GEOTEXTILE FOR DOWNSTREAM DRAIN YANGDACHENG DAM, CHINA

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In Yangdacheng dam, over 4,600 m² of geotextile were used as a filter around the downstream drain pipe. The results were satisfactory.

DESCRIPTION

Yangdacheng reservoir has a 86,000,000 m³ storage capacity. It is located on the Meng Guangli river in Jilin province. The homogeneous earthfill dam has a maximum height of 17 m and a crest length of 2,250 m. It is constructed with silty loam and silty sand fill.

The reservoir was put into service in 1980. When the water level reached 176.69 m water leakage was observed on the downstream slope . Owing to the poor quality of the construction of the drainage ditch, the ditch had become badly clogged in some parts. Seepage flow could not drain out freely. As a result, the phreatic line inside the dam rose. This caused flooding of over 300 ha of farmland and caused more than 1,200 ha of fish pond to become non functional, and unable to produce any benefit. Slides occurred on the left bank of the spillway apron and downstream of the culvert apron section. These were at least 70 m and 600 m long respectively . The reservoir was unable to store water.

DESIGN OF FILTER

Design Proposals

Permeability tests were conducted under different boundary conditions, corresponding to three typical sections of the dam. Based on these tests a pipe underdrain was selected as superior to the drainage ditch alternative. The pipe was made up of reinforced concrete with a 600 mm diameter and a greater than 2% open area. In selecting the filter material around the perforated pipe, a comparison was made between a sandy gravel filter and a geotextile. In accordance with the filter design criteria, the natural sandy gravel would have to be manufactured and made into an artificial graded material. Also, if it was chosen as the filter material, it would have to be delivered through a long distance (more than 100 km). A time and work consuming process. Since a tight construction schedule was demanded the quality assurance would be hard to control.

Geotextile is one of the new materials of construction. Its advantages are: high strength, good filtration, low cost, ease of installation and quality assurance. Moreover, the problems mentioned above may be resolved by its use. Thus, the geotextile was finally selected as the filter material in this project.

Geotextile Selection

Under unidirectional flow condition in this project, the following criteria were used:

$$O_g \leq d_{90}, \quad k_g \geq 100\, k_s$$

Where O_g is pore size of geotextile; d_{90} is the 90% finer than d size by mass of soil to be protected; k_g and k_s are the coefficients of permeability of geotextile and soil respectively.

Tests on the soil in the vicinity of the covered drainage pipe gave, d_{90} from 82 to 120 μm, k_s from 15.0 to 8.3 nm/s. The properties of geotextile adopted are shown in Table 1. It can be seen from Table 1 that the geotextile could meet the design requirement of this project.

CONSTRUCTION METHOD

According to the gradient requirement of the design excavation section and covered pipe layout, the excavation was carried out building small portions at different times. Due to high ground water table plus the disturbance by the workers, thin mud layers of various depths formed along the bottom of the trench. This made it difficult to fix each section of perforated concrete pipe to the specified elevation. To solve this problem, a number of concrete supporting pads (Figure 1) were put into the trench in advance and the space between two pads was filled with sand. Then the geotextile was placed over the sand. After that a 2 m long pipe section was set on to the geotextile and a survey level was used to adjust the pipe to design elevation.

To improve the drainage efficiency, a layer of crushed stone was placed over the pipe and a 20 mm wide

Table 1. Properties of selected geotextile

Test	Data
Type	Nonwoven
Mass per unit area	400 g/m²
Thickness	4.3 mm
Tensile strength	463 N/50mm
Puncture strength	1044 N
ε_f	88 %
Permeability (hor.)	2,200 μm/s
Permeability (vert.)	49 μm/s
O_{90} (minimum)	62 μm
O_{90} (maximum)	54 μm

Photo 1. Pipes during geotextile placement.

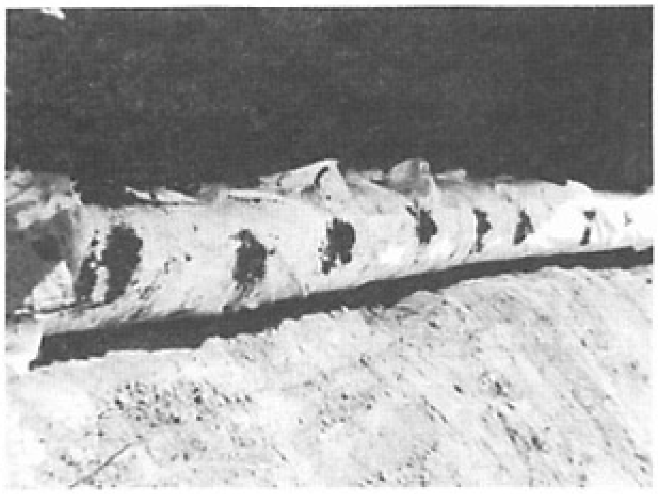

Photo 2. Pipes after geotextile placement.

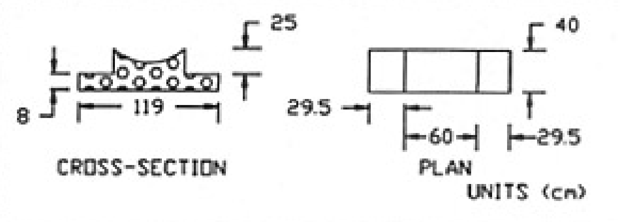

Figure 1. Supporting pad (unit:cm) (a) cross section. (b) plan.

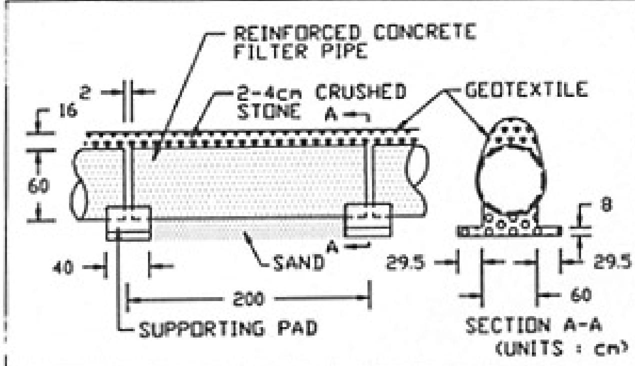

Figure 2. Section through pipe support.

space was left at each joint of the pipe sections. After that, the geotextile was laid over the crushed stone (see Figure 2) and the trench was finally backfilled with earth.

TECHNICAL AND ECONOMICAL STUDY

Cost Comparison

If sandy gravel were to be used as filter material, 5,840 m^3 of crushed stone and 4,789 workers would be needed. The total cost would be 335,000 Yuan. For a geotextile, only 400 workers and 4,600 m^2 of geotextile are needed. The cost would be 46,000 Yuan. It is seen from this comparison that the cost of the geotextile is only 13.7% of that for sandy gravel and the number of workers needed is 9% of that required for sandy gravel alternative.

Quality and Construction Period Comparison

Since the natural sandy gravel was poorly graded, using such material for the filter would not only result in difficulty controlling the layer thickness, but would often result in soil mixing at the interface. It would be a time and work consuming process. Controlling the filter grading would not be easy. Thus, the filter efficiency could hardly be guaranteed. However, the geotextile is convenient to place, easy to adjust and has an excellent filter effect. Thus, the quality is much easier to ensure and less time is needed for the construction work. The total length of pipe plus geotextile was 150 m and was placed in two months.

APPLICATION EFFECT

The project was completed on Nov. 10, 1986. Considering the water level at Section 1+800 as an example (Figure 3), in comparison to Sept. 1, 1986 before the pipe installation, the water level fell 0.394-0.429 m on Nov. 1, 1986 and dropped 0.804-1.087 m by Feb. 9, 1987. The seepage water was clear. The water level in the fish pond fell 0.8-1.0 m. This permitted reuse of the land and the fish pond downstream of the dam.

CONCLUSION

This case history demonstrates that a geotextile can be successfully used for a dam downstream covered drain pipe. Also demonstrated are the ease of the construction work and quality control, and the economical benefits.

REFERENCES

Giroud, J.P., "Filter Criteria for Geotextiles", Proc. of the 2nd. Int. Conf. on Geotextiles, Vol. 1, 1982, pp. 103-108.

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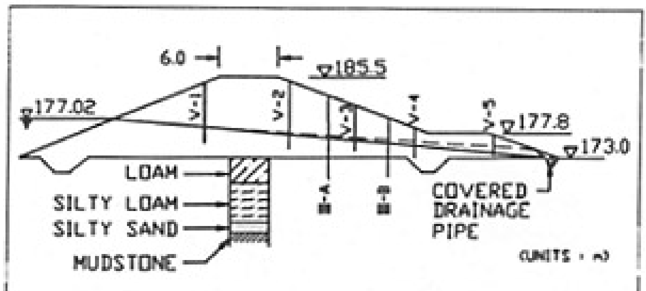

Figure 3. Variation of phreatic line before and after placement of covered pipe.