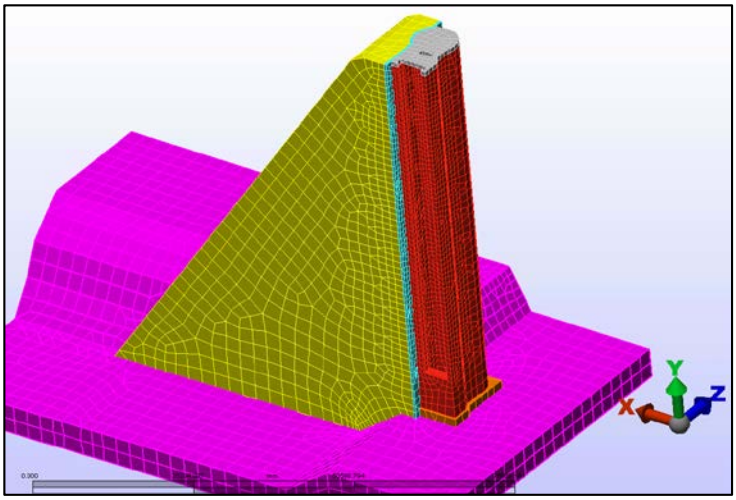
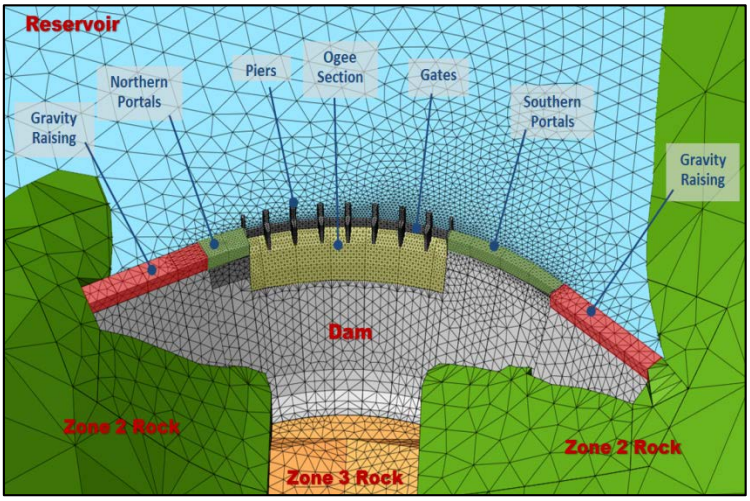
GHD Experience





Dam structural analysis and modelling

Design & Construction

Identify the need

Dams are critical infrastructure which provide significant benefits to communities in many ways including providing water supply, flood mitigation, power generation or irrigation. The design of these structures and any subsequent upgrades or remedial works can require careful and complex structural analysis.

Respond to the need

GHD has experienced dams engineering professionals who are able to respond to any need identified, from the design of new structures to the assessment of existing infrastructure. GHD offers the following services in support of dam structural analysis and modelling:

- Structural analysis of concrete dams, spillways, intake towers, outlet works, gates, valves, etc.
- The dams include concrete gravity dams, concrete arch dams (single and double curvature), concrete buttress and multiple arch dams
- Seismic and dynamic response analysis (natural frequency, harmonic response, spectral response, time history analysis)
- Thermal analysis for concrete placement for new dams and upgrade works
- Analyses can be undertaken using various software packages as appropriate for the work undertaken and client's requirements including Abaqus, DIANA, Algor, Ansys, Strand7.

Experience

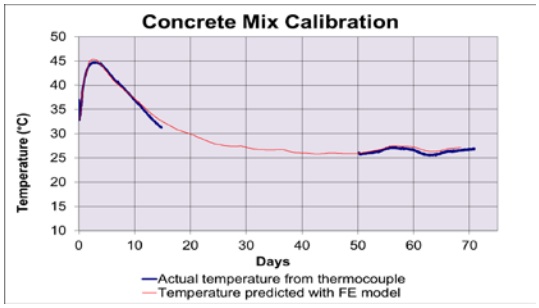
Today we have a large dedicated dams team globally and the largest such team in Australia. GHD has worked closely with clients to respond to their needs for structural analysis of new and existing dams. We have been involved in providing solutions to a number of challenging requirements on various projects. Examples of dam upgrade or remedial works projects are described below.

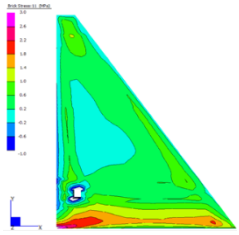
Benefits

With a dams team exceeding 100 technical staff throughout Australia, GHD has been involved in dams for almost 90 years ago. We have developed national and international recognized specialist skills in concrete dams, covering investigations, analysis, design, construction and safety for numerous arch, multiple arch and gravity dams.

Case study

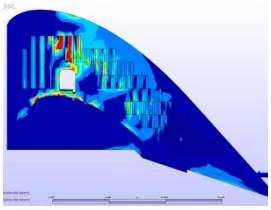
Prior to undertaking the thermal analysis for Cotter Dam, a Finite Element (FE) model was calibrated to simulate the adiabatic temperature rise and cooling of the concrete. This was achieved by measuring the temperatures in a recent concrete pour using thermocouples. The heat generator function and boundary conditions for heat loss/gain were calibrated in the FE model, so that the predicted temperature changes in the concrete matched those measured by the thermocouples, as shown in the chart below.





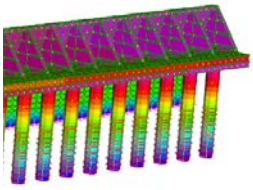
Enlarged Cotter Dam – RCC Gravity – Australian Capital Territory, Australia

The Enlarged Cotter Dam Project incorporates the new main dam, an approximately 80 m high Roller Compacted Concrete (RCC) gravity dam. GHD was engaged in 2008 to design the dam as part of the Bulk Water Alliance. The dam design involved a significant amount of finite element analysis of the dam and surrounding structures including 2D and 3D thermal analysis using multiple software packages, 3D response spectrum analysis of dam and intake tower, 3D structural analysis of dam structure, and 2D time history analysis of dam structure.



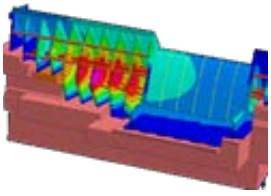
Awoonga Dam Spillway – Queensland, Australia

GHD was engaged by Gladstone Area Water Board to undertake a stability analysis for the concrete ogee crest spillway for structure for Awoonga Dam in 2014. The stability assessment for the spillway structure included 3D finite element analysis of the spillway structure including modelling of shear keys, friction between monolith blocks, previous spillway raises and foundation conditions.



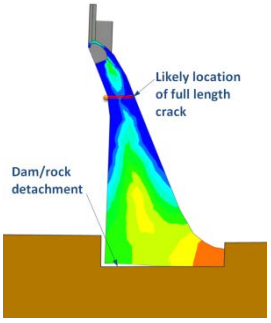
Aplins Weir Upgrade – Queensland, Australia

Prior to upgrade, the Aplins Weir on the Ross River in Townsville was vulnerable to downstream erosion. Failures had occurred on a number of occasions since construction in the 1920s, including the total loss of one abutment. GHD was engaged to perform the design of upgrade works which comprised retrofitting of a row of 1200 mm diameter concrete filled steel tubular piles through the existing base slab, coupled with the installation of a heavily reinforced overlay slab. 3D Strand7 modelling for detailed design, construction sequencing investigations, flood and earthquake response was undertaken.



Junction Dam – Slab and Buttress (Ambursen) – Victoria, Australia

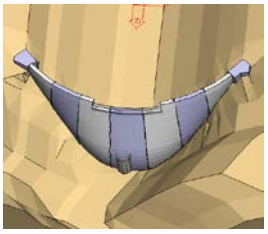
GHD was engaged to perform a safety review on Junction Dam, a reinforced concrete slab and buttress type dam part of the Kiewa Hydro Electric Scheme. The dam wall comprises 19 buttresses spaced at 6.1 m along its 116 m crest and incorporates a 36.6 m wide spillway near the left abutment. Its maximum height is 26 m. The structural assessment included a seismic linear elastic response spectrum analysis for the Operating Base Earthquake (OBE) and Maximum Design Earthquake (MDE) incorporating the subgrade reaction at the base of the dam.



Mt Bold Dam – Arch Gravity with Gravity Abutments – South Australia, Australia

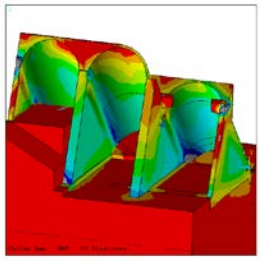
GHD was commissioned to undertake a comprehensive safety review of Mt Bold Dam. Part of this included a 3D nonlinear time-history analysis to capture the nonlinear behavior of an arch-gravity dam and to assess the behavior of the unique modifications which have been made since its original construction.

The structural assessment used the finite element program DIANA to model the dam wall and foundations. Varying types of interface elements explicitly modelled the 18 contraction joints between the monoliths, the dam-foundation contact, and the contact between the original dam and the dam raising which generally were allowed to open, close and slide thereby redistributing the demand and presenting the behavior of the dam more accurately. The dam wall was assessed in terms of stress and stability and the reinforced concrete elements of the raising were explicitly assessed for bending, shear and axial tension/compression.



Sturt River Dam – Double Curvature Arch – South Australia, Australia

As part of a staged Safety Review, GHD was engaged to undertake a 3D finite element response spectrum seismic analysis of Sturt River Dam. The dam wall is a 40 m high double curvature arch dam consisting of 7 monoliths and 2 thrust blocks on either side. The dam was modelled using the program Strand7, and included modelling of the construction staging in order to more accurately determine the stresses in the dam. Normal, flood and earthquake cases were investigated to establish any areas of overstressing or instability of the monoliths.



Julius Dam – Multiple Barrel Arch – Queensland, Australia

As part of the comprehensive safety review, GHD was employed to undertake a 3D nonlinear finite element structural analysis of Julius Dam. The structure is a multiple inclined barrel arch dam, with arch barrels resting on buttresses. The spillway is a central overflow structure of 219.5 m width and is located over the central section of the arches.

The structure was modelled with the finite element program ANSYS and included highly nonlinear contact elements to model the slip joint interaction between the adjacent arc segments within the barrel section. Assessment of the structure determined that remedial works were required.

To contact our dams service line professionals, visit www.ghd.com/dams