The Test Research of the Road Use Performance of Lime-fly Ash Stabilized Aggregate Material

Runhua ZHANG
School of Civil Engineering & Architecture, Chongqing Jiaotong University, Chongqing, 400074, CHINA

Abstract: In this paper, through a large number of literature reading, summarizing the former research about the road performance of the lime-fly ash stabilized aggregate, based on experiment using the method from the raw materials, mix proportion design, improving the early strength mixture, adding admixtures, etc. this paper does the research of the system, and strive to maximize its road performance under existing sources of material. Through the research, it is concluded that efforts to improve the early strength of lime-fly ash stabilized aggregate, sodium carbonate is suitable mixed outside early strength agent for lime-fly ash stabilized under the condition of room temperature, sodium hydroxide and compound early strength agent is suitable for low early strength agent of lime-fly ash stabilized; Fiber reinforced semi-rigid base materials can improve the fatigue life of semi-rigid material, lower modulus and higher toughness, reduce the use of pavement crack and improve the pavement performance.

Keywords: Lime-fly ash stabilized aggregate; Road performance; Polypropylene fiber; Temperature shrinkage

1. Introduction

For semi-rigid base course material, our country has on the top of the international level after nearly thirty year's investigation and application. Lime-fly ash stabilized aggregate is the semi-rigid base course material in common use which has commonly used for high type highway because of their virtue of high strength and stability and so on. But it turns up the following short aspects when has been made use of nearly twenty years.

- The initial strength is low, impact the traffic and can not open earlier.
- It is easy to bring out brushing phenomenon and then result in the pavement broken and the working life
- In the course of the strength forming and working, it will bring temperature shrink crack because of temperature changed and drying shrinkage crack because of water content changed. When the asphalt surface course is thin, this kind of crack usually extends into the surface and forms reflect crack. The crack existed not only makes the vehicle steering quality come down, but also destroys the integrated characteristic and continuity of the pavement structure and in some extent leads to weaken of structure strength.
- When the raw material is improperly chosen or the mixture ratio is improperly designed. The semi-rigid base course is easy to come forth lack of cracking resistance and anti-brushing performance and also has defect of poor freezing and thawing resistance and poor bond of the surface.
- Lime fly-ash mixture is mainly composed of fine aggregate. It is sensitive to water and makes the base course always puzzle at the drying shrinkage crack in the course of construction and working time.

Aim at the defect of semi-rigid base course material, by reading lots of literature, on the base of summing up the pavement performance study of lime-fly ash aggregate, this paper systemically studies the semi-rigid base course, furthest enhance the pavement performance of the base course material by using the existing material.

2. Mix Proportion

The best proportion of lime-fly ash stabilized class base directly affect the strength of the mixture, two ash ratio of lime-ash stabilized aggregate in the current "technical specification for construction of highway pavement base" are given: 1:2 ~ 1:4, this range is wide. In order to further validate the more suitable lime-fly ash proportion of lime-fly ash stabilized class base, in indoor we conduct five different proportion of lime-ash strength test: 1:2; 1:2. 5; 1:3; 1:3. 5; 1:4. From the experimental results, the ratio of 5 kinds of lime-fly ash stabilized aggregate intensity in different ages have differences, but the difference is not big, that is to say, in the existing experimental conditions, we can't obviously compare the superiority-

inferiority of lime-fly ash ratio of 1:2 ~ 1:4. But we can find some regularity in the test, such as lime-fly ash of 1:4 may has early high strength (28 days), but the intensity of later period (90 days to 360 days) on the low side, which is unfavorable used, the remaining ratios of 1:2, 1:2. 5 and 1:3 are not different obviously from the perspective of the intensity. The proportion of lime and fly ash is recommended so as 1:2 ~ 1:3, and high aggregate content is not more than 80%[1].

3. Grade

At the same time the strength of the laboratory test of embedded squeeze lime-fly ash stabilized aggregate, such as shrinkage performance, fatigue performance has been carried on the contrast with customer specification grading, embedded squeeze lime-fly ash stabilized aggregate shows a good road performance. Two trials show that embedded squeeze lime-fly ash stabilized aggregate not only can be used for secondary roads, through control of the largest particle size and the adjustment of aggregate gradation, this structure can also be used for highways and first-class roads. Based on unconfined compressive strength of cement stabilized gravel and compressive modulus of resilience of experimental research, using cement dosage of 5% and the standard grading of the value of the cement stabilized gravel can form good structure, it can be able to achieve the requirement of the early strength and design index, which has good road performance.

This is the table of the mixture ratio for 7:18:75, the maximum particle size of 37.5 mm, the aggregate (soil) pass rate (Table 1):

Table 1. Aggregate (soil) pass rate

37.5	31.5	19.0	9.5	4.75	2.36	1.18	0.6	0.075
100	80	50	20	2	0	/	/	/
100	90	60	30	5	0	/	/	/

The Table 2 refers to the strength parameter of embedded squeeze lime-fly ash stabilized aggregate of the mixture ratio for 7:18:75, maximum dry density for 2.05cm^3/g, optimum water rate for 9%, Cv is the deviation factor.

Table 2. Different age compressive strength

7d		28d		60d	
Strength	Cv	Strength	Cv	Strength	Cv
0.94	7.7	2.2	7.6	3.8	11.1
0.96	8.9	2.3	8.7	3.6	12.2

The Table 3 refers to the strength parameter of specification stabilized aggregate of the mixture ratio for 5:15:80, maximum dry density for 2.06cm3/g, optimum water rate for 9.3%, Cv is the deviation factor.

Table 3. Different age compressive strength

7d		28d		60d	
Strength	Cv	Strength	Cv	Strength	Cv
0.89	19.2	2.8	5.9	3.8	11.5

The Table 4 refers to the strength parameter of dense stabilized aggregate of the mixture ratio for 6:14:80, maximum dry density for 2.12cm3/g, optimum water rate for 8%, Cv is the deviation factor.

Table 4. Different age compressive strength

7d		28d		60d	
Strength	Cv	Strength	Cv	Strength	Cv
0.94	8.5	2.4	10.0	3.8	9.0
0.92	9.6	2.8	9.0	3.7	10.1

4. Early Strength Principle

Physical and chemical processes of lime-fly ash reinforcement aggregate are on the basis of the lime in the liquid phase dissociation, therefore, the state of solution is a very important condition to determine strength of mixture formation and development of. Lime dissociate into Ca and OH ions, on the one hand, for the ion exchange and all kinds of chemical reaction with possible conditions, at the same time providing alkaline environment around the solid form and making the coal fly ash in Si02 and Al0 dissolution and produce ash reaction with Ca ions[2]. Therefore, in order to accelerate the reaction process, measures must be taken to improve the solution of the ion concentration and the PH of the solution medium. Adding alkaline materials, such as NaOH, can increase the ion concentration of OH in solution, improve the PH value, promote Si0 and A103 dissolution. At the same time, it also directly involved in a chemical reaction in catalyst, to speed up the reaction of the ash. As shown in Figure 1, Figure 2 and Figure 3.

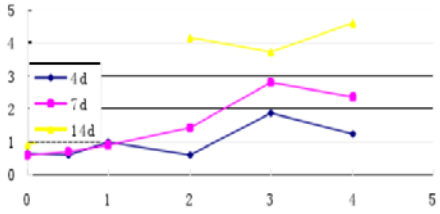

Figure 1. The diagram of NaOH content and the strength

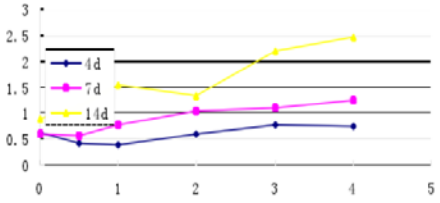

Figure 2. The diagram of Na2CO3 content and the strength

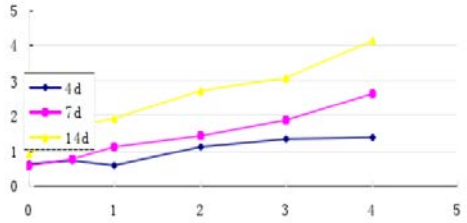

Figure 3. The diagram of complex content and strength

5. Admixture

Through participating in the test of different admixtures, alkali can as the additive agent to improve the early strength of lime-fly ash stable class, a single base class additive dosage of alkali is 1% - 3%, 7 days strength increasing 0. 2-2 times, 28 days strength increasing 0. 5-2. 2 times; Mixed valence type content is 1% - 3%, the additive agent strength increasing 0. 7 days 5-2. 2 times, 28 days strength increasing 0. 5-2 times.

By joining the polypropylene fiber can appropriately increase the compressive strength middle and late of mixture, and can reduce the compressive modulus of resilience of base materials, increase the strength and toughness, and at the grass-roots level may reduce the tensile stress of the basic bottom and the burden of surface[3]; Fiber reinforced semi-rigid base materials significantly improve the antifreeze performance of composite materials, 28 days, 60 days after lime-fly ash stabilized aggregate mixed with fiber, the maximum temperature shrinkage coefficient are less than the temperature shrinkage coefficient of lime-fly ash stabilized aggregate, but the difference is not big at the age of 28 days, when the temperature shrinkage coefficient difference is bigger at the age of 60 days; From the temperature shrinkage coefficient of lime-fly ash stabilized aggregate with the fiber of 28 days and 60 days, when fiber content is 1 ‰, fiber length is 9 cm, temperature shrinkage performance is better. As shown in Figure 4 and Figure 5.

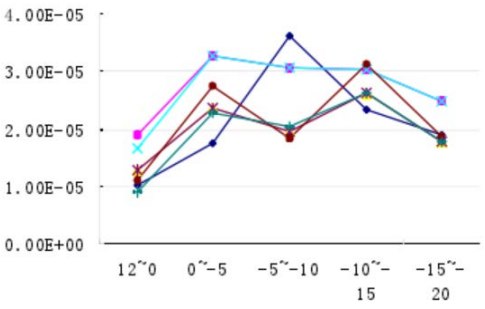

Figure 4. The compare of 28d temperature shrinkage coefficient of fiber crushed stone

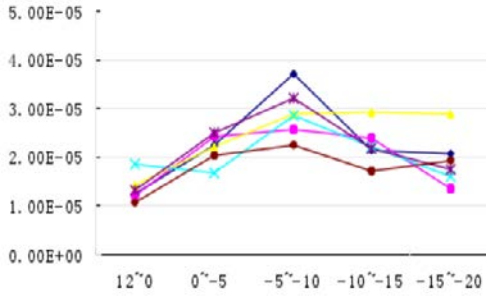

Figure 5. The compare of 60d temperature shrinkage coefficient of fiber crushed stone

Fiber reinforced semi-rigid base material contraction deformation resistance ability while in the process of slowly cooling performance is not obvious【4】. But when the temperature shock cooling speed is obviously, it can reflect the advantage of the fiber resistance to shrinkage, such as cold wave comes, summer rain suddenly.

6. Conclusion

This project is on the basis of indoor test, summarizes the research achievements of semi- rigid material in recent years, puts forward the research results and methods to improve the road performance of lime-fly ash stabilized aggregate material. The research conclusion is as follows:

1. Raw material index of semi-rigid base material impact on the road performance greatly; The calcium and magnesium content of lime, the fineness of fly ash, the quality of the silt content of aggregate and cement, aggregate grading and other index may implicate performance of lime-fly ash stabilized aggregate, through experimental research and field investigation of construction, we put forward a technical index requirements of raw materials, to improve the performance of semi- rigid base;
2. Through the test research of the road performance of lime-fly ash stabilized aggregate, analysis the structure principle and good qualities of embedded structure and squeezed dense type of lime-fly ash stabilized aggregate;
3. Through the study, the paper puts forward the measures to improve the early strength of lime-fly ash stabilized aggregate, sodium carbonate is suitable for mixed outside early strength agent of lime-fly ash stabilized aggregate under the condition of room temperature, sodium hydroxide and compound early strength agent is suitable for low early strength agent of the lime-fly ash stabilized aggregate;
4. Fiber reinforced semi-rigid base materials can improve the fatigue life of semi-rigid material, lower modulus and higher toughness, reduce the use of pavement crack and improve the pavement performance.

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