# GEOTEXTILE FILTERS FOR DOWNSTREAM DRAIN AND UPSTREAM SLOPE VALCROS DAM, FRANCE

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In 1970, for the first time, geotextiles were used in an earth dam, Valcros Dam, located in southeast France. Geotextile filters were used around the downstream gravel drain and under the rip-rap protecting the upstream slope. The geotextile performance has been documented through extensive investigation.

## DESCRIPTION

### The Dam

The dam is 135 m long and 17 m high, with 3H:1V slopes. It is constructed with silty sand containing 28% by weight of particles smaller than 0.075 mm and 85% by weight of particles smaller than 7 mm.

### Downstream Drain

Installation of downstream drains to collect water seeping through earth dams is standard practice. In Valcros Dam, the original feature is the use of a geotextile in place of a sand filter (Photo 1). The senior author decided during construction to use a geotextile because it was difficult to obtain the specified sand. A nonwoven geotextile with a mass per unit area of 300 g/m$^2$ was used.

### Upstream Slope Protection

The upstream slope was divided into three zones (Figure 1, Photo 2). Zone A was protected in the conventional manner by a 400 mm thick layer of 250 mm rounded rocks resting on a 150 mm thick layer of 6 to 40 mm gravel. Zone B was covered with only a sheet of nonwoven geotextile with a mass per unit area of 400 g/m$^2$ formed by sewing together geotextile strips which were fixed to the ground by metal pins. Zone C was protected by a 400 mm thick layer of rocks, identical to those used in Zone A, resting on the same geotextile as in Zone B.

## GEOTEXTILE SELECTION

In 1970, only one type of geotextile was available in France: a polyester, needlepunched, nonwoven geotextile with continuous filaments (Bidim). Little was known about geotextile filter criteria. The only design consideration was that the geotextile opening size should be smaller than the $d_{85}$ of the soil (7 mm). This simplistic criterion would have authorized the use of a geotextile with 7 mm openings, i.e., larger than the openings of the gravel drain. A number of years later, the use of a filter criterion [Giroud, 1982] which takes into account the soil coefficient of uniformity (very large in this case) has shown that the geotextile opening size should be less than 0.17 mm. The actual geotextile openig size was 0.15 mm.

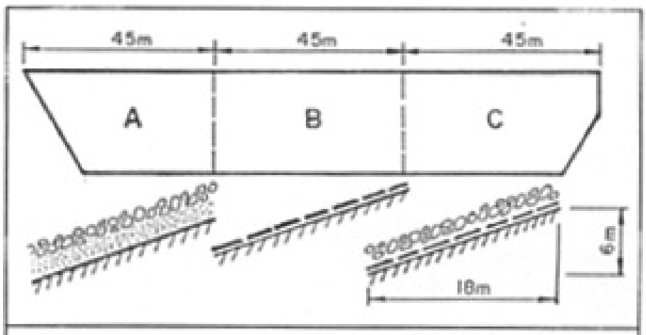


Figure 1. The three zones of the upstream slope.

## PERFORMANCE

### Downstream Drain

Since the construction of the dam in 1970, water flowing from the drain has always been clean, except during the filling of the reservoir when suspended particles were noticed. No seepage from the downstream slope of the dam has ever been observed. This indicates that the drain has functioned correctly.

### Upstream Slope Protection

Zones A and C have functioned as intended since construction. In Zone B, by 1972, the bank was eroded underneath the geotextile at two levels, at the water level by wave action and above the water level by rain. This incident, which did not endanger the safety of the dam, shows that a geotextile alone cannot prevent erosion. Furthermore, the geotextile in Zone B deteriorated as a result of exposure to sunlight.

To repair Zone B, the geotextile was cut to conform to the shape of the bank and was covered. The cover consisted of another geotextile of the same type and rocks identical to those in the other zones. Since then, the entire slope protection has been functioning satisfactorily.

## GEOTEXTILE CONDITION

In 1976, geotextile samples were taken from the dam: (a) geotextile located at the outlet of the downstream drain and exposed to sunlight for six years; (b) geotextile from the downstream drain, buried in the dam for six years; (c) geotextile from Zone B of the upstream slope protection, which was exposed to sunlight for two years (1970-1972) and then covered with a new geotextile and rocks; and (d) geotextile from Zone C of the upstream slope protection, at the water level.

Photo 1. Downstream drain during geotextile filter placement.

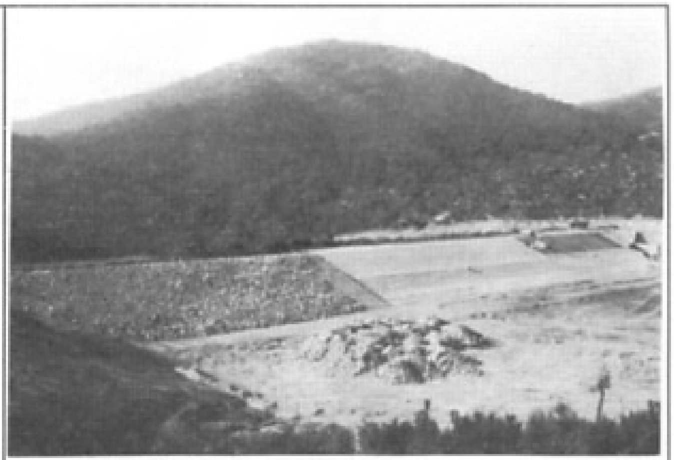

Photo 2. Upstream slope protection during geotextile placement in Zone C. (The rocks stockpiled in the foreground were placed in Zone C).

Observations made in 1976 showed that samples (b) and (d), which had been protected from sunlight by either earth or rock, appeared to be in good condition, while samples (a) and (c), which were exposed to sunlight, exhibited a colour change and were weak: filaments were broken or could be pulled out by hand. Laboratory tests conducted in 1976 have been reported by Giroud et al. [1977] and are summarized below.

Tensile tests conducted in 1976 showed the following strength losses compared to control samples: 10 to 20% for samples (b) and (d), which had not been exposed to sunlight; 50% for sample (c), which had been exposed two years; and 80% for sample (a), which had been exposed six years.

Permeability tests were conducted in 1976 on samples (b) and (d). Sample (b) was clean, while sample (d) was dirty, except in areas where it was in contact with the rocks. In those areas, sample (d) was clean on both sides, because the pressure exerted by the rocks prevented soil movement and minimized flow of water. The following values were obtained for the geotextile coefficient of permeability: 1 mm/s for sample (b) prior to washing; 1.5 mm/s for sample (b) after thorough washing; 0.165 mm/s for the dirty portion of sample (d) after light brushing to remove the soil adhering to the sample so as to retain only those particles that had actually lodged between the filaments; and 1.75 mm/s for sample (d) after thorough washing. It therefore appears that the change in permeability was negligible for sample (b), taken from the downstream drain, and was of approximately an order of magnitude for sample (d), taken from the upstream slope protection. Sample (d), however, was still much more permeable than the adjacent silty sand.

Additional samples were taken in 1992 at locations (b) and (d) where samples had been taken in 1976 [Delmas et al., 1992]. Tests conducted on the 1992 samples did not show any measurable change in tensile characteristics and permeability between 1976 and 1992.

Microstructural tests on filaments from samples taken from Valcros Dam in 1976 have been published by Leclercq and Sotton [1981, 1982, 1984], and more testing is in progress on samples taken in 1992.

The performance of the dam and the extensive testing of geotextile samples taken from the dam by several independent teams clearly demonstrate the viability of geotextile filters in dams and other applications.

**CONCLUSIONS**

The extensive investigation of the performance of the geotextiles used in Valcros Dam leads to the following conclusions:

1. Simplistic filter criteria may lead to severe problems with soils having a large coefficient of uniformity.

2. A geotextile filter may exhibit a decrease in permeability due to soil particle intrusion if it is not maintained in contact with the soil by a uniform pressure.

3. Exposure to sunlight rapidly deteriorates a geotextile, even one made from polyester.

4. A geotextile made with an adequate polymer may be buried in the ground for decades without significant deterioration.

5. A properly selected and installed geotextile may function as a filter for decades.

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