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Teaching & Research Flumes



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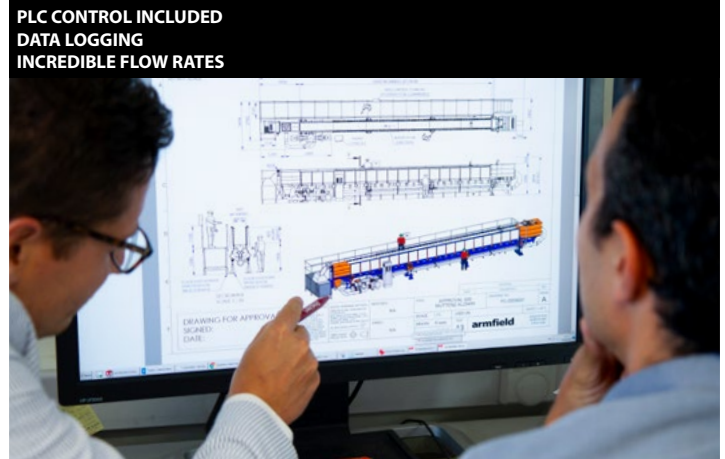
Standard teaching and research flumes – S60/80/100

Armfield has been designing and supplying open channel facilities (also referred to as flumes) to hydraulic laboratories throughout the world for over 50 years.

This brochure presents the standard range of channels/flumes available from Armfield, both for teaching and research purposes. We however can produce other sizes and layouts to suit specific design criteria.

The Armfield engineering team will work with our customers to make sure the brief, deadline and installation design needs are fully met.

All our flumes are supplied under the guidance of the Armfield professional service team who will oversee the transportation, installation, commissioning and training on site.



**PLC CONTROL INCLUDED
DATA LOGGING
INCREDIBLE FLOW RATES**



RESEARCH FLUME WITH FLOOD GATE OPTION

Options, models and instruments available

- ▶ Control and acquisition for flow, velocity, level etc.
- ▶ Sediment transport / feeding / weighing / extraction
- ▶ Random and mono wave generation systems
- ▶ Walkways, gantries and jacking systems
- ▶ Bespoke pumping solutions from single to multiple pumps with flow rates ranging from 1-1000 l/sec
- ▶ Weir types including: Venetian weir; base hinge; stop log; gate & sluice
- ▶ Integrated touchscreen PLC control and logging systems
- ▶ Optional glass base sections for full particle image velocimetry (PIV) analysis
- ▶ Standard lengths from 5m - 50m
- ▶ Models & instrumentation
- ▶ Tilting up to 30 meters
- ▶ Static bed up to 50 meters
- ▶ Free discharge or recirculation configurations
- ▶ Fixed bed or variable slope
- ▶ Self-contained or laboratory supplied water

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Issue: 1
URL: <http://www.armfield.co.uk/flumes>

Applications
ME CE

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Features and benefits of Armfield research flumes

Armfield Ltd have over 50 years experience in the design and supply of major research flumes worldwide.

Representing innovative product evolution, Armfield's research flumes can be offered as static or tilting with either free discharge or recirculation modes.

- ▶ All our flumes are supplied under the guidance of the Armfield professional service team who will oversee the transportation, installation, commissioning and training on site as part of our scope of supply
- ▶ Single or multiple pump options to suit user requirements
- ▶ The flume is constructed in a modular format allowing extension in multiples of 2.5m at a later stage if required
- ▶ Standard lengths of up to 30m can be accommodated for tilting flumes. Tilting flumes greater than 30m are available on request. Static flumes are available at any length
- ▶ Armfield have extensive experience in design and delivery of large tilting flumes and understand the operational requirements upon the jacks and the pivot. Both the pedestals and the jacking mechanism are designed to ensure stability in all operating conditions

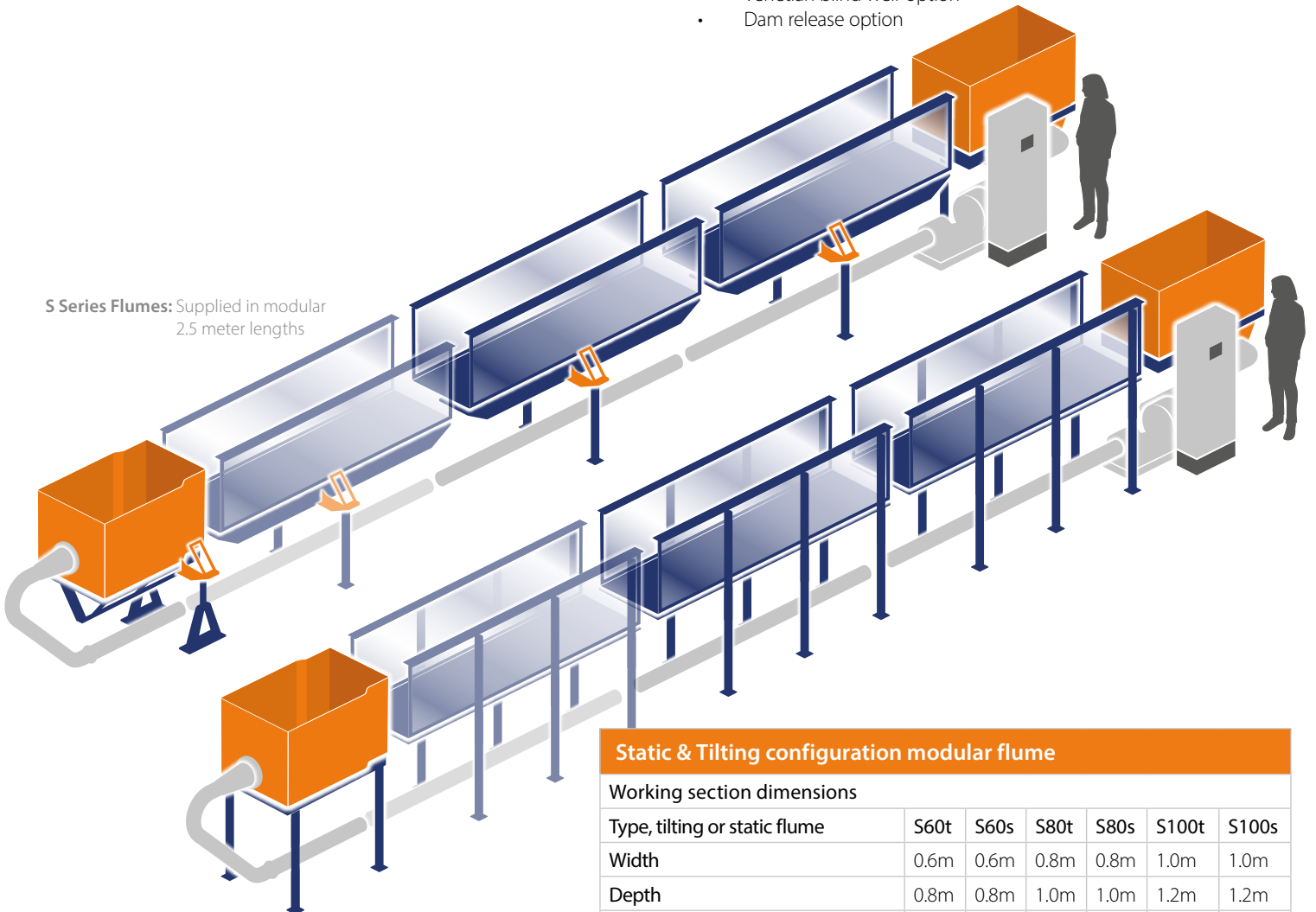
Standard Supply

- Inlet tank complete with inlet manifold
- Discharge tank
- Precision working section topped by load bearing instrument rails
- Control console
- Service system
- Software package

Options

- Recirculation
- Top-up pump for recirculation mode
- Sediment recirculation
- Jacking system
- Reservoir tanks
- Sediment weighing
- Sediment transfer
- Sediment feed
- Instrument carriage
- Powered instrument carriage
- Walkway
- Wavemaker
- Bed profiling
- Wind generation
- Base glass viewing window
- Undershot/overshot weir
- Venetian blind weir option
- Dam release option

S Series Flumes: Supplied in modular 2.5 meter lengths



Static & Tilting configuration modular flume

Working section dimensions

Type, tilting or static flume	S60t	S60s	S80t	S80s	S100t	S100s
Width	0.6m	0.6m	0.8m	0.8m	1.0m	1.0m
Depth	0.8m	0.8m	1.0m	1.0m	1.2m	1.2m
Length (in 2.5m modular increments)	5m - 30m	5m - 50m	5m - 30m	5m - 50m	5m - 30m	5m - 50m

Available in free discharge or recirculation. Bespoke lengths and widths can also be offered.

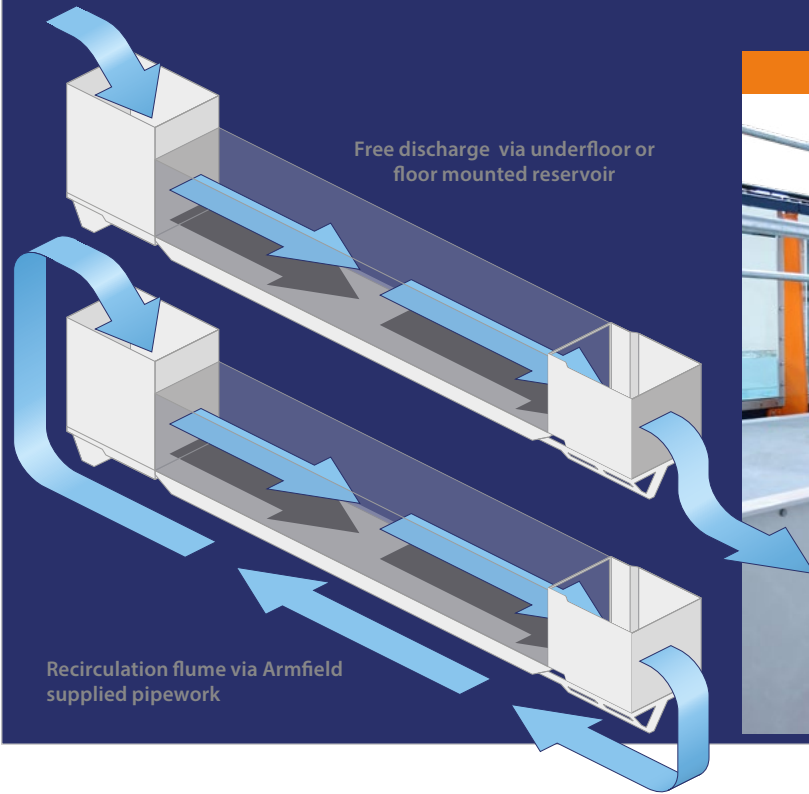
Note: length of tilting flume subject to tilt requirements

The length of a flume is dictated by many factors. Common amongst them are experimental requirements, space availability and cost.

Free discharge versus recirculation flumes

Traditionally hydraulic laboratories were constructed with underfloor sumps and/or elevated header tanks linked with a ring main rarely enjoyed by new facilities.

Armfield are able to supply flumes either in a non self-contained configuration, where they can be serviced from an existing header tank and discharge to a laboratory sump, or as fully self-contained system.



S80: Example of reservoir with walkway



3 Standard sizes available

The critical dimensions of a flume are the working length and cross-section (width and depth).

Working length also means usable length. Often the turbulent entry conditions require a substantial portion of what can be described as the 'working section' before suitable flow conditions prevail.

Armfield flumes are designed to maximise the working length. The overall dimensions of the flume are minimised through careful design of the inlet and outlet conditions and sensible use of the space underneath the flume and surrounding area.

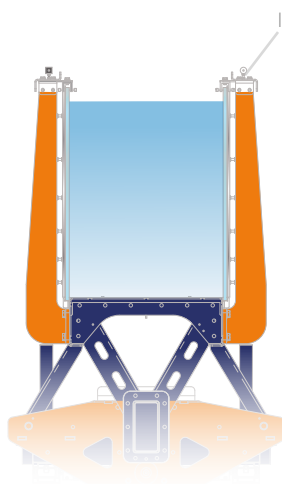
The key features of an open channel facility

The glass panels are sealed using a rubber "U" section compressed by an aluminium alloy clamping strip.

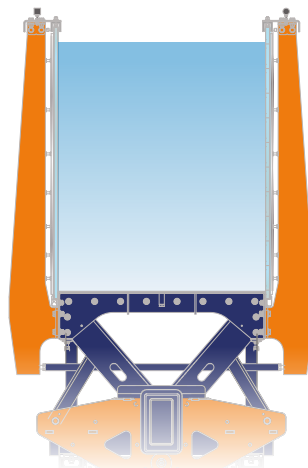
The flume bed is manufactured to high tolerances and the overall strength and rigidity of the design allows excellent stability figures to be achieved.

Instrument rails are provided along the entire working length of the flume and a continuous scale calibrated in millimetres is provided along the length of one of the rails.

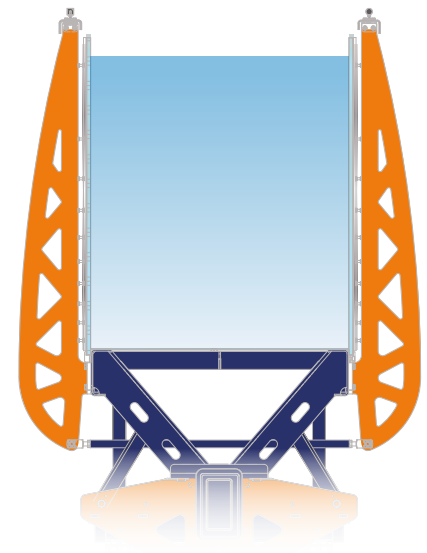
Adjustable screws allow the track to be set level and true.



S60: 60cm wide by 80cm high



S80: 80cm wide by 100cm high



S100: 100cm wide by 120 cm high

Tilting or static flume bed

Armfield can offer both static and fully automated tilting flumes. Both flume types are available in standard 2.5m lengths. Armfield can offer a range of options and enhancements to create a versatile piece of equipment for a broad range of experimental capabilities.

Static

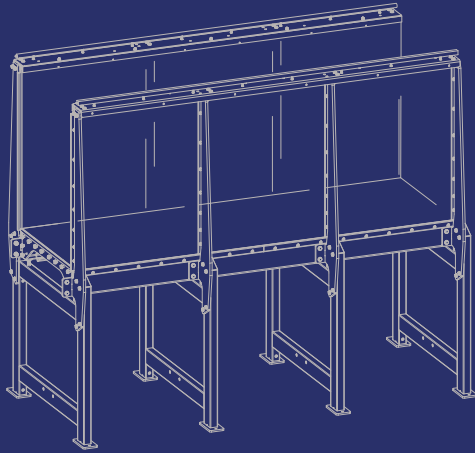
The static flume sections have an integrated supporting structure and can be supplied with a stainless steel or glass base panel. There are no restrictions on available lengths and can be extended at any stage.

Tilting

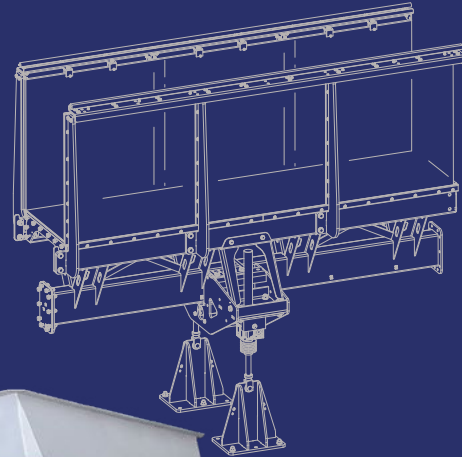
The standard tilting flumes can be supplied in lengths up to 30m and with both positive and negative tilt.** The tilting system is fully automated via the main PLC touch screen and enables users to set desired height or a height profile in conjunction with flow and test conditions.

**maximum and minimum tilt subject to overall length of flume

S series: Static flume configuration



S series: Tilting flume configuration
(maximum available tilt 5%)



S series: Tilting flume



S series: Static flume configuration

Accessories and model option list: Wave generation
Wind simulation

Wavemaking

Types: Single and multi paddle, piston or wind generated

Description: Wave generation and the effects of waves are significant areas of research.

Wave generator options can range from simple paddle systems, through to multi-paddle computer controlled wave generating systems. For many applications, particularly coastal models and flume studies, long crested and directional random waves are sufficient to model the sea state. For offshore studies and some shallow water problems multi-directional components are required.

Flumes may be used to study breakwaters, sea walls and beach behaviour or for fundamental research.

Whatever the application Armfield can supply a complete system designed to suit your particular requirements.

Wind simulation

Description: Integrated wind simulation systems can be provided offering mono or bi-direction wind

The wind generation system is integrated into the Armfield flume. Computer operated, it lets you set different wind profiles in conjunction with flow and wave generation as required.

Armfield can offer the addition of wind simulation with a variable speed fan system connected to a clear cowling running over the flume.

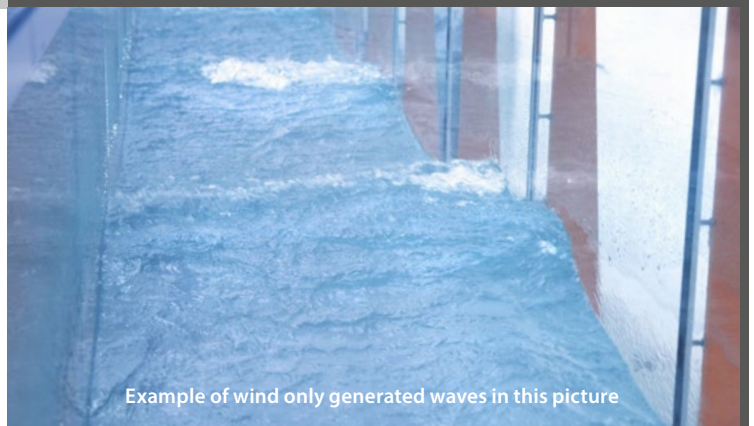
Variable wind simulation speeds up to and in excess of 25 metres per second are available.

- ▶ Wave makers available for all flumes including C4 Flume
- ▶ Computer controlled via our bespoke software
- ▶ Wind generated wave achievable

Computer controlled piston wavemaker option



Computer controlled wind generation option



Accessories and model option list: Sediment transfer
Sediment weighing

Sediment transfer

Types: Recirculation through dedicated transfer or through main pump system or deposit and collection via vibration feed and extraction point

Armfield can offer options for running sediment transfer experimentation within the flumes.

The flume is fitted with an expansion 'drop out' section which collects all mobile bed sediment and a baffle to encourage lighter suspended particles to be deposited and/or weighed.

Dedicated transfer – A separate solids handling pump is installed and connected to the drop out section. The pump can be used with sedimentation up to 10mm in size, which is then pumped to the start of the working section for redistribution. This system can be operated continuously.

Sediment transfer through the main circulation pump – This is particularly suitable for experimentation of fine suspended sediment. The pumps are lined and are designed to handle sedimentation up to 4mm in size. The suspended sediment is pumped through the main pipework. This system can be operated continuously.

Sediment collection and extraction – Where sediment needs to be collected and not automatically recirculated a series of valves are fitted to the drop out section enabling periodic extraction of deposited sediment.

- ▶ Recirculation or non recirculation options available

Sediment weighing

Description: Basket weighing system and sediment sampling

The need to gather data regarding the erosion and or deposition of sediment in relevant experiments always presents a challenge.

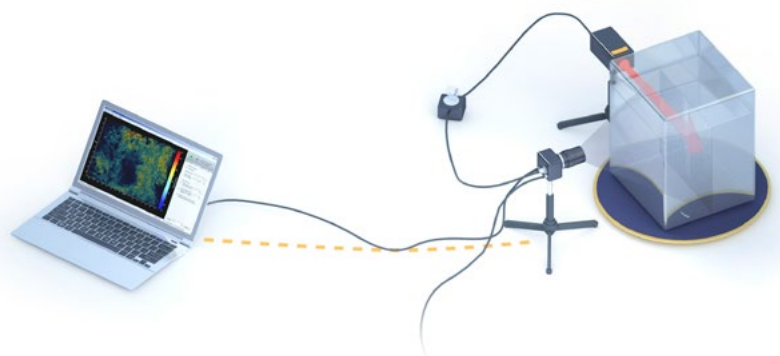
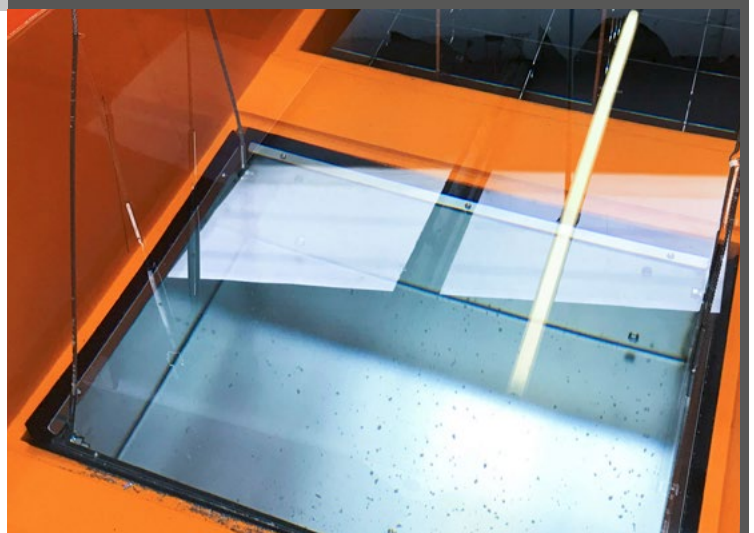
Armfield offer a weighing system that is efficient and easy to use. The system can be integrated into the software package and allows the logging of weight against time. A removable diverter plate assists to 'drop out' fast moving particulate.

- ▶ Sensor control
- ▶ Add PIV to illuminate and record particles in the flow, build up a picture of the changes in the sediment profile

Direct feed nozzle



Weighing basket



Accessories and model option list: PLC Control

PLC control system and tilting/incline control option

Types: Touch screen or analogue

The system will be supplied with a floor standing control panel. The cabinet houses the frequency inverters which control the tilt and pump motor speeds.

As standard, the Armfield flume is supplied with a PLC control system with HMI touch screen interface.

Automatic control

When the system is set in automatic mode the desired water depth, tilt/incline and flow rate can be selected. The system will then monitor the settings and using PID control data to maintain the desired output.

- ▶ In the main overview there is the function to start/stop the whole process
- ▶ The required flow rate can be set
- ▶ The required depth can be set
- ▶ The required tilt/incline can be set, not visible if option disabled. To disable set the max incline in the settings page to zero
- ▶ The required sediment feed can be set, not visible if option disabled. To disable set the max sediment in the settings page to zero
- ▶ An information window displays the system state
- ▶ The speed on the selected pump is displayed
- ▶ The selected pump number is displayed
- ▶ The pump valve position is displayed
- ▶ The weir position is displayed
- ▶ The flow rate is displayed
- ▶ The tank levels are displayed
- ▶ The running state of the pump is displayed
- ▶ The 10 pressure sensors are displayed (optional)

Touch screen control



Weir options

Types: Base hinge, undershot/overshot weir, stop log, Venetian blind weir

Venetian blind weir -

To control the water height in the flow channel, advantages are a significantly reduced drawdown upstream of the weir, reduced turbulence at the discharge, no impediment to sediment transport, extends the working section

Undershot/overshot weir -

To control the water height in the flow channel

Base hinge weir -

The standard option to control the water height in the flow channel

Stop log weir -

To control the water height in the flow channel

(Please call or contact our experts for more information sales@armfield.co.uk or telephone: +44 (0)1425 478781)

Weir control option



Venetian blind weir

Flood Gate

Description: Flood event research

With a computer controlled release system, this option will open up environmental experimentation.

Our engineers have designed an option to carry out flood event studies, leaky barriers, dam research, effect on structures and more. This flume furthers our involvement in creating equipment for environmental erosion studies.

Please contact us for more information or talk to us about your requirements. www.armfield.co.uk

Gate pre-release position



Accessories and model option list

Bed Profiling

The profiler uses a single laser, operable underwater, to determine changes in sediment depth over time. Being able to move the laser along a set path allows the user to build up a picture of the changes in the sediment profile.

3D Volumetric PIV System

The 3D PIV system is based on tomographic PIV which extends the stereoscopic approach to the third dimension.

Beach

Wave absorption beach to reduce the effect of reflected waves, other options available

Vibrating Pile

To investigate the effects of resonance on the pile, flow rate and patterns

Set of plate weirs, adjustable undershot weir + 6 plate weirs

Investigations on various plate weirs

- flow over sharp-crested weirs
- flow beneath an undershot weir
- typical measuring weirs

Broad Crested Weirs (GRP)

Investigations on underwater weirs

Venturi Flume

Flow rate measurement in rivers and channels

Parshall Flume

A standing-wave flume and incorporating a clear acrylic viewing window and clear acrylic stilling wells for level measurements

Ogee Weir

Overflow weir with manometer board for displaying the pressure characteristic

Syphon Spillway

A part width Syphon spillway, incorporating adjustable breather tube.

Self Regulation Spillway

Determine the relationship between upstream head and flow-rate through a self-regulating (air regulated) siphon.

Instrument options

Pitot Tube and Manometer Board

A Pitot static tube for measuring water velocity in the working section of the flume, mounted on a traversing carriage and incorporating Vernier height adjustment.

Bespoke customer designs

The engineering team are used to designing equipment for specific customer needs, contact us for more details: sales@armfield.co.uk

Standard Instrument Carriage

The standard instrument carriage comprises of a wheeled trolley capable of manual movement with provision to position and lock to the instrument rails using the scale on the rail and the Vernier on the carriage. It can support loads up to 250kg.

Automated Instrument Carriage

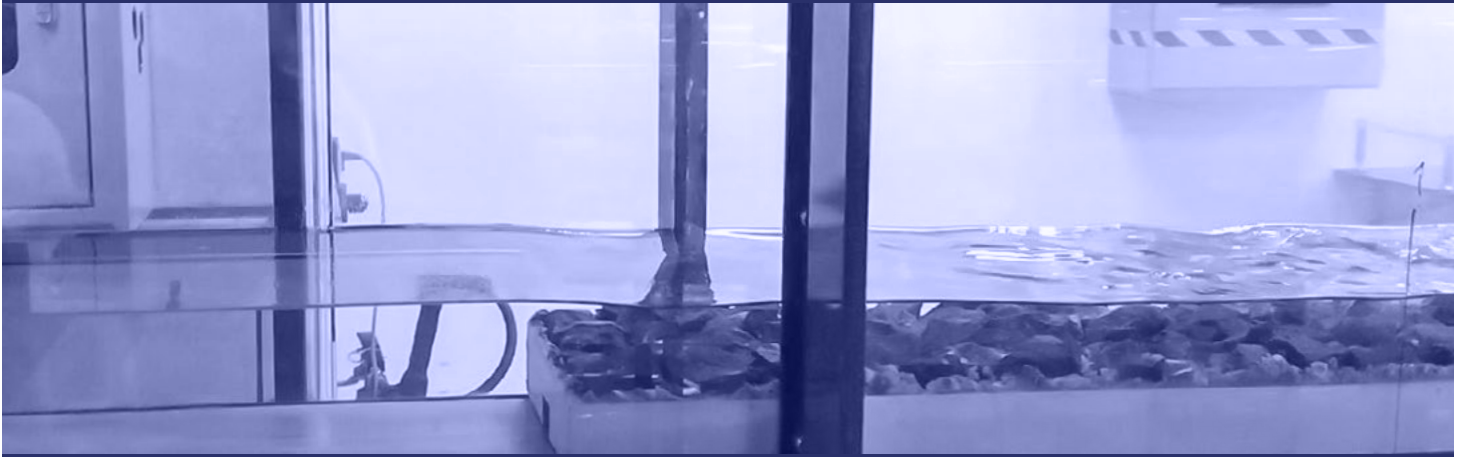
The automated instrument carriage will be supplied with a drive rail along the length of the flume with a flexible cable guide system. A powered carriage assembly and control panel with HMI which allows the user to select the desired position in the X, Y and Z direction. This will be repeatable with a precision of +/- 2mm.

A selection of instruments are available for use in flumes, channels and basins:-

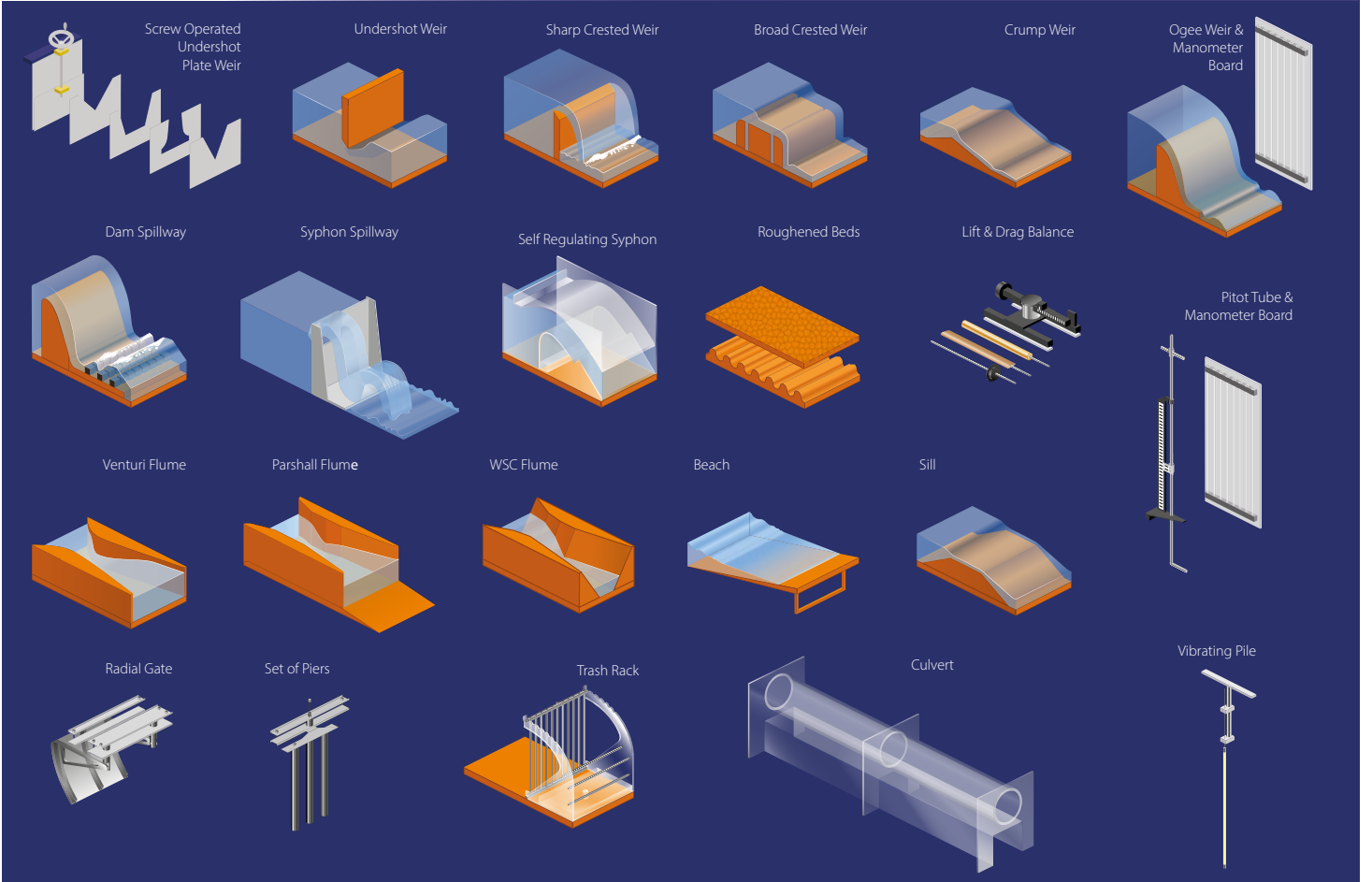
- Vernier hook & point gauges
- Manometers including water, pressurised, water-mercury
- Portable pressure meters
- Pitot tubes
- Turbulence/velocity meter
- Velocity probes, digital indicator and data logger
- Wave probe systems



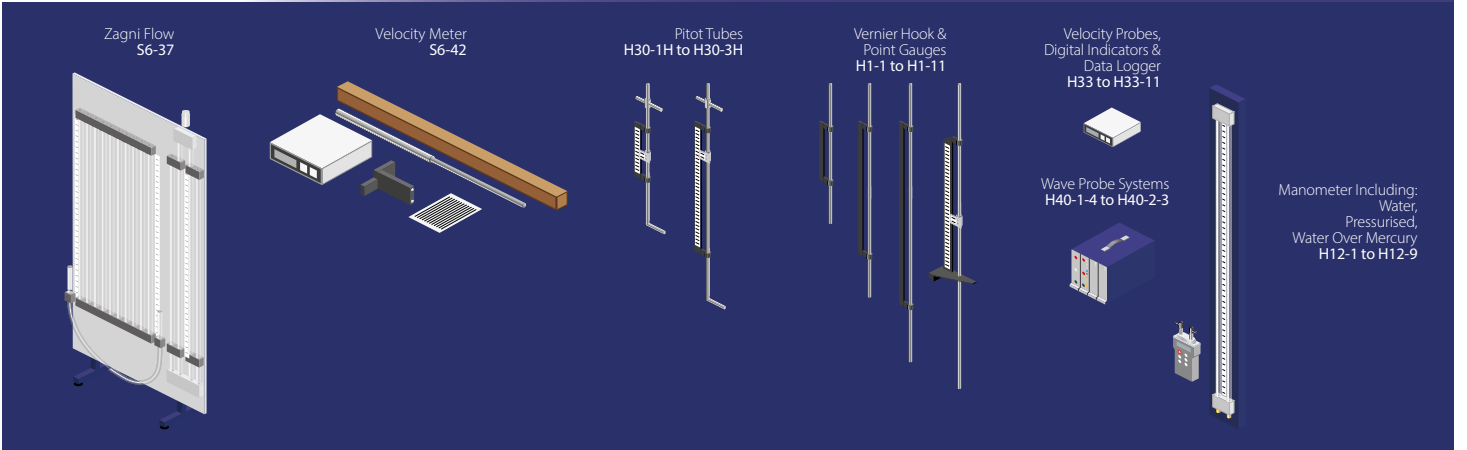
Roughened bed model option



Models



Instruments



Armfield flume installations through the ages

Armfield's reputation and expertise has grown through the 50 years of being at the forefront of flume design. Armfield flumes, whether a standard product or customised, are built on a modular principle. This allows them to be delivered to site in prefabricated, manageable sections.

We also offer a design, manufacture and installation service for specialist channel facilities of all types and sizes.

The length of a flume is dictated by many factors. Common amongst them are experimental requirements, space availability and cost. Standard Armfield flumes are therefore available as modular units ranging from 5m to 50m in increments of 2.5m.

Wherever possible the more basic components in contact with water are made of noncorroding materials, such as plastic, GRP or stainless steel.

Pumps are usually cast iron but where sediment is involved we recommend the use of special pumps, typically glass lined. Where wood or a composite material is chosen for the base and/or sides of the flume, these are carefully treated to protect against water ingress.

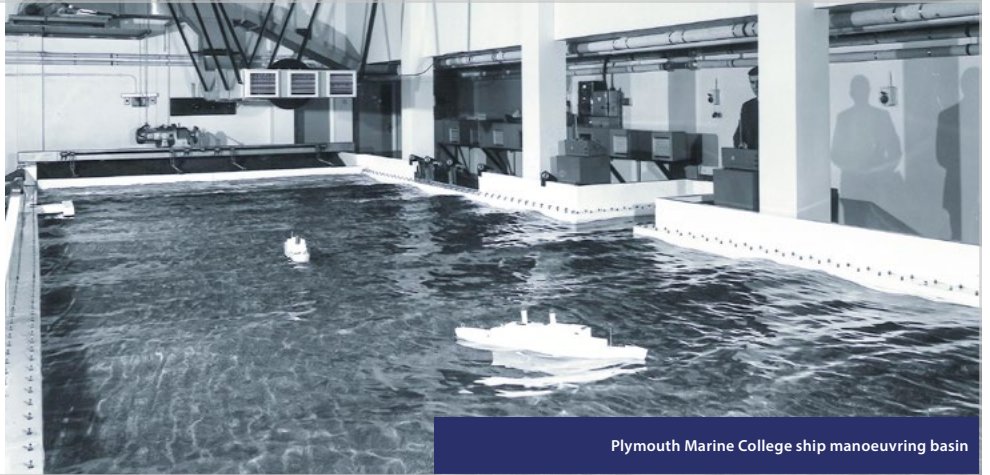
The designs are such that in some cases with help from the instruction manual, clients are able to assemble and commission the equipment without the need for our skilled staff. However this is always an option and Armfield are happy to submit a quotation for installation, commissioning and where appropriate, basic training.

Armfield's model ship manoeuvring basin.

Designed and installed over 50 years ago for training crews to steer vessels, the tank simulator had waves, wind and current to simulate docking boats on a harbour wall or a jetty.

At one end there was a podium with a seat to simulate a bridge, each of the various vessels had a camera on the bow linked to a monitor on the podium (no computers in those days - it was based on a tv system). Looking at the monitor the helmsman had a view that simulated the view from the bridge.

These were supplied to seafaring cities with the first to Plymouth Marine Training College then to Hull College to train trawlermen, to mention a few.



Plymouth Marine College ship manoeuvring basin



The working section of one four research flumes at the Danish Hydraulic Institute measuring 35m long by 3m wide and 1m deep

At 60m long, the German Darmstadt research flow channel is one of the longest Armfield have ever supplied

A unique feature of this flume is that each 10 metre section can articulate independently, either up or down, for an even more varied level of research options



Technische Universität Darmstadt, Germany
Measures 60m long

Gadjah Mada University in Yogyakarta, Indonesia

Armfield's multi-unit setup at the hydraulics laboratory at Gadjah Mada University in Yogyakarta, Indonesia

This hydraulics laboratory comprises:

- One sediment recirculating flume
- One wave tank
- Two multipurpose tilting flumes
- One multipurpose fixed bed flume



Picture shows hydrocyclone sediment extraction system



The University of Exeter flume in use for a sediment transport experiment

University of Exeter flume in use for sediment transport experiments

The University of Exeter flume has a 10m x 0.6m x 0.65m working section for teaching and research



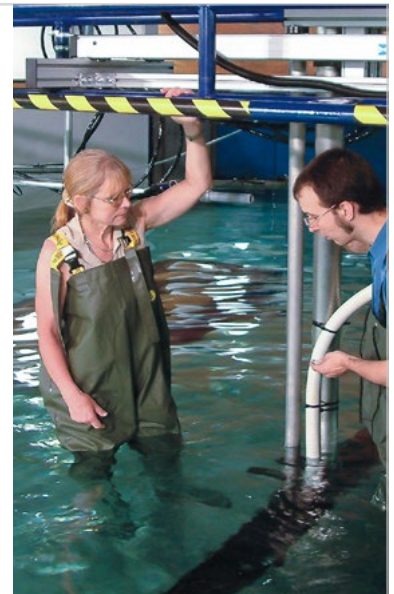
The Total Environment Simulator at the University of Hull was installed in 2002 and is used for world-leading research

Measuring 16m (length) x 6m (width) x 1.6m (height), this large flow channel is one of the most versatile research flumes in the world.

It is mainly used for river and coastal research, but has contributed to a wide range of research, ranging from studying sedimentation in the ocean to theorising formation of hill slopes on Mars.

To enable modelling of a wide variety of environmental scenarios the TES has three different flow driving mechanisms:

- Two giant pumps can deliver 1000 l/s of water
- The pumps can also recirculate sediment up to coarse sand size through the system
- At one end of the flume tank is a wave generator, consisting of eight paddles across the channel width that generate regularly or irregularly shaped waves of up to 0.5m in height
- An array of over 50 sprinklers above the flume can generate rainfall of 100mm per hour over the experimental surface



City University of Alabama has a modular, glass-sided, fixed-bed wave tank complete with wave maker, measuring 17.5 meters long

The University of South Alabama

The South Alabama special research flume with its powerful pumping equipment is 1.5m wide 1m high and 17.5m long, fitted with wave maker and data acquisition.

A brief selection of major research flow channels supplied by Armfield Limited

Location	Working section dimensions
University of Annaba, Algeria	10m x 0.3m x 0.45m
University of Vienna, Austria	10m x 0.3m x 0.45m
University of Calgary, Canada	17.5m x 0.3m x 0.45m
Concordia University, Canada	17m x 0.6m x 1.2m
University of Los Andes, Colombia	10m x 0.3m x 0.45m
Technical University of Denmark Department of Mechanical Engineering	23.5m x 2m x 0.5m / 27m x 4m x 1m / 27m x 0.6m x 0.8m 35.5m x 3m x 1m / 17.5m x 0.3m x 0.45m
Braunschweig University of Technology, Germany	20m x 0.9m x 0.6m
Coburg University of Applied Sciences, Germany	10m x 0.3m x 0.45m
Fachhochschule Lübeck, Germany	10m x 0.3m x 0.45m
FHS Nordostniedersachsen, Suderburg, Germany	7.5m x 0.3m x 0.45m
Magdeburg-Stendal University of Applied Sciences, Germany	12.5m x 0.6m x 0.8m
Philipps University of Marburg, Germany	16m x 1.2m x 0.9m
Technical University of Berlin, Germany	32m x 0.6m x 0.4m
Technische Universität Darmstadt, Germany	60m x 1m x 0.6m
University of Applied Sciences, Mainz, Germany	10m x 0.3m x 0.45m
Aristotle University of Thessaloniki, Greece	17.5m x 0.3m x 0.45m
Democritus University of Thrace – Xanthi, Greece	21m x 1.4m x 0.6m
Hong Kong University of Science and Technology, Hong Kong	15m x 2m x 2m
Gadjah Mada University, Indonesia	15m x 0.6m x 0.45m / 15m x 1m x 0.8m / 22m x 1m x 1.5m / 15m x 0.6m x 1.5m
Iran University of Science and Technology, Iran	10m x 0.3m x 0.45m
K N Toosi University of Technology, Iran	12.5m x 0.3m x 0.45m
Shahid Chamran University of Ahvaz, Iran	12.5m x 0.3m x 0.45m
University of Jordan, Amman, Jordan	10m x 0.3m x 0.45m
University of Science, Malaysia	10m x 0.3m x 0.45m
University of Technology, Malaysia	7.5m x 0.3m x 0.45m
Universiti Tun Hussein Onn Malaysia	10m x 0.3m x 0.45m
Uni Sam Ratulangi, Indonesia S60 Flume	15m x .6m x 1.2m
Norwegian University of Science and Technology, Trondheim, Norway	12.5m x 1m x 1m
NED University of Engineering and Technology, Pakistan	7.5m x 0.3m x 0.45m
University of Warmia and Mazury in Olsztyn, Poland	12.5m x 0.6m x 0.6m
King Fahd University of Petroleum and Minerals, Saudi Arabia	11m x 0.6m x 0.6m
Qassim University, Saudi Arabia	5m x 0.3m x 0.45m
Luleå University of Technology, Sweden	24m x 1m x 2m
University of Lausanne, Switzerland	16.5m x 0.6m x 0.8m
Kingston University, UK	7.5m x 0.3m x 0.45m / 10m x 0.3m x 0.45m
Loughborough University, UK	5m x 0.6m x 0.5m
National Oceanography Centre, UK	10m x 0.3m x 0.45m
Oxford Brookes University, UK	10m x 0.3m x 0.45m
Swansea University, UK	30m x 0.8m x 1.2m
University of Aberdeen, UK	12.5m x 0.3m x 0.45m
University of Bath, UK	7.5m x 0.3m x 0.45m
University of East Anglia, UK	10m x 1m x 1m
University of Exeter, UK	10m x 0.6m x 0.65m
University of Hull, UK Total Environment Simulator	15m x 6m x 1.6m
University of Oxford, UK	12.5m x 0.3m x 0.45m
University of Wales, UK	5m x 0.3m x 0.45m
University of Newcastle, UK S100 Flume	10m x 1mx 1.200m
Central State University, Ohio, USA	15m x 0.3m x 0.45m
City University of New York, USA	12m x 2m x 1m
Delaware State University, USA	5m x 0.3m x 0.45m
Florida A&M University, USA	10m x 0.3m x 0.45m
Manhattan College, New York, USA	7.5m x 0.3m x 0.45m
Texas A & M University, USA S80	25m x .80m x 1m
Pratt Institute, New York, USA	5m x 0.3m x 0.45m
Purdue University, Indiana, USA	10m x 0.6m x 0.6m
Purdue University, Indiana, USA	10m x 0.3m x 0.45m
Tarleton State University, Texas, USA	5m x 0.3m x 0.45m
Tidewater Community College, Virginia, USA	10m x 0.6m x 0.6m
University of Akron, Ohio, USA	10m x 0.3m x 0.45m
University of Maryland, College Park, USA	7.5m x 0.3m x 0.45m
University of South Alabama, USA	17.5m x 1.5m x 1m
University of Texas at Austin, USA	5m x 0.3m x 0.45m
BOKU Vienna Institute, Austria	15m x 1m x 1.2m (to be extended to 30m)
Xi'an University of Technology, China	7.5m x 0.3m x 0.45m

Armfield Engineering Installation process

Armfield has a long history in providing a complete design, build and installation service, to suit customer requirements.

As demand increases for research flumes in ever changing areas of enviromental and hydraulic analysis Armfield creates systems to study the new sciences. Armfield are experts in design, bespoke systems and lead the way in service, build, shipping, installation and commissioning of the flume.

Technical specialists provide training, ongoing assistance and support, both on site and via remote systems.

Partnering with industry and research institutions we have successfully executed some very challenging and exciting projects to enable ground-breaking studies and are proud of all our achievements.

Please contact us for your requirements sales@armfield.co.uk



Standard teaching and research flume – S60/80/100

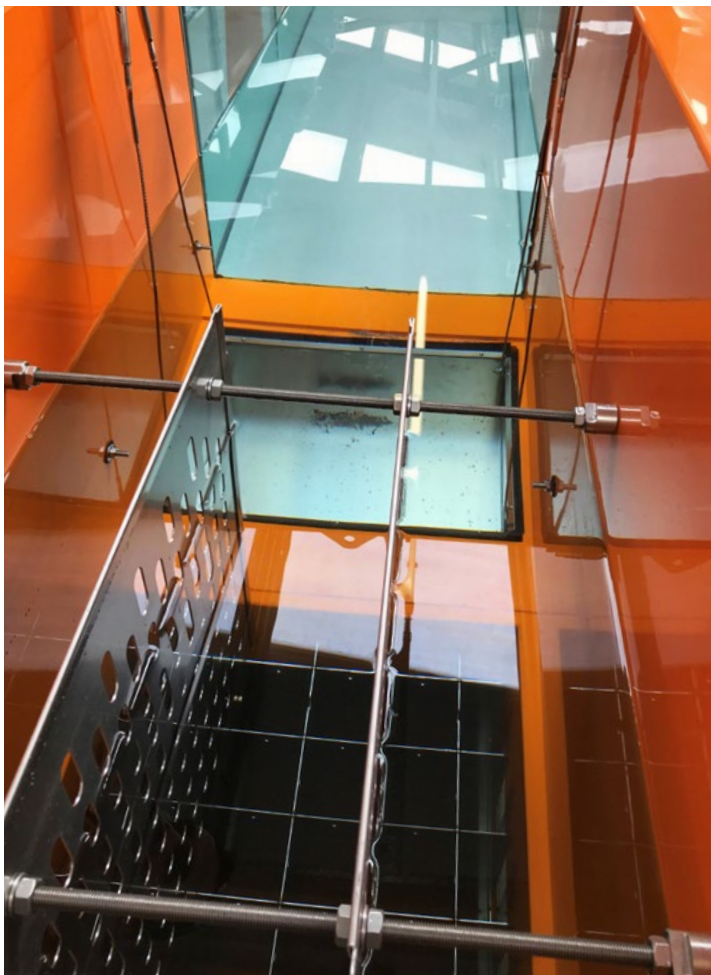


S Series Tilting Flumes: S80 model

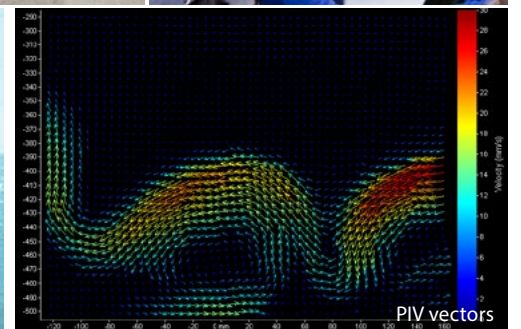
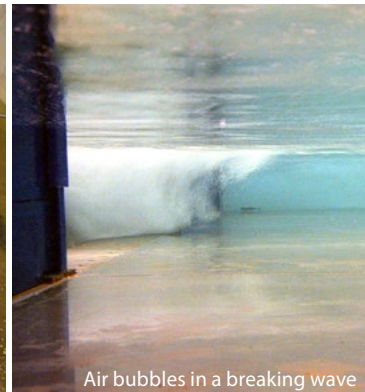
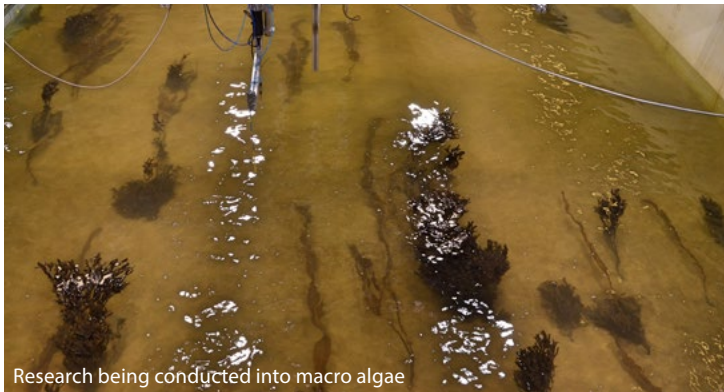
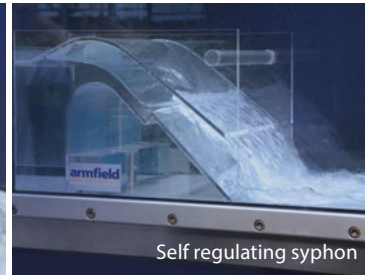
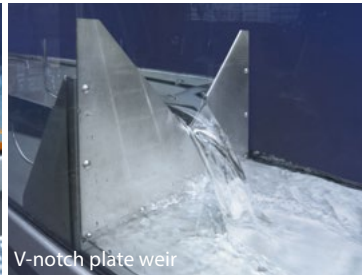
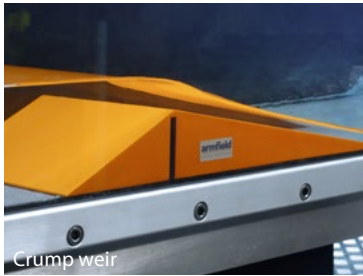
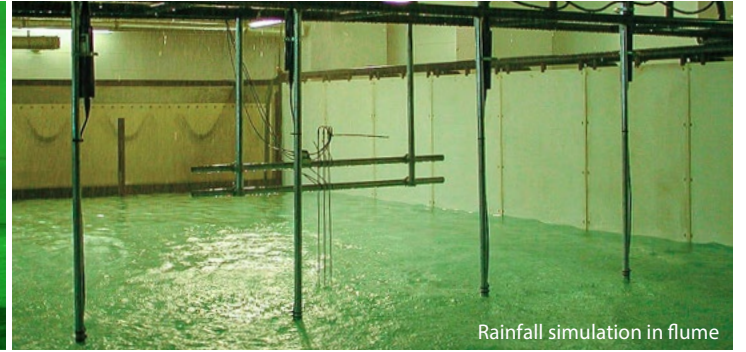
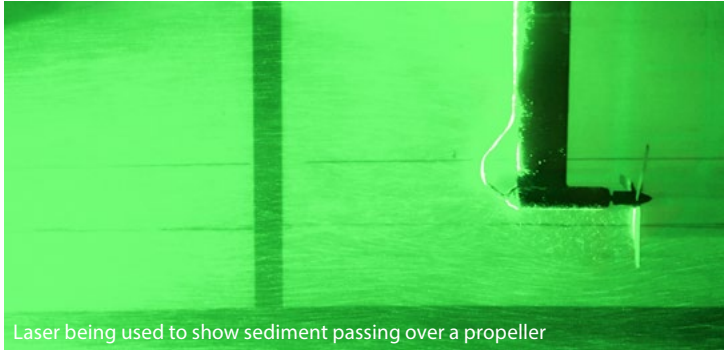




S Series Static Flume: Wind over wave with counter current flow



Experiments, options and flume research uses



Armfield Engineering Manufacturing

Armfield combine the traditions of value, service and workmanship with innovation to meet the ultimate needs of our customers. We are an ISO9001:2015 company and our equipment is supplied with CE and UI certification.

TEST & BUILD from initial client meeting to handover

Armfield's long history in fabrication, skill sets and dedicated manufacturing facilities supports our ever evolving range of products.

Working on projects across the globe including China, USA and Australia our dedicated and highly skilled team can assist you from design to final assembly, installation and testing.

Capabilities

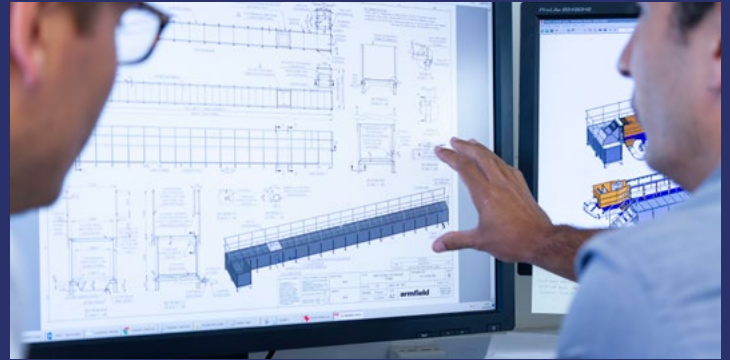
At Armfield, accountability is foremost and our exacting standards and strict quality management processes mean we are continually striving to achieve the very highest quality in every detail. With our vast experience, highly skilled team, state of the art machinery and facilities we ensure the finished product meets and exceeds our customer expectations.

Environmental

Armfield are fully committed to reducing our environmental impact across the scope of our operations and through the products and services we deliver to our customers. We aim to continually reduce our environmental impact and improve environmental efficiency through our objectives, targets, systems and programs.

Health & Safety

Occupational health and safety is of paramount importance to us at Armfield and as we aim to be leaders in our field we are fully committed to the responsibilities in ensuring the health, safety and welfare of all employees and others is maintained. We pride ourselves on delivering a positive safety culture throughout Armfield for all our employees and affiliates.



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