

Fusegates mitigate silting at Beni Amrane reservoir, Algeria

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The effects of siltation in an Algerian water supply reservoir have been mitigated by the installation of fusegates, to provide extra storage capacity. This solution proved more economic than dredging the silt. The project was completed on schedule, despite challenges such as difficult access to the spillway, and the high elevation of the site.

Most of the dams located in the Maghreb area of Africa are located in the Atlas mountains, a young mountain range which covers a large part of the region. This area has an arid to semi-arid climate with heavy rains, of short duration. A combination of the above factors leads to a high level of erosion.

The silting that results from the erosion decreases the storage capacity of the reservoirs in the area, despite the catchment's development (reforestation, embankments, construction of decanting dams, and so on). Thus, each year, Algerian reservoirs typically lose 2 to 3 per cent of their storage capacity as a result of siltation.

Possible solutions for restoring dam capacity lost to silting

The first set of solutions is dredging. This involves breaking up sucking dredges, as the silt is discharged directly into the river, downstream. Dry dredging is usually done with draglines or mechanical diggers, and the silt is stored in a free, open area.

A second set of solutions consists of raising the full supply level (FSL) of the reservoir, either by heightening the dam itself, or by using gates. Raising the FSL of the reservoir can be achieved through implementation of the non-mechanical fusegate system. The fusegates are installed side-by-side on the existing spillway to increase the FSL.

Application of the fusegate system at Beni Amrane dam

Located 50 km east of Algiers, near the town of Thenia, the 39.5 m-high Beni Amrane dam provides drinking water for the capital. Commissioned in 1988, this gravity dam quickly began to suffer from a significant level of silting, which reduced its storage capacity from $11.6 \times 10^6 \text{ m}^3$ to $5 \times 10^6 \text{ m}^3$ at the beginning



The fusegates at Beni Amrane.

of 2003. The average annual quantity of silt carried along by the Isser Wadi is estimated to be $6.7 \times 10^6 \text{ m}^3$, which corresponds to 1.6 per cent of the total inflow.

The dam was successfully heightened by installing seven straight-crested fusegates on the free spillway sill, each measuring 3.75 m high by 14.6 m wide. Made from reinforced concrete, each fusegate weighs 510 tonnes. That type of fusegate can discharge a very high head of water above its crest and is similar to the fusegates that equip the Wanakbori dam in India and the Lyell dam in Australia.

The fusegates provide an additional $7.1 \times 10^6 \text{ m}^3$ of storage capacity without raising the maximum water level calculated for a $10\,000 \text{ m}^3/\text{s}$ flood. The crest elevation of the spillway has been raised from el. 63.5 to el. 67. The extra storage capacity improves the water quality by extending the sedimentation time.

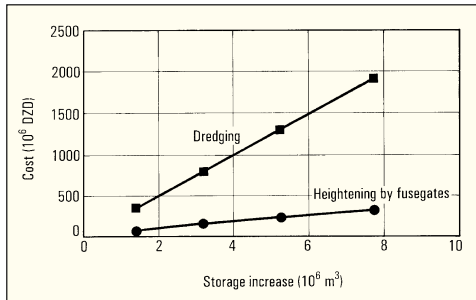
Difficult access to the spillway, along with its height, made this project quite technically challenging. The steel inlet wells, which were too heavy to be installed directly on top of the concrete shafts by crane, had to be produced in several parts and bolted onto the dam on site.

Concurrently, the National Dam Agency established strict project planning, so as to be able to store as much of the spring runoff as possible. The ambitious schedule was followed faithfully, thanks to 24 hour/day operation teams, and the project was completed within 16 weeks, without any cost overruns.

Fortunately, the major earthquake of 21 May 2003, did not claim any casualties at the dam site. The Hydroplus installation held up satisfactorily under the



The Beni Amrane uprating project under construction.



Comparison of the costs of dredging with the installation of fusegates at Beni Amrane, for an equivalent gain in the storage capacity of the reservoir.

earthquake loading (which produced a magnitude of 6.1 on the Richter scale) and no damage was incurred by the fusegates.

Cost-effectiveness of the fusegates

Before awarding the contract, the National Dam Agency evaluated various options, including dredging and conventional gates. As shown in the Figure above, it appeared that the fusegates constituted the best economical solution.

In addition, fusegates offer inherent, competitive advantages including self-operation, low maintenance and reliability of operation. Moreover, the fusegate solution was attractive because it has a limited impact on the local environment, and the right-of-way zone of the dam and its reservoir have remained intact (that

means, the MWL was not modified). Finally, compared with a dredging operation which would have to be spread over a long period of time, fusegates are quickly installed on the spillway.

Conclusion

Fusegate technology presents an attractive alternative to owners and consultants who wish to recover the lost storage capacity of their reservoirs quickly, and therefore increase the lifespan of their existing dams. The simplicity of the concept guarantees reliability, and the corresponding investment cost is minimal.

The Beni Amrane dam project in Algeria underlines the success of the fusegates, which have a wide range of uses, in all countries where the silting up of existing reservoirs is a recurrent problem. Other North African countries are currently considering adopting the same type of solution. ◇

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