Investigation of unfired Bricks Prepared by Shangluo Molybdenum tailings

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Abstract. Using molybdenum tailings in Shangluo as a core sample and the cement as gelled material, the unfired brick is prepared by mixing molybdenum tailings, cement, sand, silica powder and accelerating admixture, and then stirring and vibration. The effects of molybdenum tailings content, the ratio of molybdenum tailings to river sand and the addition of the silica powder on mechanical properties of the unfired brick. Results show that With the addition of molybdenum tailings increased, the mechanical properties of the unfired brick was decreased. When the addition of molybdenum tailings is below 75%, the flexural strength and compressive strengh are above 4.83MPa and 15.69MPa respectively, it meets MU15 standard. With the ratio molybdenum tailings to river sand increasing, the mechanical properties decreased firstly, and then increased. The mechanical properties of unfired brick is decreased with increasing of the silica powder.

Introduction

Entered the new century, a large of solid waste(e.g. taillings, slags, sluges, et al) are stockpiled, so that not only occupied over land and seriously polluted environment, but also the useful components of th tailings can not be fully utilized, resulting in a waste of resources[1]. And while the lives and property of the people are seriously threated. Shangluo tailings resources accounte for 1% of the country and one third of the province. Hence, it is great significance with using Shangluo tailings resources to develop recycling economy.

At present, every country carry out extensive research which work on the comprehensive utilization of the tailings by investing a lot of people, material and financial resource. The results show that Hanxing tailings can be used to produce building bricks with the standard number higher than MU10 by pressing method by Yin Hongfeng[2]. The unit weight and compressive strength of the lightweight baking-free brick prepared by different ratio of raw material and maintenance condition were studied by Feng Qiming[3]. And results show the dry bulk weight of lightweight baking-free brick was only as much as 2/3 of solid shale brick, but the compressive strength was up to 9.3MPa when the mass percent of copper mine tailings was 70% to 80%. The unfired bricks prepared with municipal sludge were studied by Yu Yanzhen[4]. It show that when the mass percent of the silt of the Yellow river, coal gangue, municipal sludge, grain slag, cement are 6wt%, 4wt%, 30wt%, 50wt%, and 10wt% respectively, the best bricks with 30.82MPa compressive strength. Therefore, in this work, the effect of the addition of molybdenum tailings and silica powder, and the ratio of molybdenum tailings to river sand on mechanical properties of unfired bricks were investigated.

Experimental and Materials

Molybdenum tailing

This experiment used molybdenum tailing from Jiulong company, and its chemical composition is showed in table 1.

Table 1 Chemical composition of molybdenum tailing

chemical composition	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	SO_3	Loss on ignition
Content/%	72.38	3.88	9.19	1.08	2.25	0.27	1.93	1.06	0.13	0.22	5.00	2.56

cement, Accelerating admixture and water

The cement is Qinling P.Q. 32.5R, its chemical composition is showed in table 2. The accelerating admixture is PC which is carboxylic acid polymers.The water is from local tap water.

Table 2 Chemical composition of cement

Chemical composition	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	SO_3	Loss on ignition
Content/%	20.38	6.01	3.39	2.37	63.81	2.48	~

experimental process

Fig.1 shows technical flowsheet of unburned brick. Molybdenum tailings, cement, river sand and silica powder were calculated and dry mixed for 2min. And then dry power raw material was added the water and wet mixed for 2min. Accelerating admixture was added and stirred. The raw material which were mixed uniformly was poured into steel mould which is 160mm×40mm×40mm, and then were maintained in the curing box. After 3d, 7d and 28d, mechanical properties of unburned brick were tested by universal testing machine and bending machine.

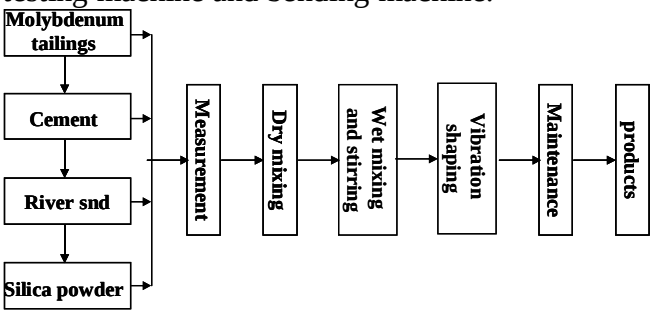

Fig.1 Technical flowsheet of unburned brick

Results and Discussion

The effect of the addition of molybdenum tailings on the properties of Baking-free Bricks

Table 3 and fig.2 show the effect of molybdenum tailing on flexural strength and compressive strength of unfired brick at the different molybdenum tailings content. With increasing molybdenum tailings, flexural strength and comprehensive strength of the unfired brick were decreased. Meanwile, with curing time prolonging, the mechanical properties of unfired brick was increased. When curing time is 7d, the mechanical properties of unfired brick attained 80% which is the final.

Table 3. Experimental results of the addition of molybdenum tailings

The ratio of dry solids			Water addition for mixing/%	3d mechanical properties/MPa		7d mechanical properties/MPa		28d mechanical properties/MPa	
Molybden-um tailings/ %	Cement amount/ %	Accelerating Admixture/%		Flexural strength	Compr-essive strength	Flexural strength	Compres sive strength	Flexural strength	Compr-essive strength
55	44	1	15	3.35	10.86	5.87	21.56	7.56	27.35
60	39	1	15	3.12	10.23	5.21	19.32	6.42	23.36
65	34	1	15	3	9.98	4.56	16.71	5.85	22.56
70	29	1	15	2.85	9.79	4.3	15.65	5.36	20.12
75	24	1	15	2.58	9.25	3.86	14.36	4.83	15.69

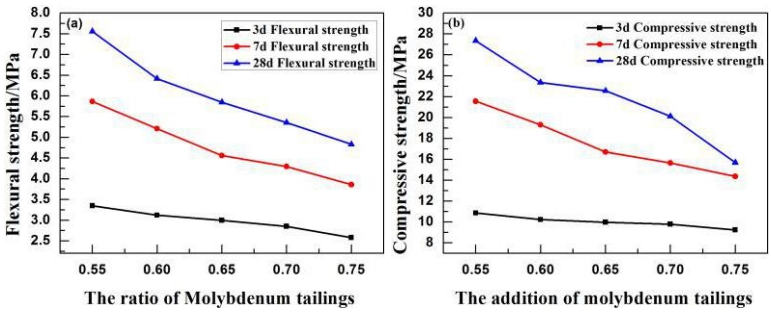

Fig.2 The effect of molybdenum tailings on mechanical properties:
(a) Flexural strength; (b) Compressive strength

When the addition of molybdenum tailings is 55%, after 28d, the flexural strength and compressive strength are 7.56MPa and 27.35MPa respectively. Its mechanical properties meets MU25. When the addition of molybdenum tailings 60%~70%, the flexural strength and compressive strength are 5.36~6.42MPa and 20.12~23.36MPa respectively. Its mechanical properties meets MU20. When the addition of molybdenum tailings reach to 75%, the flexural strength and compressive strength decrease to 4.83MPa and 15.69MPa, and its mechanical properties meets MU15.

In the reaction process, the raw materials reacts with water, as show below. It formed CSH and CAH. The particles of molybdenum tailing were bonded by CSH and CAH, and formed skeletal structure. Hence, unfired brick attains mechanical strength. However, When the addition of molybdenum is larger, the gelled material is lacking in the unfired brick, so the skeletal structure is reduced, and the mechanical properties of unfired brick was decreased.In curing process, the reaction was occurred continuously. The curing time is more longer, the reaction is more full, so the properties of the brick is more better.

$$CaO + H_2O = Ca(OH)_2$$

$$mCa(OH)_2 + SiO_2 + xH_2O = CaO \cdot SiO_2 \cdot xH_2O(CSH)$$

$$mCa(OH)_2 + Al_2O_3 + xH_2O = CaO \cdot Al_2O_3 \cdot xH_2O(CAH)$$

The effect of ratio of molybdenum tailings to river sand on the properties of unfired Bricks

Table 4 and Fig.3 show the effect of a mass ratio of molybdenum tailings to river sand on mechanical properties of unfired brick. It can be seen from Table 5 and fig.4 that with a mass ratio of molybdenum to river sand increasing, the mechanical properties decreased firstly, and then increased. When the ratio is 1:3.7, the flexural strength and compressive strength are 5.01MPa and 20.86Mpa respectively at 28d. When the ratio is 1:1, the flexural strength and compressive strength decreased to 4.48MPa and 16.89Mpa respectively. When When the ratio is 1:3.7, the mechanical properties increased, the flexural strength and compressive strength increased to 4.96MPa and 19.95Mpa respectively. The reason is that the main chemical components of the molybdenum and sand is SiO_2, but the other components are different and react with each other. It lead to the CSH and CAH decreased, so the mechanical properties is more smaller.

Table 4. Experimental results of a mass ratio of molybdenum tailings to river sand

The ratio of dry solids				Water addition for mixing/ %	3d mechanical properties/MPa		7d mechanical properties/MPa		28d mechanical properties/MPa	
Cement amount/ %	Molybden-um tailings/ %	Sand addition /%	Accelerating Admixture/%		Flexural strength	Compr-essive strength	Flexural strength	Compr-essive strength	Flexural strength	Compr-essive strength
29	15	55	1	15	3.11	12.07	3.62	16.39	5.01	20.86
29	25	45	1	15	2.65	12.74	3.53	18.82	4.98	19.22
29	35	35	1	15	2.45	10.04	3.40	14.53	4.48	16.89
29	45	25	1	15	2.72	8.99	3.58	15.76	4.51	18.10
29	55	15	1	15	3.18	7.94	3.92	18.66	4.96	19.95

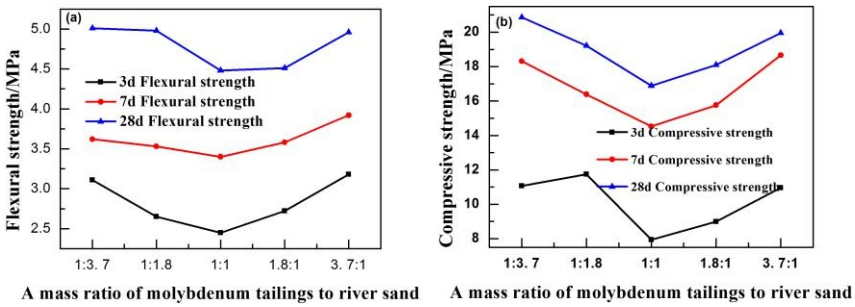

Fig.3 The effect of a mass ratio of molybdenum tailings to river sand on mechanical properties: (a) Flexural strength; (b) Compressive strength

The effect of silica powder on the properties of Baking-free Bricks

Table 5 and Fig.4 show The effect of the addition of silica powder on mechanical properties of the unfired brick. With the addition of silica powder increased, the mechanical properties of unfired brick is decreased. When the addition of silica powder is 3%, the flexural strength and compressive strength are 4.58MPa and 13.69Mpa respectively at 28d. When the addition of silica powder is 9%, the flexural strength and compressive strength are 3.99MPa and 12.35Mpa respectively. When the addition of silica powder is 15%, the flexural strength and compressive strength are 2.88MPa and 9.64Mpa respectively.

Table 5. Experimental results of the addition of silica powder

The ratio of dry solids				Water addition for mixing/ %	3d mechanical properties/MPa		7d mechanical properties/MPa		28dmechanical properties/MPa	
Cement amount/ %	Molybden-um tailings/ %	Silica powder/ %	Accelerating Admixture/%		Flexural strength	Compr-essive strength	Flexural strength	Compr-essive strength	Flexural strength	Compr-essive strength
29	67	3	1	15	1.48	2.95	3.87	10.21	4.26	13.69
29	64	6	1	15	1.5	3.0	3.54	9.79	4.08	13.25
29	61	9	1	20	1.32	2.5	3.05	8.56	3.99	12.35
29	8	12	1	20	0.82	1.69	2.12	5.64	3.16	9.89
29	55	15	1	22	0.7	1.8	1.69	5.54	2.88	9.64

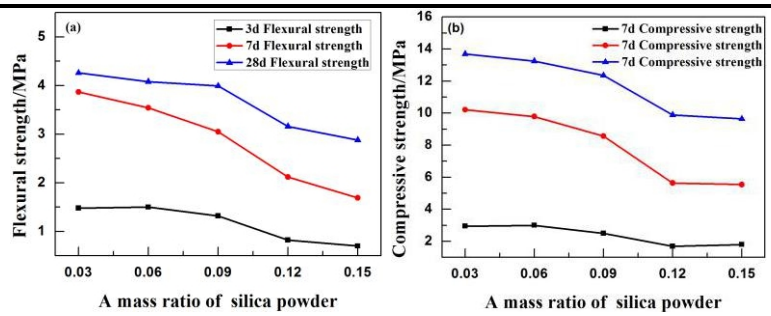

Fig.4 The effect of the addition of silica powder on mechanical properties: (a) Flexural strength; (b) Compressive strength

Conclusions

With the addition of molybdenum tailings increased, the mechanical properties of the unfired brick was decreased. When the addition of molybdenum tailings is below 75%, the flexural strength and compressive strengh are above 4.83MPa and 15.69MPa respectively, it meets MU15 standard. With the ratio molybdenum tailings to river sand increasing, the mechanical properties decreased firstly, and then increased. The mechanical properties of unfired brick is decreased with increasing of the silica powder.

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Reference

[1] Meng Zenhui, Ni Wen, Zhang Yuyan. Current state of ore tailings reusing and its future development in China[J]. China Mine Engineering, 2010, 39(5): 4-9.

[2]Yin Hongfeng, Xia Lilong, Ren Yun, et al. Investigation on Making Building Bricks with Tailings of Hanxing Iron Mine[J]. METAL MINE, 2006, (356): 79-81.

[3] Feng Qiming, Wang Weiqing, Zhang Bolian, et al. Research on Technics of Lightweight Baking-free Brick made of Lead-Zinc Ore Tailings from Qinghai Province[J]. Non-Metallic Mines, 2011, 34(3): 6-8.

[4] Yanzhen Yu, Lipan Guan, Yan Feng, et al. Study on preparing municipal sludge unfired bricks[C]. Proceedings of Beijing 2009 International Environmental Technology Conference, 2009, Beijing: 578-584.