

Experimental Study on the Curing Effect of Dredged Sediments with Three Types of Curing Agents

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Abstract. Sediment solidification technology is widely used to dispose dredged sediment, three types of curing agents were used in this study to solidified the dredged sediment from shallows in Nantong with three types of curing agents: JY, ZL and FJ. The results showed that the optimal additive amounts of these three curing agents were 140g JY, 16g ZL, 2.0g FJ per 1000g of the dredged sediment respectively, their 28d USC were up to 2.48 MPa, 2.96 MPa and 3.00 MPa. JY has obvious early strength effect, which of FJ is not that obvious, but the later-stage strength of sediment solidified by FJ are relatively higher.

1 Introduction

Untreated dredged sediments usually contain large amount of water and harmful pollutants, such as harmful organisms and heavy metal, if stacked directly, it will take up much space and will pose a threat to environment, especially the soil and groundwater. People have been exploring many ways to solve these problems, the widely applied methods are composting, landfill and incineration[1]. Because dredged sediments are very soft soils that have very poor geotechnical properties[2], there are not suitable for landfill[3] before those disposal process, solidification/stabilization is the most common way of sediment pretreatment.

There are many studies about solidification with cement, fly ash, lime and other materials at home and broad. Yonghua Cao et al[4]., conducted laboratory tests to study the curing effect with cement, fly ash, soil and lime, the results showed that these materials could improve the strength of sludge obviously, after further drying, the strength could completely meet the requirements of landfill, when the mass ratio of lime, soil and sludge was 1:4:5, the 25d compressive strength is more than 9 kN. Qingshan Meng et al[5] studied the early solidification of sludge in East Lake in Wuhan, They found that the 20% cement, fly ash for 3 times the cement volume, and gypsum for 30% of the cement volume are the optimum mixture ratio for different water content sludge of East Lake. Wangxing Luo et al[6] studied the solidification treatment of dredged silt from Fenjiang River with cement, lime and blast furnace slag, the results showed that, when used separately, cement and lime had remarkable solidification effects on the dredged silt, while blast furnace slag had little solidification effect.

When the mixing ratio of cement, lime and blast furnace slag were 5%, 5% and 15% to 20%, respectively, the moisture content and UCS of the solidified silt could meet the requirements of landfill. Many studies showed that when cement increased, the strength of sediments would increased, too, But the costs would also increased. In addition to traditional curing agents, domestic and foreign experts have been studying the new sludge curing agent[7]. Some people added the industrial waste to the sediments to replace the cement, Xing Huang[8] and Yi Liu[9] used waste gypsum and phosphogypsum as additives respectively, proved that the curing effect was better when adding additives. Some scholars have also studied the polymer materials and water-reducing agent on curing the sediments.

2 Materials and methods

2.1 Materials

The sediment in this study were taken from the dredged sediment of shallows in Nantong, Jiangsu Province. The properties of the sediment are shown in table 1. Tap water, Portland cement, three types of commercial curing agent JY, ZL and FJ. The agent JY is a type of colorless liquid surfactant whose pH is 9.42; the agent ZL is a type of brown liquid polymer curing agent whose pH is 12.56; the FJ is a kind of acidic powder, the pH of it is 2.58.

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Table 1. The properties of the dredged sediment

Index	Value
Density	1.47g/cm ³
Moisture	50.3%
Liquid limit	48.3%
Plastic limit	32.0%
Plastic index	16.3

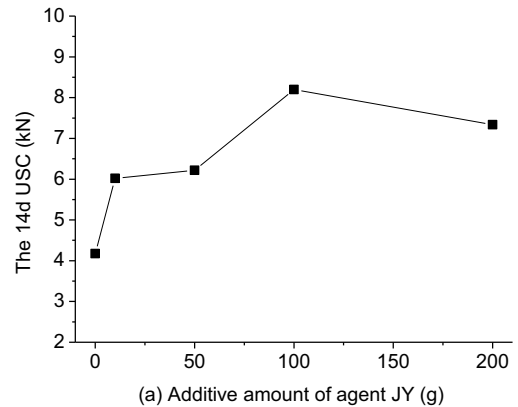


Fig.1 The 14d USC on different additive amount of agent JY

2.2 Experimental and text method

Sized 70.7mm×70.7mm×70.7mm plastic moulds are used to stow the solidified sediment to shape them, after 1 day, released the blocks from the moulds, and put them at a room that temperature is 20°C±1°C, and the humidity is more than 95% for 14 days or 28 days. Test the unconfined compressive strength(USC) of these blocks by NYL-600 compression-testing machine.

3 Results and discussion

Figure 1~3 are the 14d USC on different additive amount of the curing agent A, B, C. Figure 1 shown that the curing agent JY had good effect on solidifying the sediment, when adding 150g cement and the curing agent JY 0g, 10g, 50g, 100g, 200g per 1000g of the sediment, the USC increased first and then decreased, and the USC increased by 1.815 to 4.024kN compared with the blank sample. It could be found that the optimum additive amount of curing agent JY is between 60~200g. Figure 2 shown that when adding 150g cement and the curing agent ZL 0g, 10g, 20g, 30g, 40g per 1000g of the sediment, the USC decreased on the contrary, and the USC increased by 6.067kN when added 10g curing agent ZL. It could be found that the optimum additive amount of curing agent ZL is between 0~20g. Figure 3 shown the USC decreased sharply when adding 150g cement and the additive amount of curing agent FJ 0g, 1g, 10g, 100g, 200g per 1000g of the sediment, the optimum additive amount of curing agent FJ is between 0~10g.

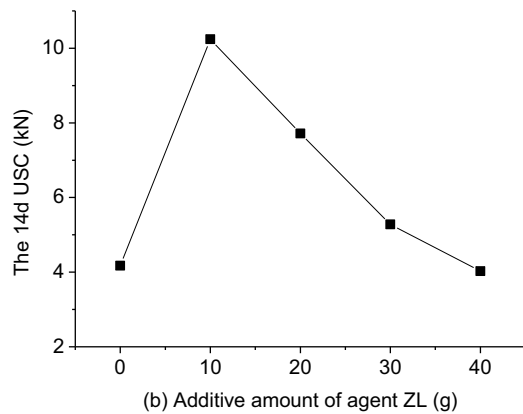


Fig.2 The 14d USC on different additive amount of agent ZL

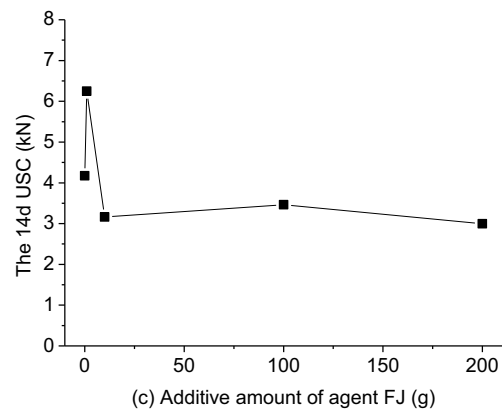


Fig.3 The 14d USC on different additive amount of agent FJ

Narrowed the gradient of the additive amount of JY, ZL, FJ according to the results above. Figure 4~6 are the 14d USC and 28d USC on different additive amount of the curing agent JY, ZL, FJ. Figure 4 shown that when adding 150g cement and the curing agent JY 0g, 80g, 100g, 120g, 140g, 160g, 180g respectively per 1000g of sediment, the 28d USC were higher than the 14d USC in the mass. No matter the 14d USC or 28d USC, when

140g curing agent JY was added, the USC was the highest one. But the 28d USC increased little compared with the 14d USC, that meant the curing agent JY had early strength effect. Figure 5 shown that adding 150g cement and the curing agent ZL 0g, 1g, 5g, 10g, 12g, 16g, 20g respectively per 1000g of sediment, there were obvious increase of the 28d USC compared with the 14d USC, the maximum value appeared when the curing agent was 16g. Figure 6 shown that when adding 150g cement and the curing agent FJ 0g, 0.2g, 0.6g, 1.0g, 2.0g, 3.0, 4.0g per 1000g of sediment, the curing effect were remarkable especially the 28d USC, almost each group was more than 8 kN, obviously higher than the blank sample. The figure showed that the optimal additive amounts of these three curing agents were 140g JY, 16g ZL, 2.0g FJ per 1000g of the dredged sediment respectively. After unit conversion, their 28d USC were 2.48 MPa, 2.96 MPa and 3.00 MPa respectively.

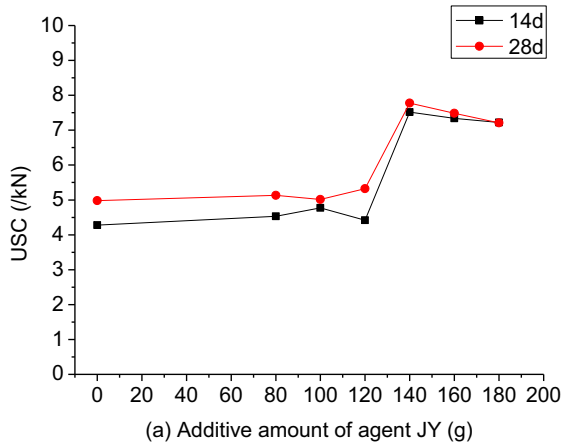


Fig.4 The 14d and 28d USC on different additive amount of agent JY

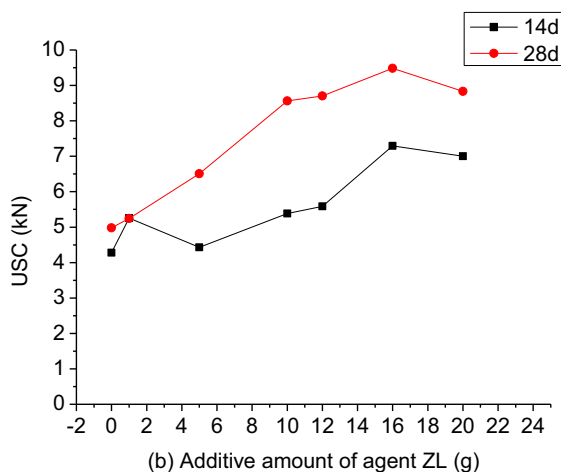


Fig.5 The 14d and 28d USC on different additive amount of agent ZL

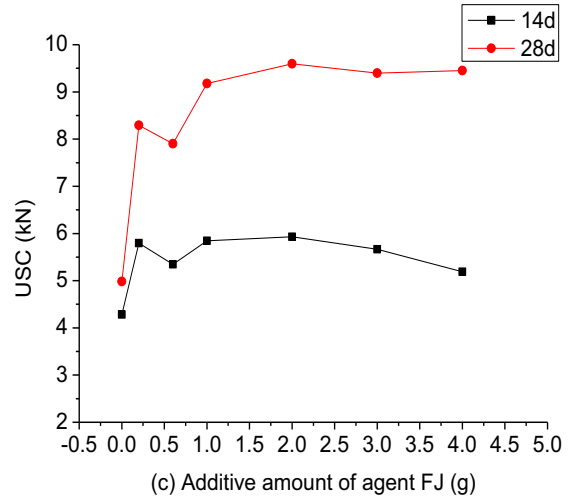


Fig.6 The 14d and 28d USC on different additive amount of agent FJ

4 Conclusion

Through the experimental study, some conclusions could be draw that the optimal additive amounts of these three curing agents were 140g JY, 16g ZL, 2.0g FJ per 1000g of the dredged sediment respectively, their 28d USC were up to 2.48 MPa, 2.96 MPa and 3.00 MPa. JY has obvious early strength effect, which of FJ is not that obvious, but the later-stage strength of sediment solidified by FJ are relatively higher.

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