Performance of Sylvenstein Dam During Major Flood

TS2: Flood management at existing dams

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Sylvenstein Dam During Major Flood

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The Sylvenstein Dam, Bavaria, Germany
The Sylvenstein Dam, Bavaria, Germany
Rational to construct the dam

Main reasons

- **Flood protection** by controlling several major flood discharges into lower lying regions of the Isar River
- **Low flow augmentation** of the Isar River keeping a minimum water level for the industry along the Isar River

Added reasons

- **Hydro energy and tourism**
The Sylvenstein Dam, Bavaria, Germany

The Dam

The Dam from U/S during installation of the cut-off wall
The Sylvenstein Dam, Bavaria, Germany

Data of the Dam

Crest length: 180 m

Height a. found. level: 44 m

Max. impounding level: 767 m a.s.l.

Regular storage capacity: 750 Mio. m³
The Sylvenstein Dam, Bavaria, Germany
Construction of the Dam 1954 to 1959
The Sylvenstein Dam, Bavaria, Germany
Section along the dam axis

180 m

44 m

approx. 100 m
The Sylvenstein Dam, Bavaria, Germany
Section across the dam

Max. storage level 767 m MSL
Mean storage level 752 m MSL
Deepest drawdown level 736.40 m MSL

Drainage piles
Seepage tunnel
Plastic concrete cut-off wall
multi-row Grout curtain
The New Concrete Cut-off wall (COW)
Technical feasibility

Main characteristics specified for the Cut-off wall concrete
- Low permeability / High plasticity / High durability
- Good and long workability
- Short setting time for efficient sequencing

Wall and Joints
- Continuous wall
- Minimum thickness

Good connection to bedrock all along the COW and to the concrete buttress
The Sylvenstein Dam, Bavaria, Germany
Finite Element Method to model the dam

- Compressive strength
  Plastic concrete COW
  $q_u: > 1300 \text{ kN/m}^2$ (28d)

- Elasticity module $E$:
  $< 450 \text{ MN/m}^2$

- Bending tensile strength
  $b_z: 400 – 500 \text{ kN/m}^2$
To achieve the planned permeability of $k_f < 10^{-9} \text{ m/s}$, a diaphragm wall of 1 m ensuring the designed continuity of the sealing system.

A depth of 70 m assuring the stability to suffusion and considering the soil analysis from a soil-investigation-campaign in 2011.
The New Concrete Cut-off wall (COW) Construction
The New Concrete Cut-off wall (COW) Construction

180 m

30 m in Alluvium - Cutter
40 m in the Dam - Grab

Connection to the steep bedrock flanks

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The New Concrete Cut-off wall (COW) Construction

Embedment in to rock
30 cm at each interface COW – rock

Dolomit
Uniaxial compressive strength
21 - 96 MPa
(average 60 MPa)
How to define rock embedment?

Desander cuttings without rock

Rock-embedment achieved
Work in progress …
Towards the end of May 2013, extensive heavy precipitation took place, resulting in massive flood discharges and large scale flooding in Bavaria.

Especially from May 30th to June 3rd, the water levels reached record heights with catastrophic impacts.
Flood situation in Bavaria in June 2013
Operating the Sylvenstein Reservoir

The Sylvenstein Dam performed satisfactorily.
Three large flood peaks hit the Sylvenstein Dam during the flood.

The first peak arrived at the reservoir in the morning of June 1st with about 300 m³/sec.

The following day, the second peak reached the dam with approx. 550 m³/sec.
After a very short subsiding phase of approx. ½ day, the highest peak arrived with approx. 675 m³/sec; (almost HQ-20).

On June 3rd, 99.7 % of the controllable water retention space of the Sylvenstein Dam was filled.
Flood situation in Bavaria in June 2013
Operating the Sylvenstein Reservoir

The Faller Gorge Bridge
June 2013 shortly after filling the reservoir

... and in June 2014 with approx. mean reservoir level

approx. 6 m
The manageable flood control storage space of the Sylvenstein reservoir reached on August 3rd, 2013 a level of 99.7% impoundment volume.

The detention storage reached 61 Mio. m³ and was almost completely used. The maximum inflow into the reservoir was at 675 m³/sec at the same time the maximum permissible outflow was only 60 m³/sec.

With the reservoir management and limited release of water, it was achieved to keep the burden on the downstream abstractors in the region towards Munich-Freising-Landshut and the Danube towards Passau to a minimum.
Sylvenstein Dam – Flood June 2013

Conclusion

- “The present retrofitting of the Sylvenstein Dam, has reached an essential milestone with the COW installation in 2012 (by BAUER Spezialtiefbau GmbH”).
- “Due to the achieved definite permeability of the dam and therefore, achieved stability against piping, it was possible to increase the amount of water retained to a new record height and to reduce the outflow considerably to spare the downstream abstractors”.
- “The relatively long time during which the water can be retained is striking. The flood can be considered as the first real endurance test for the new cut-off wall”.

Source/Quote: Dr. Tobias Lang (Water Board Weilheim; Bavaria)
Appreciation to all participants

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