WATER & WASTEWATER

BHR Group
EXPERTS IN FLUID ENGINEERING

Hydraulic design validation methods:
OUR EXPERT OPINION

Many existing infrastructure networks cannot keep up with modern-day demands for water and sanitation. The provision of major new civil infrastructure projects to deliver increased capacity and sustainable networks is therefore a key priority. In delivering these projects to time, cost and quality, whilst undertaking active risk-mitigation, project managers need to make informed decisions about project design early in the process.

Ian Hart, Head of Water & Wastewater considers the key elements in determining the best project-specific approach for clients' needs.

Helping you find the right approach for your project

The hydraulic design of channels, structures and reservoirs is critical to the success of infrastructure projects in water and fluid related environments. Poor design leads to inefficiencies, through unpredicted turbulence, restricted throughputs, pumping inefficiencies, and erosion. All of these factors can have significant adverse effects on both capital and operating expenditure.

Whether the project involves designing smart water networks, building flood control/water management structures, or installing water, drainage and sewer systems, you need confidence that the fluid dynamics will work within your structure. The best way to do this is to test the design thoroughly before you start on site.

Identifying the best technique to support your project goals is the first step. Subject to your requirements, a physical or a CFD (computational fluid dynamics) model should give you the answers you're looking for. Both techniques will yield results showing what the fluid is doing at the locations of interest. There are pros and cons to both methods and the choice between CFD, physical modelling or both, comes down to the specifics of the job at hand. CFD modelling is almost always quicker to execute than physical modelling and has advantages over physical modelling for complicated or repetitive geometries. CFD modelling is generally cheaper and CFD models are almost always built to full size.

However, there are some applications where physical modelling is the obvious choice to deliver reliable engineering design validation.

Pump intake design, vortex strength and temporal variation for example, are all more accurately modelled physically.

Physical modelling has the advantage when it comes to time-dependent phenomena, such as particle drop-out or re-entrainment as system flow rate ramps up, compared to steady-state CFD modelling. However, regardless of your preference, it's important to remember that if a technique is named in the standard (such as ANSI for example), then any choice has been removed.

Setting a clear brief

Being clear on your requirements as early as possible will help you make the right choice. What exactly is it that you need to know about your proposed structure? What will inform your design choices? Both physical and CFD modelling demonstrate fluid mechanics in a structure. Those structures may contain many small features – what impact might these have on the flow dynamics?

Don't forget that standards vary within industries and geographical location, and there isn't always a "one size fits all" solution. If in doubt, ask.

BHR Group engineers have many years' experience in modelling and will happily review your requirements and advise on the best modelling scenario.

Is time critical?

Both CFD and physical models have a lead time in which the model is constructed. CFD model construction is often (but not always) quicker, and yields results faster. Notably, results for multiple scenarios are often achievable in a shorter time span with a CFD model. However, physical models provide an additional trust factor – the models are visible and you can observe your model in action. It is also relatively easy to test alternatives. A skilled physical modeller will be able to add or change features while a physical model is operating, to quickly test alternatives. It also remains the case that some physical phenomena still cannot be accurately predicted using CFD.

How many times might you need to ask a question?

Both CFD and Physical models may be run again and again. Once a CFD simulation has been run, data is available to interrogate any point within it.

A physical model may need to be re-instrumented/ calibrated and re-run to provide a result for a different location, but once it is built, a scale physical model can be run under different flow conditions or modified as required for as many runs as are needed to validate the design.

Joined-up thinking

Hydraulic design validation definitely doesn't have to be one option or the other. Numerical and computational modelling used in conjunction with physical scale models provides an effective and validated analysis of the performance of a system, design or adaptation. At BHR, we typically use CFD and physical modelling together to provide complimentary data from which we can iterate our testing process and inform design decisions.

OUR EXPERTISE

Our team has played a key role in delivering some of the largest and most complex civil infrastructure projects, including:

- Tunnels
- Flood control and water management
- Water & wastewater treatment plant
- Water supply / wastewater handling
- Water, drainage & sewer
- Dams, water / runoff storage reservoirs
- Sustainable drainage systems

How to decide?

Stakeholders need confidence that the prototype design will meet all criteria prior to construction. Modelling of systems provides a verification tool across broad ranges of operation and demand, to provide confidence that the "as built" system will deliver the expected performance. The only limitations are physics and budget.

It seems obvious, but the best technique to use is the one that will tell you the results you need. The hard part is deciding which technique is best for your specific project. That's where BHR engineers can help.

If in doubt, ask the experts!

Problems in design, validation and optimisation can result in lengthy and costly project delays. The importance of engineers experienced in fluid engineering, hydrodynamics and computational simulation on the profitability and safety of civil infrastructure projects involving fluid transport cannot be overstated.

Whatever your hydraulic engineering project, BHR's experts have the specialist knowledge and cutting-edge technology to help you make the right choices.

We understand its a hard decision to make. To help you better understand your options, we'd be more than happy to come to your premises and give your team a free seminar. Call us to find out more and reserve a date.