Geosynthetics, J. Kuwano & J. Koseki (eds)

Research on flood control mechanical technology with larger geocontainer

Zhang, B.
Hydraulic Research Institute of YRCC, Zhengzhou 450000, China

Wang, Z.
Flood Control Office of YRCC, Zhengzhou 450000, China

Wang, Z.
Hydraulic Research Institute of YRCC, Zhengzhou 450000, China and Hydraulic and Hydroelectric Academy of Hehai University, Nanjing 210098, China

Deng, Y.
Hydraulic Research Institute of YRCC, Zhengzhou 450000, China

Keywords: larger geocontainer, mechanical rush repair, geosynthetics, rush repair technology, Yellow River

ABSTRACT: This paper introduces mechanized rush repair technology with larger geocontainers, discusses the stress state of a larger geocontainer in the sinking process and analyses its stability against impact and friction; it provides theory that supports for materials selection, structural design and manufacture of large geocontainers. It is found that larger geocontainers, attached to the riverbed well under its load, are fit for filling up scour hole and advantage to stabilize underwater base dam. Accordingly, it can replace the conventional rush repair tools, such as, cages with stone, willows pillow, jackstone and large netting cage, especially in locations where stone lacked. Now, geocontainers volumes are 10 m^3 or more. Cooperating it with large-scale machines: crane, digging mechanics, self-offload trucks and earth mover etc, the loading work can be finished in ten minutes. Perfect results were obtained by applying the method in Caiji 54th and Wang'an 14th dam of Lankao county in lower Yellow River.

1 INTRODUCTION

In thousands of years, people along the Yellow River have obtained very rich flood control experience during their struggle against the Yellow River. According to water and sediment characteristic, they used the local materials and have invented many flood control technology, such as cages with stone, willow pillow, jackstone and large netting cage etc. The application of such materials and technology formed the basic methods of Yellow River flood control which has gave great effect in flood control and rush repair, and it is still important flood control measures recently.[1] With the developing of technology and economy, more than twenty special flood control teams have been set up in lower Yellow River, they have earth mover, digging machines, self-offload trucks and other huge equipments, which enhance rush repair ability in flood control. Nowadays, the application of fiber netting cage and geosynthetics has brought great change in flood control, which has evident virtue as saving manpower, accelerating flood control speed and reserving materials easily etc. In order to solve how to organize rush repair in special situations such as a lack of stones or a shortage of stones because of rainy season, the paper puts forward flood control technologies with larger Geocontainer.[2] Larger geocontainers with volume from 10 m^3 to 12 m^3 are successly developed, they can be mechanically stuffed, transported, thrown with digging equipment, self-offload trucks, earth movers and loaders. It only needs ten minutes to finish the stuff work. These materials were tested in Caiji 54th dam and Wang'an 14th dam of Lankao County in lower Yellow River, which have been subjected to 2800 m^3/s flood during water and sediment regulation. In addition, transportation and jackstone of Larger Geocontainer is analysed in water in fengqiu shunhejie 13th dam.

2 STABILITY ANALYSIS OF LARGER GEOCONTAINER

2.1 *Bearing analysis for larger geocontainer in water*

2.1.1 *Geocontainer state*

If the geocontainer is filled and compacted by mechanical equipment, a maximum density of about 1470 kg/m^3 can be reached, and a maximum water-content coefficient about 24%. Normally, the sand in the container has a higher porosity and the density is between 1.15 g/cm^3 and 1.33 g/cm^3. As thrown into water, the geocontainer will go through a series of complex changes. The geocontainer is soaked tardily, the gas in it exhausts slowly until soil saturates, and the mechanical property of the soil changed considerably during that period.

2.1.2 *Stress state of larger geocontainer thrown to water*

Thrown to water by self-offload trucks, the geocontainer mainly endures gravity and friction drag. When the car hopper of self-offload trucks slopes down to 45°~50°, the geocontainer will immediately slide out itself, and the badly designed geocontainer would be broken up because of violent impact force. Generally, they will kneel down to the ground. Besides, if the geocontainer is not dumped directly at the right position, it will be pushed by digging mechanics or earth movers to its final position (see Figures 1 and 2). These forces must be considered when designing the structure and selecting materials.

Figure 1. Geocontainer pushed by bulldozer.

Figure 2. Geocontainer pushed by digging mechanics.

2.1.3 *Stress state of larger geocontainer thrown into water*

There are two kinds of stress states: (1) being slided down from cliff; (2) being sunk down in water. During sinking, it endured the same stress as stone except its smaller density. When larger geocontainer is thrown into water, the air in it wills gathers together and turns to ballonets that will bring buoyant force and affect the sinking and stability of larger geocontainer. During sinking, the larger geocontainer mainly endures gravity, buoyancy, slope friction drag, circumfluence resistance, and hydrodynamic pressure. The sinking time and displacement are decided by resultant force. Gengmingquan and Songdongpo have done experiments to study the stability. Moreover, the larger geocontainer offsets are affected by current velocity and water depth. The more rapid the current velocity, the bigger offset the larger geocontainer is. The more deep the water depth is, the bigger offset the larger geocontainer is.

2.2 *Stability analysis of shock resistance of larger geocontainer*

If the air in geocontainer is taken into account (compactedness is 0.7~0.8, calculated by geocontainers' size and its filling soil amount), looser the earth is, more air in it, so it is more porose. If the air-out capability of the geocontainer is poor, its floatage will be strong, for its gas is difficult to be discharged. As result, the geocontainer will be unstable. Consequently, the materials chosen to produce geocontainers should be feasible to exhaust gas. The soil should be compacted before filled into geocontainers experimental program.

2.3 *Friction stability analysis of geocontainers*

The friction stability of geocontainers underwater is very important. The adopted friction coefficient is the smaller of the following: the friction coefficient among geotechnical materials and the friction coefficient between geotechnical materials and soil. In total, the friction coefficient between geotechnical materials and soil is bigger, while the coefficient between geotechnical materials and geotechnical materials is smaller. In geocontainer's underwater construction, the stability of the geocontainer is highly dependent on parameters, such as current velocity, scour hole's formation, geocontainer's state, geocontainer's strength. In the condition of speedy proceeding, the underwater construction will be stable when the geocontainer is static at an angle after it is destabilized for a certain time.

3 STRUCTURAL DESIGNS AND RUSH REPAIR METHOD OF LARGER GEOCONTAINERS

3.1 *Structure and dimension*

The dimension of the larger geocontainer is 4.5 m × 2.4 m × 1.3 m, determined by the car hopper dimension of the self dumping truck. The geotextitile is determined by the qualifications: strength, deformation rate, hydraulic permeability, air discharge and soil saving in the process of rush repair. If they are produced with weaved fabric and compound geotechnical materials (200-250 gr/m^2), a 5 cm-wide reinforcement band is demanded at 1 m intervals in order to reinforce geocontainers strength. See the following pictures: Figure 3 and Figure 4; while, hemp ropes or chemical fibre rope bound at 1 m intervals are used for containers of non-woven fabrics to reinforce geocontainers strength.

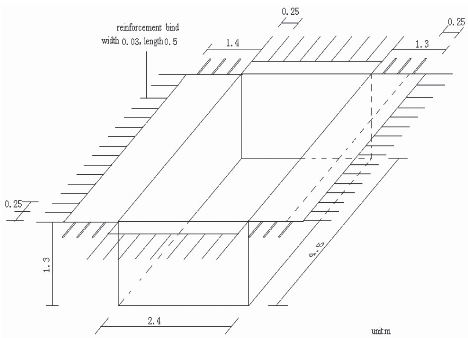

Figure 3. Structure and size of lager geocontainer.

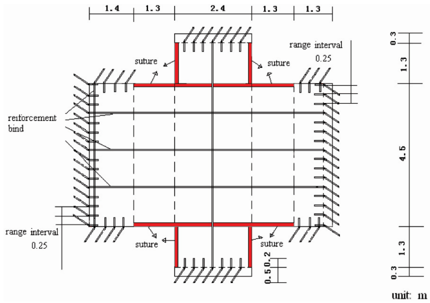

Figure 4. Developed representation of larger geocontainer manufacture.

3.2 *Rush repair method and characteristic of larger geocontainers*

Geotechnical composite materials are made into big packets according to the shape and capacity requirement in mechanized rush repair with larger geocontainer. Larger geocontainers, filled with loose soil and other materials, are used in mechanized rushing repair in flood control, with the cooperation of large-scale machines, such as charging cranes, digging machines and self-offload trucks. The methods and characteristics of rush repair with larger geocontainers are as follows:

Larger geocontainers are assembled in self-offload trucks with charging cranes and digging machines, which meets mechanical work requirement of self-offload trucks. The empty pockets can be pre-sewn and stored conveniently. As the material can be quickly transported to danger spot, quickly loaded and pitched in an emergency, larger geocontainer has the following advantages:

– Convenient transport, simple manipulate and quick rush repair, comprehensive applicable domain: throwing in ship, at bank, by hand or by machine.
– No restriction on soil quality, so it can be obtained on site and replace of jackstone in some cases.
– Can substitute for willow and stone fascines, protect ecological environment.

Figure 5. Larger geocontainers as brought on the site from the factory.

Figure 6. Mechanical cast loose soils.

The essential of mechanized rush repair with larger geocontainers is that it separates the geocontainers processing site from the throwing stie, breaking the limitation of small work site in traditional rush repair technology, realizing the assembly line work, increasing the efficiency of rush repair.

4 ANALYZE THE RUSH REPAIRS EFFECT OF LARGER GEOCONTAINERS

1 Experimental result of throwing large geocontainer in underwater execution of Caiji 54th dam and rush repair of Wang'an 14th dam of Lankao County proves that:

(1) Scientific site arrangement can accelerate mechanized work. The number of self-offload trucks can be determined by the operated cycle time of distance and digging mechanics, which

should not be too large to insure a high product rate at minimum costs. For example, 50 m underwater execution, a D85-blader, 3 digging mechanics and 10-12 self-offload trucks are the most effective teamwork.

(2) 10 m^3 large geocontainer can solid stand in water and perform on the condition that the water depth is about 4 m-6 m and the measured discharge velocity is less than 1.0 m/s. See Figure 7 and Figure 8.

Figure 7. Underwater execution of large geocontainer.

Figure 8. Resisting current scour of large geocontainer.

2 Experimental results of throwing large geocontainers in 13th dam underwater execution of Shunhe road of Fengqiu reveal that:

(1) Earth-filled woven fabric large geocontainer can't form stable mass in the condition that the water depth is about 8 m-10 m and the measured discharge velocity is 1.5 m/s, large stream impacts dam. The mainly reason is that the strength of throwing larger geocontainer is related to current scour. The velocity of one 10 m^3 geocontainer per 25-35 minutes couldn't satisfy the requirement of underwater execution.

(2) Most larger geocontainers were cracked at upper commissure and soil lost sharply when woven fabric larger geocontainers were thrown, so that the efficiency is low. The air in container can't be ejected underwater for the reason that permeability of the woven fabric is too poor. Resulting in buoyancy forces, due to that the pulse-on velocity is low and the scour resistance is feeble.

5 CONCLUSIONS

The materials selection, structure, size, manufacture and mechanized loading, transaction and throwing etc. of larger geocontainer are solved through the experiment. The following conclusions and suggestions can be obtained on the basis of the experimental results:

(1) The mechanized rush repair of larger geocontainer, embodying the principal of high strength, high efficiency, factory process and mechanization work, has many advantages and development potential. This method presents new technical support for flood control and rush repair work.

(2) To solve low strength and liable to crack when thrown, this paper introduces the method of tying larger geocontainer with reinforcement band or string.

(3) With the characteristic of soft deformability, the larger geocontainer is fit for filling up scour hole. It can attach the riverbed under its load, and is beneficial to the stability of underwater base dam and advantage the rush repair work of stream groin.

(4) Larger geocontainers with volume from 10 m^3 to 12 m^3 are successfully developed, Experimental results reveal that 10 m^3 large geocontainers have good applicable effect.

(5) It is very complex to estimate the stability of underwater geocontainers. It can be determined by water-depth, current velocity condition, and execution technology. It is suggested that the stability and execution technology should be further analyzed and experimented and investigated.

REFERENCES

1 Luo, Qingjun. (2000). "Technology of Flood Control Rush Repair", Yellow River Water Conservancy Publishing House.

2 Zhang, Baosen. Zhu, Taishun. (2004). "Research on Modern Rush Repair Technology of Yellow River Training Works", Yellow River Water Conservancy Publishing House.