fill.

4 STRENGTH EXPERIMENT

Orthogonal test design with four factors, each having three levels, is adopted in the experiment. The factors and their levels are: (1) tailings: coarse tailings (co. t), fine tailings (f. t) and classified tailings (cl. t); (2) cement-sand ratio: 1∶5, 1∶10 and 1∶15; (3) slurry density: 65%, 70% and 75%; (4) curing time: 7, 28 and 90 days.

The experimental conditions and results are summarized in Table 3.

Table 3 Orthogonal test results

No.	Cement-sand ratio	Slurry density /%	Curing days	Tailings	Strength /MPa
1	1∶5	65	7	cl. t	2.57
2	1∶5	65	28	co. t	3.27
3	1∶5	65	90	f. t	5.50
4	1∶10	65	90	cl. t	0.43
5	1∶10	65	7	co. t	0.64
6	1∶10	65	28	f. t	1.00
7	1∶15	65	28	cl. t	1.24
8	1∶15	65	90	co. t	0.80
9	1∶15	65	7	f. t	0.63
10	1∶5	70	90	cl. t	6.20
11	1∶5	70	7	co. t	1.88
12	1∶5	70	28	f. t	4.63
13	1∶10	70	28	cl. t	2.73
14	1∶5	70	90	co. t	2.38
15	1∶10	70	7	f. t	0.39
16	1∶15	70	7	cl. t	0.45
17	1∶15	70	28	co. t	0.34
18	1∶15	70	90	f. t	2.20
19	1∶5	75	28	cl. t	5.95
20	1∶5	75	90	co. t	4.85
21	1∶5	75	7	f. t	1.53
22	1∶10	75	7	cl. t	0.83
23	1∶10	75	28	co. t	1.07
24	1∶10	75	90	f. t	2.50
25	1∶15	75	90	cl. t	3.05
26	1∶15	75	7	co. t	0.26
27	1∶15	75	28	f. t	0.88

5 THE ANALYSISES OF THE EXPERIMENTAL RESULTS

5.1 *The Tailings and Curing Days*

Generally, the compressive resistances of the tailings fill become higher and higher with time. That of the classified tailings fill increases rapidly and reach its maximum in 28 days or so; other two kinds of tailings fills strengthes rise stably. The coarse tailings fill has greater initial-stage strength (see Table 4), but the fine tailings fill posses large longer-term strength, which is consistent with those mentioned in section 3. As an instance, the 7-day strength of coarse tailings fill having 70% slurry density and 1∶5 cement-sand ratio is 1.88 MPa (see test No. 11 in Table 3), whereas the fine tailings fill No. 21 at the same cement-sand ratio and curing days as No. 11 (slurry density 75%) is only 1.53 MPa. In the case of layer fill, therefore, high initial strength allows for the use of the coarse tailings. As for such fill asking for high ultimate strength as artical sill pillar, fine tailings are ideal aggregate of the fill.

Table 4 The effects of the kinds of tailings on the strengthes(σ_c) of the fill at different curing curing days

Tailings	σ_c (MPa) at the following curing days		
	7d	28d	90d
Coarse tailings	0.93	1.56	2.68
Fine tailings	0.85	2.17	3.40
Classified tailings	1.28	3.31	3.23

5.2 *The Tailings and Slurry Density*

Obviously, the denser the fill, the higher the strength. Fine tailings are mixed more easily with cement in the fill than coarse tailings. As a results, it is difficult for cement grains to be washed away at low density (say less than 60%～70%) so that the effect of the fill is better than that of the coarse tailings, even classified tailings (Table 5). Along with the increase of the slurry density (more than 75%), the loss of cement is suppressed. Coarse and classified tailings are respectively 70% (such as test No. 12) and 75% (say No. 20, No. 23).

Table 5 The joint function of the tailings and slurry density

Tailings	$\bar{\sigma}_c$ (MPa) at the following slurry density		
	65%	70%	75%
Coarse tailings	1.57	1.53	2.06
Fine tailings	2.38	2.41	1.64
Classified tailings	1.40	3.13	3.29

6 CONCLUSIONS

The filling effects of the tailings at different positions in tailings pond are different for their various grades and physical characteristics. The main conclusions derived from the researches are:

(1) The grades of the tailings are finer and finer from discharge point to drainage shaft, but such physical aspects as porosity, settling rate are gradually improved correspodingly;

(2) The coarse tailings near discharge point have high initial stage strengthes and are suitable for layer fill; but the fine tailings close to drainage shaft are more ideal for the construction of the artical sill pillar by their greater long-term strengthes;

(3) The fine tailings are recommended in the low density fill, and in the case of high density fill, coarse tailings should be considered precedently;

(4) Both the coarse tailings near the discharge point and the fine tailings next to drainage shaft can be used as the filling materials directly. The fill of Kangjiawan Zone, Shuikoushan Mineral Bureau, is a successful example with above mentioned two kinds of crude tailings. About 30 000 m^3 of fill quantity has been completed in the zone. The samples test in-situ has proved that the 28-day strength of cemented fill with 1 : 5 cement-sand ratio and 70% slurry density reaches 4.57 MPa, enough to layer and the construction of the artical sill pillar.