Flood Modeller Pro

Case Study

Breach analysis of Cobbinshaw reservoir, Scotland (UK)

British Waterways Scotland (now trading as Scottish Canals) requested that a breach analysis of Cobbinshaw Reservoir (Scotland) should be carried out to reassess the dam category.

Our software was selected as the most appropriate tool because of its unique functionality, particularly the Flood Modeller 2D TVD solver. This was due to the extremely transient nature of the flows resulting from the breach. The key objectives of the analysis were to:

- Review and update the hydrology to determine the reservoir levels for the breach hydrograph.
- Determine a breach hydrograph.
- Develop and run a two-dimensional breach model.
- Undertake a risk assessment to estimate damages and likely loss of life in the event of a breach.

Hydrology and reservoir routing

In order to determine the appropriate reservoir levels, both the Probable Maximum Flood (PMF) and 1 in 10,000 year flood were modelled. The PMF was modelled using Flood Estimation Handbook (FEH) rainfall statistics and FEH catchment descriptors. The 1 in 10,000 year flood was modelled using FSR rainfall statistics and FEH catchment descriptors.

The flood hydrographs for each scenario were modelled using our 1D solver (using the FEH boundary for the PMF and the FSSR16 boundary for the 1 in 10,000 year event).

In accordance with FEH guidance, a direct rainfall boundary was used to simulate rainfall landing directly onto the surface of the reservoir, as this represented approximately 15% of the total catchment area.

Flood Modeller Pro can be used for a range of applications, including:

- 1D and 2D floodplain modelling
- Floodplain mapping
- Flood forecasting
- Hydrological analysis
- Embankment/levee failure
- Dam breach analysis
- Detailed design
- Structure blockage

Cobbinshaw reservoir, Scotland

Contact us

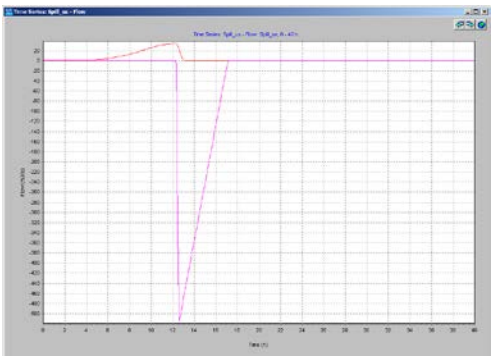
Sales: +44 (0)845 094 7990
Support: +44 (0)845 094 7994
www.floodmodeller.com

JACOBS

With a legacy stretching back 40 years, Flood Modeller allows users to model rivers, floodplains and urban areas, using our powerful 1D and 2D solvers.

"The final breach hydrograph was combined with the PMF outflow over the spillway to form the inflow boundary into the 2D inundation model. The inverse inflow breach hydrograph (i.e. outflow from the reservoir routing model) and spillway flow are represented below."

Andrew Ross, Principal Asset Engineer
(Scottish Canals)



Final baseline reservoir outflows (inundation model inflows)

Our 1D solver was also used to represent the reservoir system, and to simulate the reservoir routing. Cobbinshaw reservoir was represented as two discrete reservoir units to represent the hydraulic boundary presented by a causeway running across the western end of the reservoir.

Dam break analysis

The calculation of the dam break hydrograph followed the guidance set out in the Interim Guide to Quantitative Risk Assessment for UK Reservoirs (Kellogg, Brown and Root, 2004). This derives a triangular breach hydrograph using Froelich's equation, which uses the physical properties of "Height" (Peak water level above base of dam) and "volume" (at maximum water level).

The final breach hydrograph was combined with the PMF outflow over the spillway to form the inflow boundary into the 2D inundation model. The inverse inflow breach hydrograph (i.e. outflow from the reservoir routing model) and spillway flow are represented below.

Two-dimensional modelling

The inundation modelling was undertaken using the Flood Modeller 2D solvers. An initial model run was undertaken using the 2D FAST solver, which provided a useful indicative flood map to support and inform the site visit. The final 2D model runs were undertaken using the 2D Total Variation Diminishing (TVD) numerical solver, with a time step of 0.025 seconds, due to the extremely transient nature of the flows resulting from the breach.

Ground surface elevations were represented using Light Detection and Ranging (LiDAR) data averaged across discrete 8m by 8m grid cell squares, which was sufficiently accurate to represent the topographic features that control the pattern of inundation. The model simulation computed time series outputs of flow at a series of user specified locations along the valley. Gridded outputs of maximum flow, water level, depth, velocity and hazard were produced to cover the entire 2D model domain.

Direct damage and risk to life calculations

Direct damages and risk to life calculations were facilitated by the availability of the Scottish National Property Dataset. Calculations were made using standard methods described in the Multi Coloured Manual (2004) and by Defra (2006 and 2008). Calculations were implemented using the damage calculator tool, provided as part of our software at no extra cost.

The calculation of likely loss of life follows the approach recommended by Defra, 2008. Gridded results of Time of Inundation and Flood Hazard Rating (which combines velocity and flood depth) were used to calculate a value for the number of people likely to lose their life at each property point within the Scottish National Property Dataset.

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