

Standard teaching and research flume – S6 MkII

The Armfield S6-MKII laboratory flow channel is one of the most important tools available to the hydraulics or civil engineer whether engaged in teaching basic principles or researching solutions to practical problems. Many applications in fluid mechanics are associated with the flow of water through an open channel where the water has a free surface that is exposed to the air at atmospheric pressure.

The flumes are available in different lengths from 5 to 15m in 2.5m and examples are installed in educational and research establishments throughout the world.

A comprehensive range of accessories, and measuring instruments is available including discharge control, wave generation and a closed loop for sediment transport studies.

TILTING UP TO 15 METERS
MODULAR DESIGN
CONTROL AND DATA LOGGING VIA PC
SEDIMENT TRANSPORT OPTIONS
MANUAL OR ELECTRICAL JACKING



S6MkII shown with sediment transportation option



Features / benefits

- ▶ Accurate for education and research
- ▶ Designed for ease of visibility:- toughened glass sides, slimline side supports and comfortable viewing height
- ▶ Modular construction supplied in pre-glazed sections for rapid and easy site assembly
- ▶ Wave generation options which can be used to propagate random or regular waves in the working section

S6 MK II Glass Sided Tilting Flumes

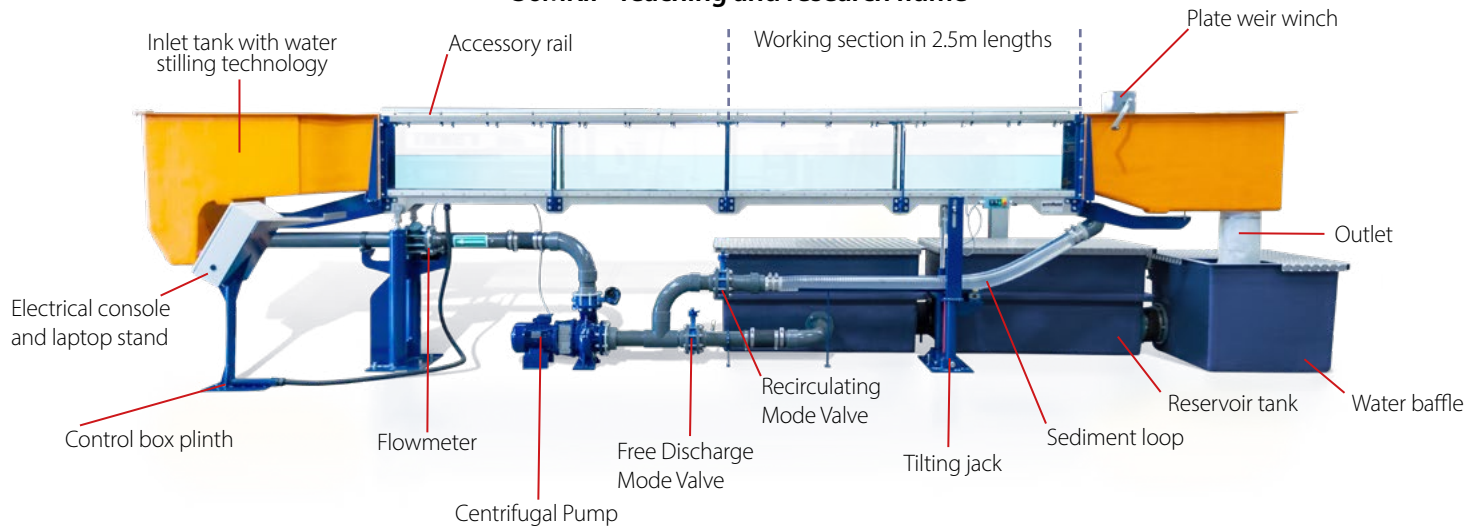
Description

There are numerous design features associated with Armfield flumes

** Not all features are appropriate for every channel.*

- ▶ Accurate for education and research
- ▶ Extremely stable design, no user adjustments required to the flume bed
- ▶ Floor space requirements reduced to a minimum
- ▶ Fabricated high precision stainless steel channel bed
- ▶ Quick conversion to closed-loop recirculation for sediment transport studies
- ▶ Precision screw jacks provide accurate slope adjustment with minimum effort (powered jacks available as an option)
- ▶ Adjustable instrument rails with positioning scales fitted over the whole working length
- ▶ Fully profiled inlet tank fitted with stilling and smoothing devices
- ▶ Discharge tank with adjustable overshoot weir and draft tube to avoid splashing and enhance noise reduction
- ▶ Modular construction supplied in pre-glazed sections for rapid and easy assembly on site
- ▶ Wave generation options, both regular and random
- ▶ Comprehensive range of optional accessories, instruments and models available
- ▶ Non-corroding durable GRP tanks throughout
- ▶ Transparent sides are of toughened glass, which is extremely strong, abrasion resistant, dimensionally stable, does not discolour or scratch and is inherently safe
- ▶ Working section allows adjustability, enabling extremely accurate setting
- ▶ Under frame designed to reduce load deflections to a minimum
- ▶ Close tolerances specified and achieved.

S6MKII - Teaching and research flume



Working section from 5 meters to 15 meters →



Engineering

The most important aspect of a tilting flume is retaining the integrity of the working section.

To achieve this requires an extremely rigid design which ensures almost no deflection regardless of load or tilt.



Experiments and Research

The Armfield S6-MKII flume has been developed during 30 years of continuous production, and examples are installed in educational and research establishments throughout the world.

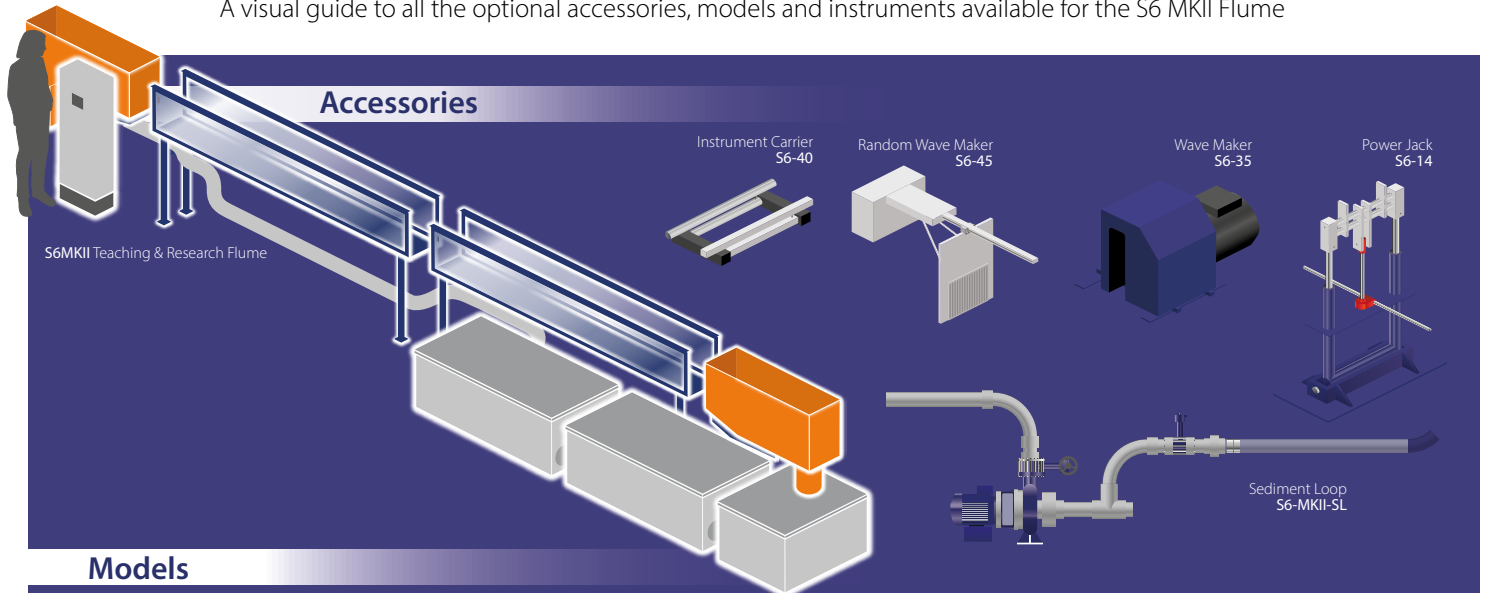
The flumes are available in different lengths to suit the application, short versions for basic investigations and longer versions for investigations of gradually varied flow profiles with non-uniform channel flow



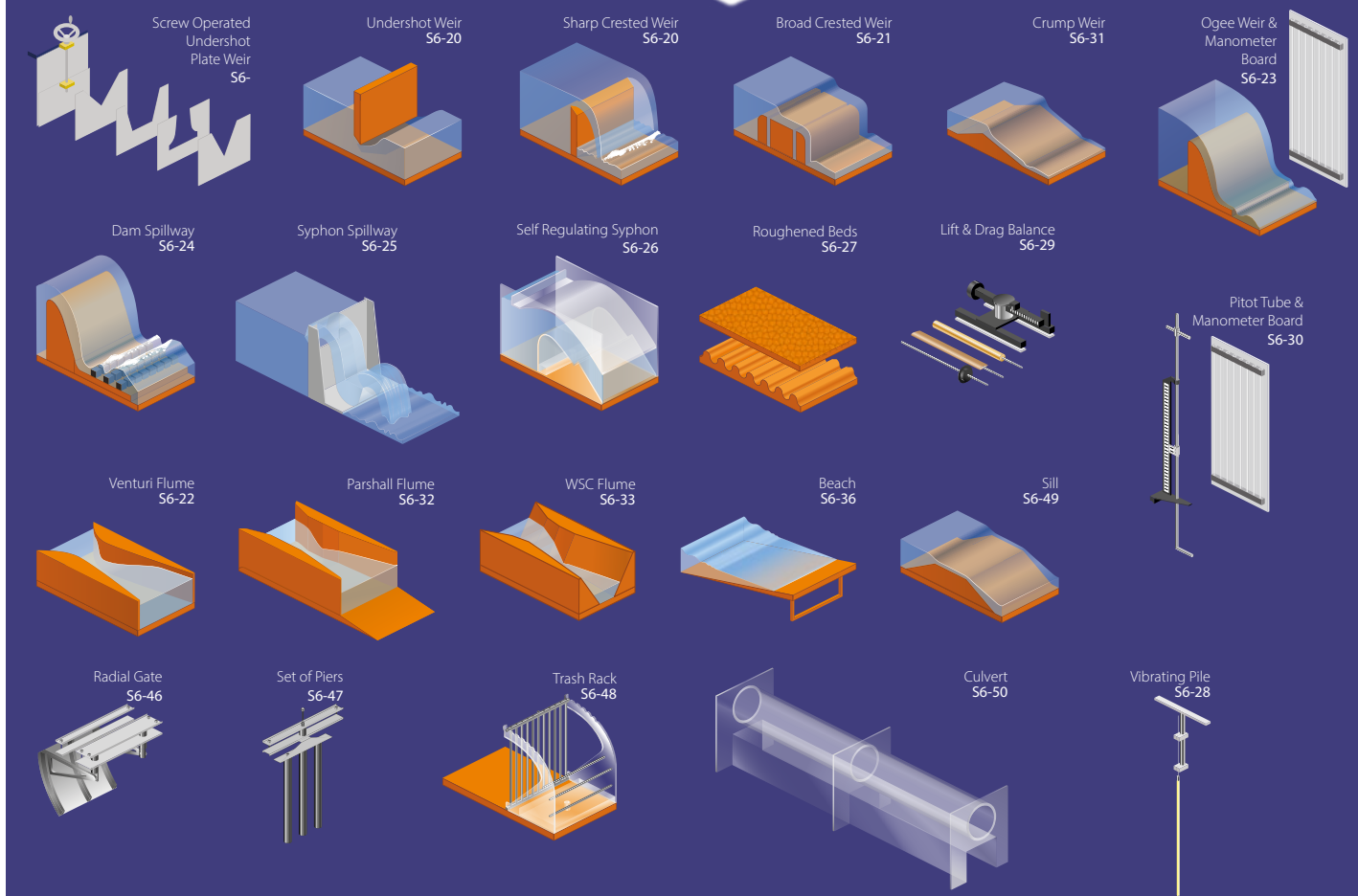
S6 Accessories, Models and Instruments

A visual guide to all the optional accessories, models and instruments available for the S6 MKII Flume

Accessories



Models



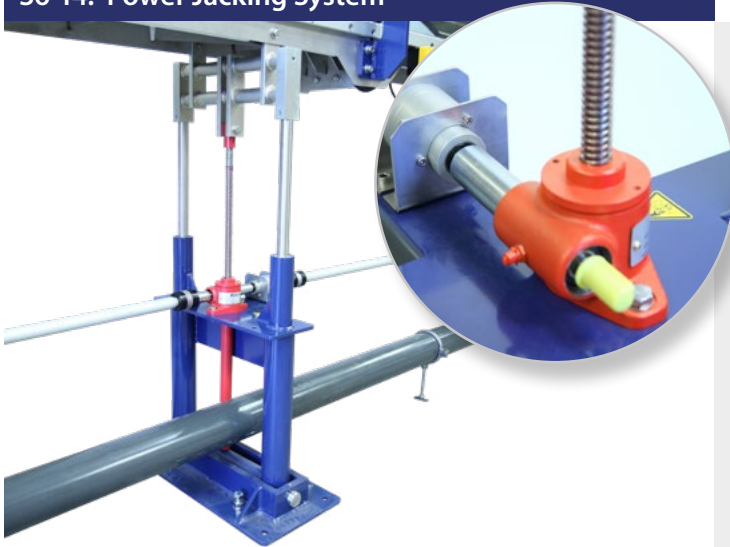
Instruments



Accessories – S6-MkII Standard flume

A comprehensive range of accessories are available for selection. These provide the basis for a large number of practical experiments in open channel flow including the use and operation of regulating and gauging structures.

S6-14: Power Jacking System



Tilting flumes need jacks to raise and lower them. The need for stability and the size and weight of the installation make this element of crucial importance.

Various options are available, including chain drive and hydraulic lift. None, however, give the degree of repeatable accuracy achievable with screw jacks driven through shafting and gear boxes. Long flumes need a series of jack stations carefully linked to avoid distortion of the main frame.

S6-35: Wave Generator



The S6-35 wave generator has a variable speed drive motor and is used to obtain regular waves.

- ▶ Simple, regular, flap-type generator designed to be mounted on the flume discharge tank.
- ▶ The wave generator is used to propagate waves in the working section

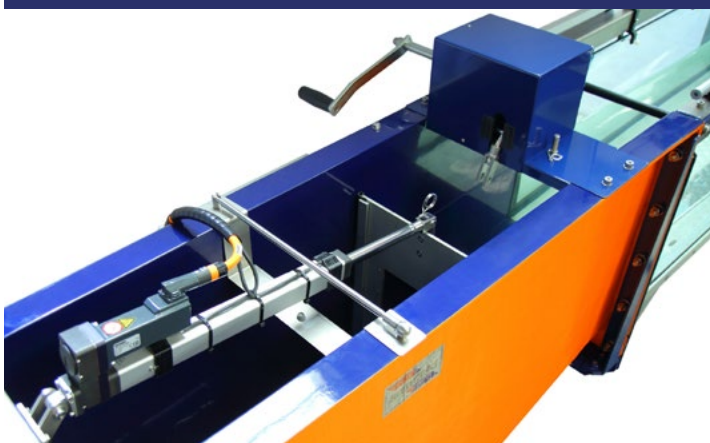
Note: Essential accessory S6-36 Beach

S6-40: Instrument Carrier



- ▶ Position lock
- ▶ The instrument carrier is a carriage with 3 point suspension that uses the instrument rails along the top of the flow channel to provide both longitudinal and transverse movement
- ▶ Different instruments can be attached to the carrier using appropriate holes in the triangular plate

S6-45: Random Wave Maker



- ▶ The S6-45 utilises the base hinge weir in the discharge tank of S6MkII Flume as the paddle to propagate random or regular waves in the working section
- ▶ The form of waves is created using computer software via a PC that is connected to the wave maker

Note: PC not supplied

Flume Models – S6-MkII Standard flume

Non-corroding materials have been used to reduce maintenance time and increase the working life of the models.

S6-20: Plate Weir



- ▶ Screw operated adjustable undershot plate weir (Sluice gate)
- ▶ Mounting block, for a range of interchangeable plate weirs that are included in the supply:

Sharp crested weir (with aeration pipe) - Rectangular notch weir
Trapezoidal notch weir - 90° vee notch weir - 60° vee notch weir
Sutro notch weir (linear proportional weir)

Note: End user fabrication and use of own weirs are possible and encouraged for project work.

S6-21: Broad Crested Weir



- ▶ **Rectangular Sharp Cornered Weir**
Determine the relationship between upstream head and flow-rates for water flowing over a sharp cornered BCW
Calculate discharge coefficients/observe flow patterns
- ▶ **Rectangular Streamlined Weir**
Determine the effects of weir height on characteristics, critical flow conditions and required upstream water level

S6-23: Ogee Weir & Manometer Board



Eight pressure tapping's (2 upstream, 5 downstream, 1 at apex) complete with multi-tube piezometer board.

- ▶ Determine pressure variations at the surface of the Ogee Weir at different flow conditions and observe the flow patterns obtained
- ▶ Determine the relationship between flow-rate and upstream head
- ▶ Calculate the discharge coefficient

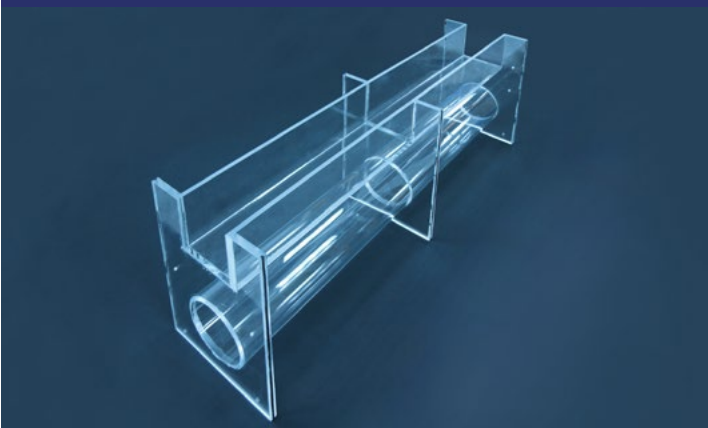
S6-31: Crump Weir



Single pressure tapping at apex, complete with piezometer tube.

- ▶ Determine the relationship between upstream head and flow-rate
- ▶ Determine the modular limit and to observe the flow patterns obtained
- ▶ Determine the head at the apex of the weir and its relationship with flow-rate and depths upstream and downstream
- ▶ Reinforced Apex to avoid damage

S6-50: Culvert

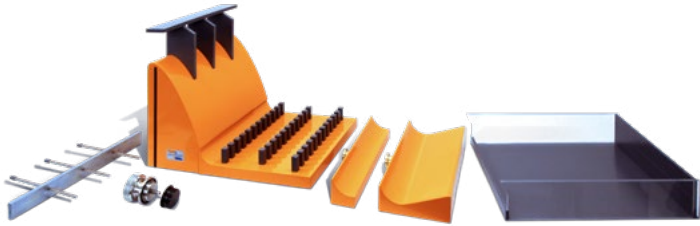


The S6-50 is used to determine the head/discharge characteristics and to determine the conditions necessary for the Culvert to run full.

Flume Models Continued – S6-MkII Standard flume

Non-corroding materials have been used to reduce maintenance time and increase the working life of the models.

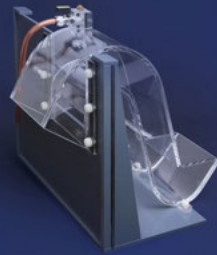
S6-24: Dam Spillway Models



To observe flow patterns associated with the flow of water over a Dam Spillway. Complete with the following interchangeable downstream sections:

- ▶ Spillway toe
- ▶ Roller bucket toe
- ▶ Apron with removable energy dissipater
- ▶ Gravel Box and Stop Logs

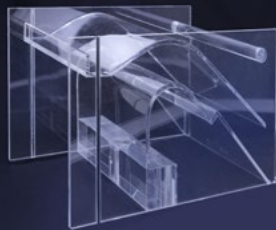
S6-25: Syphon Spillway



Complete with adjustable air regulation.

- ▶ Determine the relationship between upstream head and flow-rate through a syphon spillway in the 'Blackwater' fully primed condition.
- ▶ Calculate the discharge coefficient
- ▶ Observe the operation of the syphon as it primes and de-primed

S6-26: Self-regulation Syphon



- ▶ Determine the relationship between upstream head and flow-rate through a self-regulating (air regulated) syphon
- ▶ Calculate the discharge coefficient
- ▶ Observe the operation of the syphon as it primes and de-primed

S6-27: Roughened Beds



Comprises two beds of different roughness.

- ▶ Gravel Bed
- ▶ Corrugated Bed

Each 2.5m long bed consists of three sections

To investigate the effect of a roughened or corrugated bed on the depth of water at different flow rates

Obtain appropriate coefficients to satisfy the Manning Formula

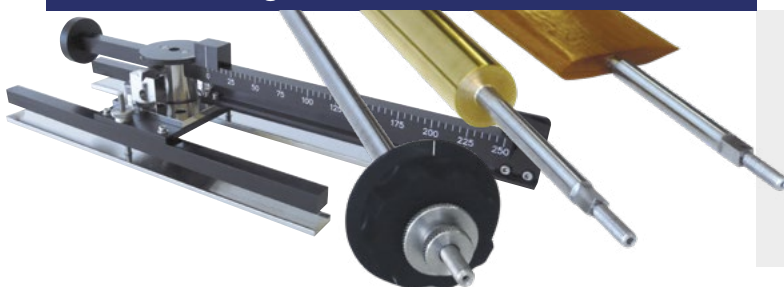
S6-28: Vibrating Pile



For the study of vortex shedding by piles and tall structures.

- ▶ Investigate the effect of flow rate and Reynold's number on the flow patterns around a vertical pipe
- ▶ To investigate the effects of resonance on the pile

S6-29: Lift & Drag Balance with Models



Three models -

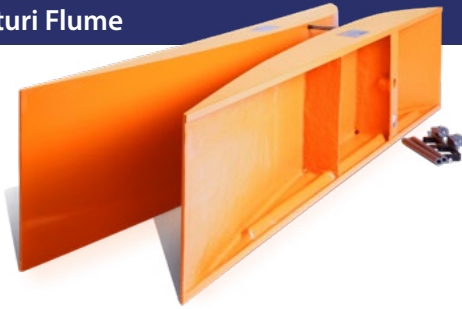
large and small diameter cylinders and an aerofoil section.

- ▶ Determine and compare the drag force on two cylinders with different diameters at different water velocities
- ▶ Compare the drag force on a symmetrical hydrofoil and a cylinder with the same frontal area
- ▶ Determine the lift and drag forces produced by a symmetrical hydrofoil at different angles of attack and different water velocities

Flume Models Continued – S6-MkII Standard flume

Non-corroding materials have been used to reduce maintenance time and increase the working life of the models.

S6-22: Venturi Flume



A set of GRP mouldings for installation in the channel section to form a venturi flume.

- ▶ Determine the relationship between upstream head and flow-rate for water flowing through a venturi flume
- ▶ Calculate discharge coefficient and observe the flow pattern obtained

S6-32: Parshall Flume



One of the most widely used methods of measuring the flow of water in open channels.

- ▶ Investigate the flow of fluid through a Parshall flume and compare the experimental measurements with standard reference graphs

S6-33: WSC Flume



Developed by Washington State College (WSC), this trapezoidal flume conforms more closely to natural channel sections and passes sediment even more freely than the Parshall Flume.

- ▶ Investigate the flow of fluid through a WSC flume and compare the experimental measurements with standard reference graphs
- ▶ Investigate the effect of submergence on the accuracy of measurements using a WSC Flume when the flume becomes drowned

S6-36: Beach



Wave absorption beach for use with S6-35 or S6-45 to reduce the effect of reflected waves.

S6-49: Sill



- ▶ The S6-49 is used to observe the flow patterns associated with the flow of water over different bed profile.
- ▶ It allows the behaviour of open channel flow at a reduction of flow cross-section to be investigated.

S6-47: Set of Piers



Investigate the backwater rise upstream of piers for both subcritical and supercritical flow around and between the piers and the effect of:

- ▶ Geometric shape of the pier
- ▶ High/low values of Froude number (Super/sub critical flow)
- ▶ Opening Ratio
- ▶ Multiple piers in combination
- ▶ Erosion/Scour caused by piers in sediment (option S6-MKII-SL required)
- ▶ Angle of attack when piers are not parallel with the flow

Flume Models Continued – S6-MkII Standard flume

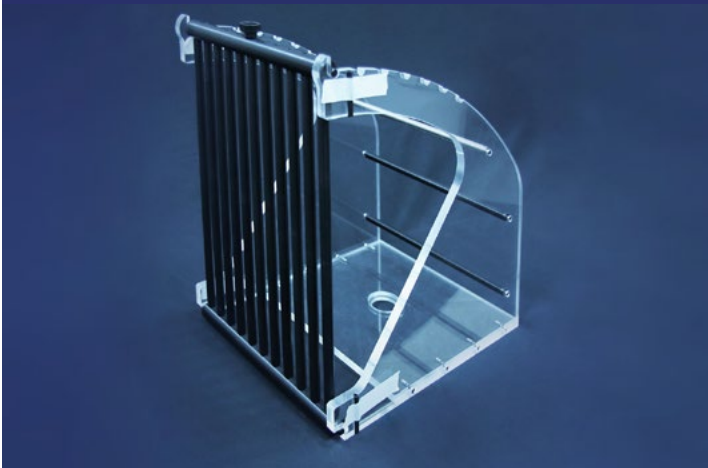
Non-corroding materials have been used to reduce maintenance time and increase the working life of the models.

S6-46: Radial Gate



- ▶ The S6-46 allows the relationship between upstream head and flow-rate beneath a radial gate under different operating conditions to be determined
- ▶ Discharge coefficient in each condition to be calculated

S6-48: Trash Rack



The S6-48 is used to determine the head-loss associated with trash rack design with regards to geometry of the rack spacing and the bar shape.

These are designed to filter floating & submerged debris and aquatic life from waterways that may otherwise damage downstream structures for example hydroelectric equipment.

S6-42: Velocity Meter and Mountings



- ▶ High speed probe supplied
- ▶ Velocity probe and digital meter, complete with mounting bracket suitable for attachment to the S6-40
- ▶ Orientation and height of the probe can be varied
- ▶ Range 0.6. to 3m/sec.

S6-30: Pitot Tube & Manometer Board



Complete with traversing carriage and vernier height adjustment, and an inverted paraffin water manometer for magnification of small pressure differences

Note: Requires S6-40 Instrument Carrier

Flume Instruments – S6-MkII Standard flume

Non-corroding materials have been used to reduce maintenance time and increase the working life of the models.

S6-37: Zagni Flow Monitoring Systems



- ▶ Manual Monitoring System
- ▶ Consists of a free standing manometer board and instrument carriage fitted with Pitot tube and interconnecting tubing.
- ▶ This system may be used to establish the basic parameters of fluid flow in the channel including:

Invert slope
Surface profiles
Pressure profiles
Velocity profiles

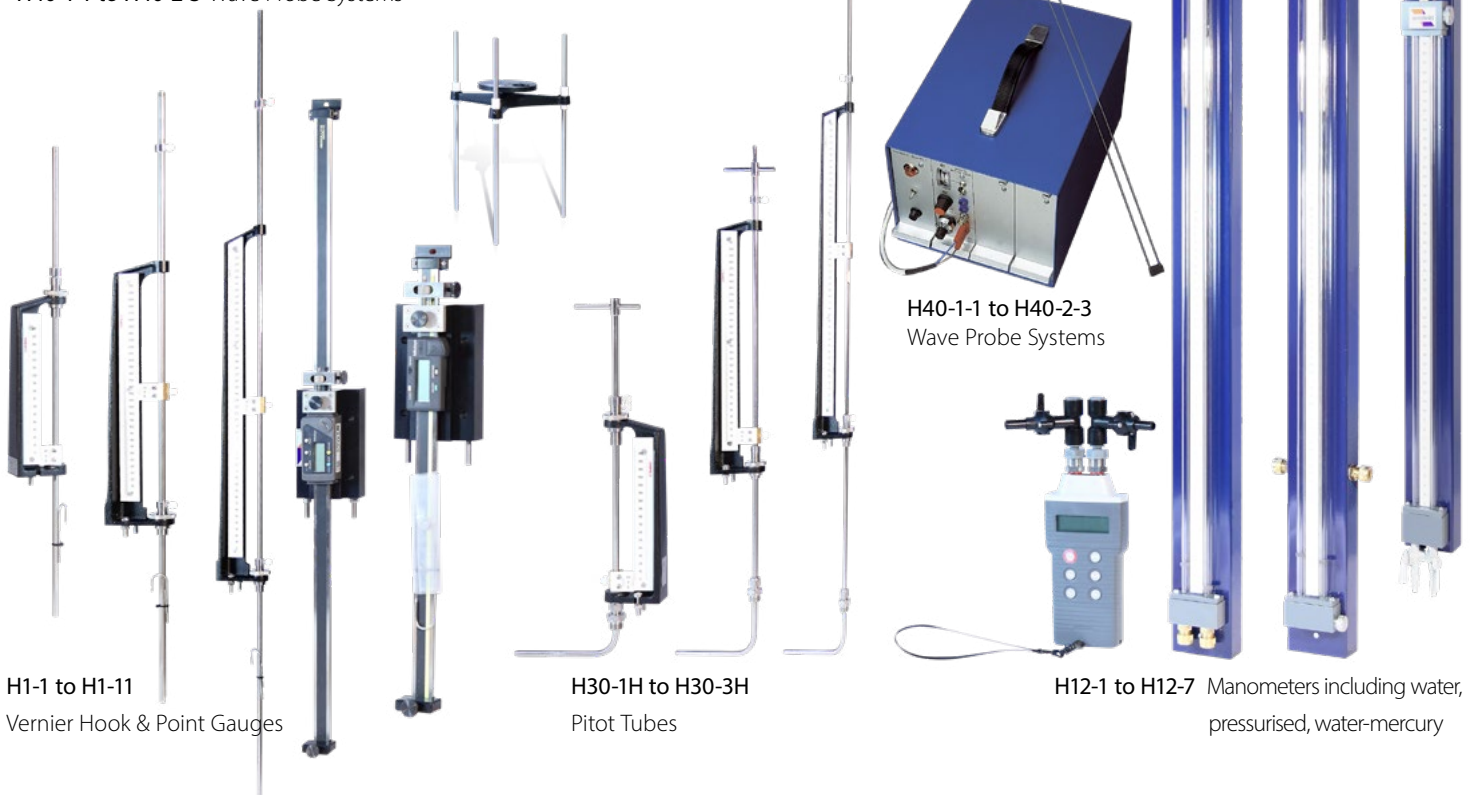
Instrumentation

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

- H1-1 to H1-11 Vernier Hook & Point Gauges
- H12-1 to H12-7 Manometers including water, pressurised, water-mercury
- H12-8 to H12-9 Portable Pressure Meters
- H30-1H to H30-3H Pitot Tubes
- H32 Turbulence/Velocity Meter
- H33 to H33-11 Velocity Probes, Digital Indicator and Data logger
- H40-1-1 to H40-2-3 Wave Probe Systems



H33 to H33-11
Velocity Probes, Digital Indicator &
Data logger



H1-1 to H1-11
Vernier Hook & Point Gauges

H30-1H to H30-3H
Pitot Tubes

H40-1-1 to H40-2-3
Wave Probe Systems

H12-1 to H12-7 Manometers including water,
pressurised, water-mercury

S6 MK II Sediment Loop

A sediment loop can also be fitted as an optional extra during manufacture of the S6-MKII tilting flume. This allows sediment in suspension to be re-circulated through the channel without settling in the sump tanks.

The centrifugal pump is designed to be used for sediment with a working grain size of 3mm.

- ▶ Special Glass Lined Pump
- ▶ Pump and redeposit of bed and suspended load in the flume
- ▶ Recirculation of sediment in suspension
- ▶ Butterfly valve for each of configuration change
- ▶ Reflects "In the field" scenario

S6-45 Random Wave Maker

The S6-45 Control box connects to a PC (not supplied by Armfield) via a USB interface.

- ▶ Wave generation software
- ▶ Regular waves
- ▶ Irregular waves - filtered white noise
- ▶ Irregular waves - Fourier series
- ▶ User defined wave generation techniques

This is an advanced software package designed to simulate long crested sea conditions. When it is running, the parameters of the generated sea state and a real time graphical display of the paddle movement are shown on screen. It can generate Regular, Irregular and Solitary waves.

It is capable of running on any Windows compatible-PC.

Laboratory Teaching Exercises (include)

- ▶ Characteristics of flow over rectangular thin plate weirs (Overshot)
- ▶ Characteristics of flow over profiled thin plate weirs (Overshot)
- ▶ Characteristics of flow over a sharp cornered broad crested weir
- ▶ Characteristics of flow over a streamlined broad crested weir
- ▶ Characteristics of flow over a Crump Weir
- ▶ Characteristics of flow over an Ogee Weir
- ▶ Characteristics of flow through a Venturi flume
- ▶ Characteristics of flow through a Parshall Flume
- ▶ Characteristics of flow through a WSC Flume
- ▶ Characteristics of flow over a Sill
- ▶ Characteristics of flow over a Dam Spillway
- ▶ Characteristics of flow over a Siphon Spillway
- ▶ Characteristics of flow through a self-regulating siphon
- ▶ Characteristics of Flow over a Gravel Bed
- ▶ Characteristics of flow over a Corrugated Bed
- ▶ Characteristics of flow around a Cylindrical Pile
- ▶ Characteristics of flow through a Culvert
- ▶ Characteristics of flow under a Radial Gate
- ▶ Critical depth– Derivation of the Specific Energy Equation
- ▶ Discharge beneath a Sluice Gate (Undershot weir)
- ▶ Force on a Sluice Gate (Undershot weir)
- ▶ The Lift and Drag Force on Submerged Structures
- ▶ Observation of scour at Pier legs
- ▶ Head loss through a Trash Rack
- ▶ Hydraulic Jump

All Armfield Teaching and research flumes can optionally be supplied with two variants of our market leading software providing Data Acquisition and optional addition of Software control.

Data Logging and Instrumentation System S6-MKII-DTA-ALITE is a software-based application with supporting hardware providing the following functionality:

- ▶ Electronic inclinometer to measure slope of bed
- ▶ Electronic manometer to measure: Including bed tapping's, pressure readings from hydraulic structures
- ▶ Differential pressure sensor for use with Pitot tube
- ▶ Voltage input channels for use with their instrumentation
- ▶ Thermistor sensor to measure water temperature
- ▶ USB interface and software included to allow data logging of the above parameters. The software includes sophisticated sampling, calibration and graph plotting facilities including the ability to save or export the data in Microsoft Excel format

The S6-MKII-DTA-ASuite Software Control and Data Acquisition package includes the S6-MKII-DTA-ALITE data logging and instrumentation software and in addition incorporates an inverter within the control console for electronic speed control for the flow channel pump.

Control Functions:

- ▶ Inverter speed control of circulating pump, either by front panel control or from a PC. When using PC control the pump speed can be set in a PID loop to maintain a constant flow rate
- ▶ Control of powered jacking system to set specific slope of bed

Note: The S6-MKII-DTA-ASuite must be purchased at the time of order because it cannot be retrofit.

Flume control screen



Ordering specification

- ▶ A self-contained glass sided tilting flume for fluid mechanics laboratory experiments, project work and research activities
- ▶ The flume working channel is assembled from modular sections of 2.5m length. A wide choice of standard lengths are available from 5m upwards
- ▶ The flume cross-section is 300mm wide by 450mm deep
- ▶ A fabricated high precision stainless steel bed provides excellent strength and rigidity, eliminating the need for a separate under-frame. No adjustments other than the jacking stations are necessary in order to set up and maintain the equipment, achieving typical bed deformations better than 1mm
- ▶ Each flume incorporates a discharge tank fitted with an adjustable overshot weir and draught tube to avoid splashing and noise
- ▶ An electro-magnetic flow meter is incorporated as standard
- ▶ A comprehensive range of optional accessories and instruments is available to supplement the capabilities of the basic flume
- ▶ Closed-loop recirculation is an option for sediment transport studies

Technical specifications

Walls	Toughened glass
Bed	Exclusively fabricated from stainless steel
End tanks	GRP (Glass Reinforced Plastic)
Sump tanks & pipework	PVC (Polyvinyl chloride) & PE (polyethylene)
Pump	Close-coupled centrifugal
Flow regulation valve	Hand wheel operated butterfly
Tilt parameters	+ve slope 1:40 max (1.4°) -ve slope 1:200 max (0.28°)
Flow meter	Electro-magnetic
Maximum flow rate	30 Litres/sec
Bed stability	1.0mm (typical) at 400mm water depth
Side wall stability	0.5mm (typical) at 400mm water depth
Width	0.3m
Depth	0.45m

Requirements

Scale



- ▶ Electrical supply 3Ph, 50-60Hz
- ▶ The user must have access to a PC
- ▶ Software requires a computer running Windows XP or above with a USB port. (Computer not supplied by Armfield).

Tilting configurable modular flumes S6MKII

Working section dimensions

Type	Tilting or standard flume
Width	0.3m
Depth	0.45m
Length (in 2.5m modular increments)	5m - 15m

Above lists standard size flume, available in free discharge or recirculation. Bespoke lengths and widths can also be offered.

Packed and crated shipping specifications

Volume	To be confirmed at time of order
Gross weight	

Experimental Models & Instrumentation

A comprehensive range of optional accessories, models and measuring instruments are available for selection. These provide the basis for a large number of practical experiments in open channel flow including the use and operation of regulating and gauging structures.

Non-corroding materials have been used to reduce maintenance time and increase the working life of the models.

- ▶ S6-20: Plate Weirs
- ▶ S6-21: Broad Crested Weirs
- ▶ S6-22: Venturi Flume
- ▶ S6-23: Ogee Weir & Manometer Board
- ▶ S6-24: Dam Spillway Models
- ▶ S6-25: Syphon Spillway
- ▶ S6-26: Self-regulating Syphon
- ▶ S6-27: Roughened Beds
- ▶ S6-28: Vibrating Pile
- ▶ S6-29: Lift & Drag Balance & Models
- ▶ S6-30: Pitot Tube & Manometer Board
- ▶ S6-31: Crump Weir
- ▶ S6-32: Parshall Flume
- ▶ S6-33: WSC Flume
- ▶ S6-35: Wave Generator
- ▶ S6-36: Beach
- ▶ S6-37: Zagni Flow Monitoring Systems
- ▶ S6-40: Instrument Carrier
- ▶ S6-42: Velocity Meter and Mountings
- ▶ S6-45: Random Wave Maker
- ▶ S6-46: Radial Gate
- ▶ S6-47: Set of Piers
- ▶ S6-48: Trash Rack
- ▶ S6-49: Sill
- ▶ S6-50: Culvert
- ▶ S6-MkII-DTA-ASUITE Software Control and Data Acquisition Package
- ▶ Data Logging and Instrumentation System (S6-MkII-DTA-ALITE)

Ordering codes

S6 MkII flumes - cross section 300mm wide x 450mm deep

S6 MkII - 5.0m	Basic self contained flume (no electrics)
S6 MkII - 7.5m	Basic self contained flume (no electrics)
S6 MkII - 10m	Basic self contained flume (no electrics)
S6 MkII - 12.5m	Basic self contained flume (no electrics)
S6 MkII - 15m	Basic self contained flume (no electrics)
S6 MkII - C	415V/3ph/50Hz - Basic electrics comprising control console & pump
S6 MkII - D	208V/3ph/60Hz - Basic electrics comprising control console & pump
S6 MkII - E	380V/3ph/50Hz - Basic electrics comprising control console & pump
S6 MkII - F	220V/3ph/60Hz - Basic electrics comprising control console & pump
S6 MkII - SL	Sediment loop for any of the above flumes
S6 MkII - 14 - 1	Powered jacks for 5.0m or 7.5m flumes
S6 MkII - 14 - 2	Powered jacks for 10m or 12.5m flumes
S6 MkII - 14 - 3	Powered jacks for 15m flumes

S6 MkII standard warranty applies with this product

Knowledge base

- > 28 years' expertise in research & development technology
- > 50 years' providing engaging engineering teaching equipment

Benefit from our experience, just call or email to discuss your laboratory needs, latest project or application.

An ISO 9001:2015 Company



armfield.co.uk

Aftercare

Installation
Commissioning
Training
Service and maintenance
Support: armfieldassist.com