Design, Preparation and Property of Phosphorous Slag Road Base Materials

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Abstract: In this paper, two types of PHS road base materials were designed, lime-fly ash stabilizing phosphorous slag (LFPHS) materials and cement stabilizing phosphorous slag-gravel (CPHSG) materials. The preparation research showed that LFPHS and CPHSG with satisfied strength could be made with significant amounts of PHS (60% ~ 70% in LFPHS, 20% ~ 30% in CPHSG). The materials property testing results indicated that LFPHS had good performance in anti-cracking and the less heavy metal leaching quantity comparing with level V according to Chinese GB3828-88.

Key words: phosphorous slag; road base materials; anti-cracking; leaching ability of heavy metal
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1 Experimental

The objective of this research is to find a new approach to utilize phosphorous slag (PHS) wastes without any additional treatment technologies. Since PHS is similar to fine aggregate in particle size and grading, it was found to be a potential substrate for aggregate in road base materials. Two types of PHS road base materials were designed, including lime-fly ash stabilizing phosphorous slag (LFPHS) materials and cement stabilizing phosphorous slag-gravel (CPHSG) materials.

1.1 Materials

The PHS was from Guizhou, China. A low-magnification scanning electron microscope picture of the surface of a PHS particle is shown in left Fig. 1, which shows the rough surface of the grain and some pores with a diameter around 25μm. A higher-magnification picture of the inner pore structure of the PHS is provided in right Fig. 1. The PHS appears to be porous, with pores distributed over a wide range of sizes.

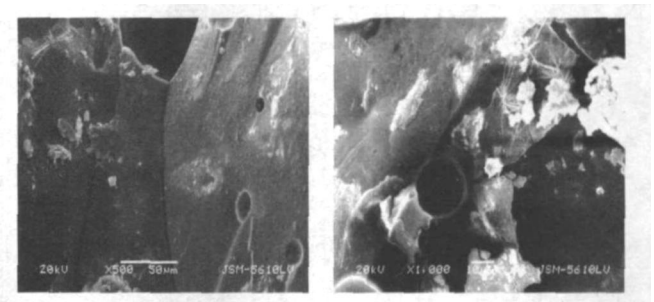

Fig. 1 Scanning electron microscope pictures of PHS

1.2 PHS road materials design

The compositions of LFPHS and CPHSG road material mixes are given in Tab. 1, Tab. 2, respectively.

Tab. 1 Mixing proportion of LFPHS (%)

	LFPHS 80	LFPHS 70	LFPHS 60	LFPHS 50	LFPHS 40	Reference LFA
Lime	8	8	8	8	8	8
FA	80	70	60	50	40	92
PHS	12	22	32	42	52	—

Tab. 2 Mixing proportion of CPHSG (%)

	CPHSG 1/3	CPHSG 1/2	CPHSG 2/3	CPHSG 3/3	Reference CG
Cement	4	4	4	4	4
Limestone	60	60	60	60	60
Stone chip	27	20	13	0	40
PHS	13	20	27	40	—

1.3 Test details

The unconfined compressive strength test, split strength test and resilient modulus test of PHS base material were done with the JTJ057-94. The heavy metal leaching quality test is conducted using the EPT (Extract Procedure Toxic Text).

2 Results and discussion

Fig. 2 presents the unconfined compressive strength of LFPHS and CPHSG. It shows that both LF-

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PHS and CPHSG had remarkable improvement in unconfined compressive strength comparing with reference LFA and CG. LFPHS had the highest strength with PHS content amounting to 60% ~70%. CPHSG eave the highest strength with PHS replacement of stone chip amounting to 50% ~60%.

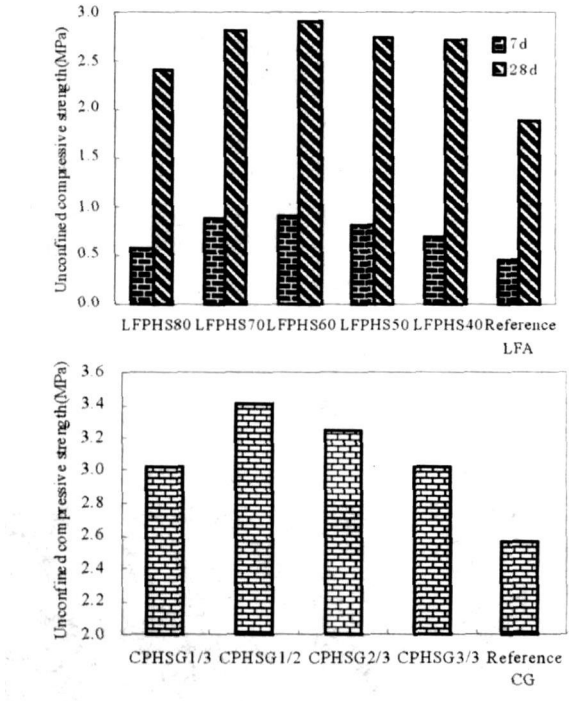

Fig. 2 The compressive strength of LFPHS and CPHSG

Tab. 3 shows the mechanical properties test results of LFPHS comparing with reference LFA. It shows that LFPHS had the higher splitting strength and resilient modulus than LFA at the age of 180. The LFPHS could be designed as the pavement sub-base materials or even base materials due to good performance on the anti-cracking.

Tab. 4 shows the heavy mental leaching quality test results of LFPHS by comparing with fly ash and the PHS. It can be seen that LFPHS has less As, Cd, Pb, Se leaching quality and more barium leaching quality comparing with PHS. Comparing with fly ash, heavy mental leaching quality is the same as PHS except arsenic. All the heavy mental leaching quality in LFPHS is less than reference value except barium indicating that LFPHS has no pollution on the environment.

Tab. 3 The mechanical properties of LFPHS compared to LFA

Pavement base materials	Splitting strength (180 d) / (MPa)		Resilient modulus (180 d) / (MPa)	
	design	test	design	test
Reference LFA	0.4 ~ 0.6	0.64	600 ~ 900	1279
LFPHS	—	1.10	—	1408

Reference LFA— lime: fly ash= 8 :92

Tab. 4 The heavy mental leaching of LFPHS compared to fly ash and PHS

Sample	Heavy mental leaching quality (μg/L)						
	As	Ba	Cd	Pb	Cr	Se	Ag
Fly ash	3.5	280×10^3	2.4	40.0	< 1.5	12.3	22.1
PHS	224	340×10^3	0.9	8.0	< 1.5	6.5	22.8
LFPHS	8.1	2115×10^3	0.9	< 0.3	< 1.5	4.7	25.5
Reference (≤)	100	20	10	100	100	—	—

Reference— level V according to Chinese Standards GB3828—88.

3 Conclusions

The PHS road base material is a very efficient approach to fully utilize PHS. LFPHS and CPHSG with satisfied strength can be made with significant amounts of PHS (60% ~70% in LFPHS, 20% ~30% in CPHSG). LFPHS has good performance in anti-cracking and the less heavy metal leaching quantity, which is less than level V according to Chinese GB3828-88.

磷渣路面基层材料的设计、制备与性能研究

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摘 要: 设计了石灰粉煤灰稳定磷渣和水泥稳定磷渣碎石路面两种基层材料。研究表明, 石灰粉煤灰稳定磷渣中, 磷渣掺量达 60% ~70%, 水泥稳定磷渣碎石中, 磷渣掺量达 20% ~30%时, 具有理想的强度, 用作路面基层材料; 性能测试研究表明, 石灰粉煤灰稳定磷渣具有很好的抗裂性, 其重金属溶出量达到国标 GB3828-88 V级标准。

关键词: 磷渣; 路面基层材料; 抗裂性; 重金属溶出;
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