

## Spillway and Outlet Gates – Design and analysis

### Identify the need

Dams are critical infrastructure that provides significant benefits to communities including water supply, flood mitigation, power generation or irrigation. Dams are often equipped with gates to provide control of spillway flows or outlet releases. These structures may require upgrades or remedial works because of a need for increased storage or as a result of deterioration due to ageing, changes in design standards or inadequate original design. The need for these works can be identified in a number of ways including:

- Routine surveillance
- Safety evaluation of dams and appurtenant structures
- Failure of an element of the gate structure
- Evaluation of original design and construction against modern design and construction practices
- Portfolio or detailed risk assessment process
- Revised yield or demand assessment
- Changed operational requirements

### Respond to the need

GHD has experienced dams engineering professionals who are able to respond to any need identified, whether it is in an emergency situation, part of an improvement works or development of new infrastructure.

The type or service provided would depend on the need identified and the level of involvement required by the client.

### Service offering

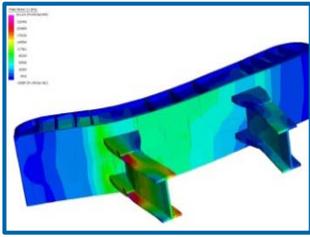
GHD offers the whole range of services relating to spillway and outlet gate engineering, including:

- Safety or maintenance inspections
- Operational and preparedness testing
- Options studies and concept design for new or remedial works and upgrades
- Detail design and tender documentation
- Hydraulic design and modeling
- Structural analysis, including Finite Element Analysis (FEA)
- Manufacturing and construction phase support
- Preparation of Operation & Maintenance Manuals

### Experience

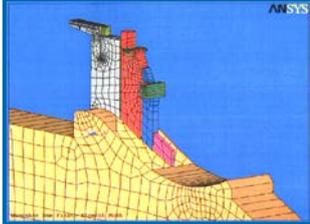
GHD has been working on dams since the company's birth almost 90 years ago. Today we have a large dedicated dams team globally and the largest such team in Australia.

We work closely with clients in responding to their needs in relation to spillways and outlet works. We have been involved in providing solutions to a number of challenging requirements on various projects. A selection of these projects is described below.



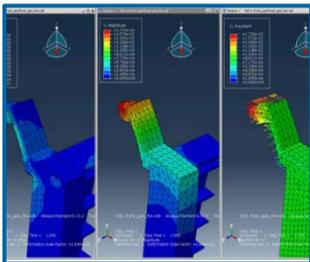
### Cairn Curran Dam, Victoria – FEA of spillway radial gate trunnions

The consulting services comprised a finite element analysis (FEA) to determine the performance of the trunnion beam under current and future loads, and to design the upgrade works to withstand future loads, if required. The analysis identified the need to strengthen a number of areas of the trunnion beam. The advantage of utilising a FE method was that specific areas requiring modification could be identified. This allowed construction costs to be minimized by only localized strengthening of the identified areas.



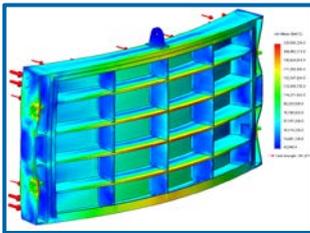
### Wivenhoe Dam, Queensland – Seismic analysis of radial gates, piers and bridge

GHD was engaged to analyse the spillway radial gates, supporting piers, bridge structure and gate winches to determine their suitability to resist stresses induced by seismic loading. Two load cases were considered, the Operating Basis Earthquake and the Maximum Design Earthquake. The analysis utilised a combination of FEA and frame analysis methods to reduce the model sizes and time required for the study.



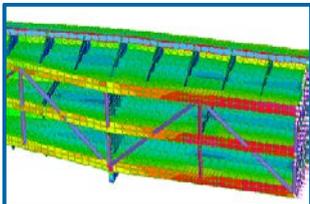
### Project – Subject to Confidentiality.

The project involved a combination of hydraulic modelling using Computational Fluid Dynamics (CFD), 3D solid modelling and FEA to determine the loads on the gate during flood conditions, and to analyse the gate elements when exposed to these loadings. The gates and spillway were modelled using Solidworks. The model was used for the CFD analysis. A number of flood levels were modelled in CFD and the maximum expected load on the gates was determined. The loads were then used in a FEA to identify the highly stressed areas. The complexity of the arrangement precluded the use of conventional analysis methods.



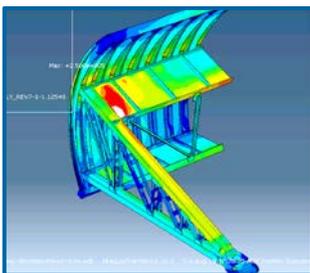
### Enlarged Cotter Dam, ACT – Design of diversion control gate

The diversion works used during construction of the Enlarged Cotter Dam required the installation of a fixed wheel slide gate. The original design was done using conventional calculations that are well developed for this type of gate. Changed conditions during construction required the gate to be strengthened for higher load conditions. Due to the complexity of the modifications investigated, FE methods were used to analyse the resulting structure.



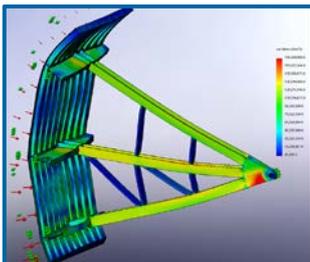
### Warragamba Dam, NSW – Structural assessment of radial gate stoplogs

The stoplogs for the Warragamba Dam radial gates were designed and manufactured in 1965. They are used yearly for planned maintenance of the radial gates. GHD was commissioned to perform a condition assessment and structural analysis of the stoplogs in line with modern design requirements. The structural analysis was done using the FE software Strand7 to investigate how the condition of the structure impacted its strength.



### Somerset Dam, Queensland – Capacity analysis of radial and sluice gates

As part of a larger study to investigate the effects on the dam due to higher flood levels, including overtopping of the dam, the spillway radial gates and bottom outlet sluice gates were analysed for the higher heads. The sluice gates were analysed for an opening cycle as well as when closed against the higher heads. The radial gates were checked when closed until failure level, as well as in the open position with water load due to the higher flood levels. Loading on the gates was determined using CFD software Star CCM+. The FEA was done using the FE software ABACUS.



### Wivenhoe Dam, Queensland, Australia – Capacity analysis of radial gates

The Wivenhoe spillway radial gates were analysed to determine how much they could be raised without structural reinforcement. This was done as part of a larger study done for Seqwater to investigate raising options for increasing the flood mitigation potential of the dam. The radial gates were modelled and analysed using the software Solidworks.

To contact our dams service line professionals, visit:  
[www.ghd.com/dams](http://www.ghd.com/dams)

