HR Wallingford
Working with water

Equipment

Wavemakers for physical models

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Multi-element wavemakers

The multi-element wavemaker is used to create long and short crested waves for either deep or shallow water. Each wavemaker is custom-built to meet the client's requirements and is equipped with HR Wallingford's Dynamic Wave Absorption System.

Installation is quick and straightforward with HR Wallingford providing commissioning, training and on-going support.

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Key features

- Generates short and long-crested random waves at normal and oblique angles using HR Merlin signal generation software
- Dynamic Wave Absorption guarantees precise control of wave conditions
- Wet-backed piston paddles ensure that performance is not limited by stroke for shallow water applications
- Stainless steel and GRP construction delivers a design life in excess of 20 years
- Digital AC servo motors provide precise control and rapid response
- Wavemakers supplied in either 4 or 8 paddle modules for ease of installation
- Easy to maintain with all precision components above water
- Hinge flap wavemakers are available for deep water basins, designed for easy removal of modules for maintenance tasks.

Multi-element wavemakers

When using physical models to test the design of ports and harbours, coastal protection schemes or off-shore structures, engineers must be able to work with a wide range of realistic wave conditions.

HR Wallingford has extensive experience in designing and building wave generating systems that realistically simulate sea conditions. We have supplied wavemakers to many laboratories around the world and they have been in use on our own models at Wallingford for over 50 years.

Piston type wavemakers

HR Wallingford's piston-type multi-element wavemakers are made up from a number of self contained eight-paddle modules. This enables them to be easily installed, moved to different positions within the basin and to be extended as required. It also dramatically reduces the manufacturing costs of the wavemaker.

These wavemakers are predominantly used in shallow water applications of up to 1m depth. The main advantage of this type of design is that the stroke is not limited which makes a piston wavemaker ideal for producing solitary waves, absorbing reflected waves and compensating for long period set down phenomena.

Hinge type wavemakers

HR Wallingford also supplies wavemakers for deep water basins and towing tanks. These hinge type paddles are supplied in modular frames, each with four paddles that are fixed to the inside of the basin.

The design of the hinge wavemaker support frame is such that it can be incorporated into basins and towing tanks with a two point fixing system that allows the modules to be removed for periodic maintenance.

Paddle drive system

Paddle width varies from 0.5-0.75m depending upon the client's requirements. All paddles are of a wet-back design which means that there are no complicated seals between paddles or the basin walls and the floor. The paddles are mounted on linear slide assemblies that are supported from a common framework for the piston paddles. This leaves all motors, bearings and precision components well above the water level. All mounting parts below water level in the hinge paddle are rated for operation in this environment.

Each paddle is driven by an electric servo motor operating through a gearbox and either a rack and pinion for the piston, or toothed belt for the hinge paddles. The gearbox has an eccentric mounting to allow the rack and pinion to mesh with negligible backlash. The paddles are designed in such a way that the possibility of side movement is minimised and interference by overlapping is prevented.

All components are made from corrosion resistant steel that ensures reliable and low maintenance operation. The design of both drive systems ensures that they do not require a sealed lubrication system. All that is needed is an occasional clean and re-grease to maintain them in good operational condition. The framework of each module is made from stainless steel, the paddles from either glass reinforced plastic, or folded stainless steel sheet.

In order to reduce space behind the wavemaker, a beach is incorporated into the framework of each module to absorb any splashing or back waves. This beach is made from a reticulated plastic foam.

The servo motors are controlled by intelligent digital drives. Each drive provides all the gain and damping for the motor to ensure that the paddle accurately follows the position demand signal. While the wavemaker is running, the drives can be interrogated and a variety of parameters can be monitored such as the motor speed, current and drive temperature.

Control System

Due to the mobility of the piston wavemaker modules, a motor drive cabinet is mounted on the framework. This houses all the motor drives and associated controls. For deep water hinge wavemakers the Motor Drive Control Panels (MDCP) are located outside the tank, to the rear of the modules. Allowance for the routing of cables should be considered during the design stages.

HR Wallingford's multi-element wavemakers run with HR Merlin signal generation software – see the brochure Long & short crested sea generation for physical models (EQ-010).

The output from the signal generation computer is transferred to an embedded PLC, which is located in the MDCP. For installations where the control room is some distance from the wavemaker we provide a remote control unit to provide an emergency stop button for the operator. There is a second emergency stop button mounted on to the MDCP.

Dynamic Wave Absorption

In some studies, there can be considerable reflection from the model being tested. However, dynamic wave absorption overcomes this problem and provides precise control of wave conditions throughout the model. Without Dynamic Wave Absorption, these reflected waves can be re-reflected from the paddle and build up in the basin. This result is the wave spectra become distorted and, in the extreme case, the waves become unstable. Dynamic wave absorption prevents waves being reflected back from the paddle by measuring the wave height at the paddle. It then modifies the demand signal in real time to take account of the additional waves that have been reflected from the model in the basin.

Design life

The motors, drives and bearing assemblies of the wavemaker are standard components in a wide range of industries where they often run continuously. In comparison, wavemakers tend to be used for only a few hours a day and there are often long periods between studies while models are built and bathymetry constructed.

Studies usually use random waves which impose less wear on the components than the peak demands of the regular waves that they have been designed for. For these reasons, a wavemaker can be expected to have a life well in excess of 20 years.

Equipment for physical modelling

Using experience gained over the last 60 years, scientists and engineers at HR Wallingford have developed a range of state of the art physical modelling technology. From wave generating systems which simulate sea conditions to providing instrumentation and software to gather and analyse results, our comprehensive range of products is in use in laboratories around the world.

We make our technology and expertise available to other model users. And because all designs have been rigorously proven on our own research and commercial consultancy projects, you can be confident that they satisfy the most stringent requirements.

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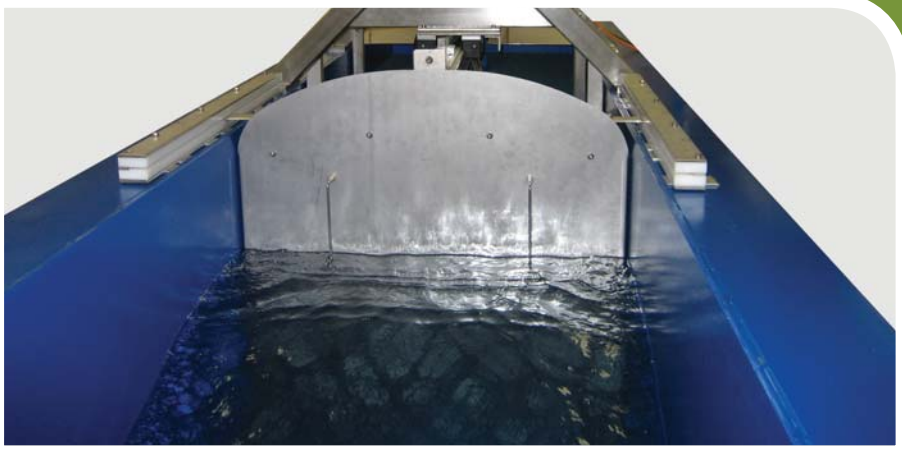
Flume wavemakers



As one of the world's leading hydraulics laboratories, HR Wallingford has more than 50 years experience in all aspects of physical modelling and has supplied wavemakers to laboratories around the world.

Each wavemaker is custom-built to the client's requirements and is equipped with HR Wallingford's Dynamic Wave Absorption System.

Installation is quick and straightforward with HR Wallingford providing commissioning, training and on-going support.

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Key features

- Generates long-crested random waves using HR Merlin signal generation software
- Dynamic Wave Absorption guarantees precise control of wave conditions
- Wet-backed piston paddle provides long stroke
- Stainless steel and GRP construction delivers a design life in excess of 20 years
- Digital AC servo motor provides precise control and rapid response
- Easy to maintain with all bearings and precision components above water
- Hinged flap wavemakers are available for deep water and hydraulically powered wavemakers are available for very large flumes

Flume wavemakers

When using physical models to test the design of coastal structures or to investigate wave processes, engineers must be able to work with a wide range of realistic wave conditions.

HR Wallingford has extensive experience in designing and building wave generating systems that realistically simulate sea conditions. We have supplied wavemakers to many laboratories around the world and they have been in use on our own models at Wallingford for many years.

Flume wavemakers are normally driven by AC electric servo motors. Very large wavemakers are hydraulically powered.

Flume wavemakers are based on a wet-back design for simplicity and ease of maintenance. All flume wavemakers have dynamic wave absorption fitted as standard

Electrically powered wavemakers

Piston type wavemakers

For water depths up to 1.5m the wavemaker is a piston type where the paddle moves backwards and forwards horizontally. The advantage of this type of design is that the stroke is not limited, making the piston wavemaker ideal for producing solitary waves, absorbing reflected waves and compensating for long period set down phenomena.

Depending upon the width of the flume, the paddle is mounted underneath either one or two electric drive actuators. These actuators are suspended from a structure that spans the flume walls. Alternatively the structure can be free-standing if required. With this arrangement all the bearings and precision components are situated well above the water level.

Each drive actuator comprises a specially designed extruded beam which runs between a series of

linear bearings. This beam is driven backwards and forwards by digital AC servo motor that operates through a gearbox with rack and pinion. The motor has a low inertia which is necessary for high frequency operation and the rack and pinion allows the high velocity to be achieved which would not be possible with other types of drive.

The gearbox has an eccentric mounting to allow the rack and pinion to mesh with negligible backlash. The rack and pinion method of driving the paddle is simple and does not require a sealed lubrication system. All that is required is an occasional wipe down and re-grease to maintain it in good condition. The result is a reliable wavemaker with low maintenance requirements.

Stainless steel is used for all the metal work of the wavemaker. The rack is also made of stainless steel and the bearings and bearing slides have a special corrosion resistant coating.

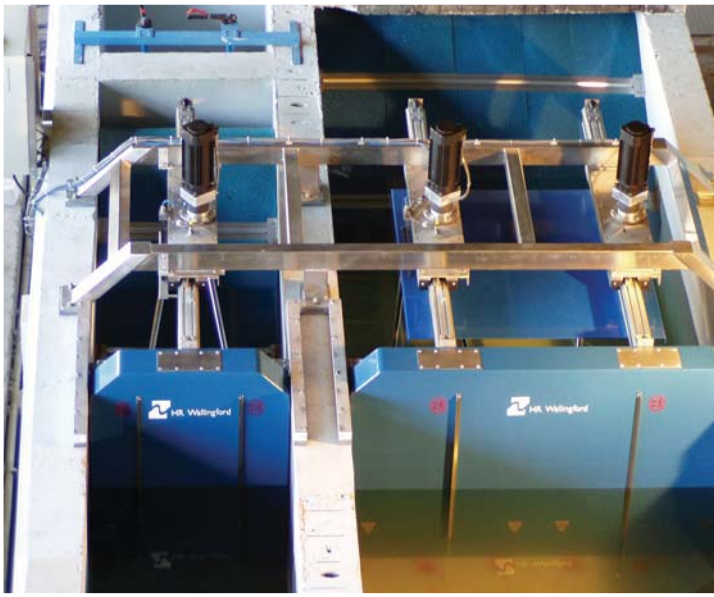
An absorbing beach is fitted behind the paddle to prevent splashing. The beach consists of an open cell foam material which is held in place within the framework of the wave maker.

The AC servo motor is controlled by an intelligent digital drive. The drive provides all the gain and damping for the motor to ensure that the paddle accurately follows the position demand signal. While the wavemaker is running, the drive can be interrogated and a variety of parameters can be monitored such as the motor speed, current and drive temperature.

Control system

The motor drive and electronics for the paddle are housed in a Motor Drive Control Panel (MDCP) that is mounted beside the flume.

The output from the signal generation computer is transferred to an embedded PLC, which is located in the MDCP. For installations where the control room is some distance from the wavemaker we provide a remote control unit to provide an emergency stop button for the operator. There is a second emergency stop button mounted on to the MDCP.



Design life

The motor, drive and bearing assembly of the wavemaker are standard components in a wide range of industries where they often run continuously. In comparison, wavemakers tend to be used for only a few hours a day and there are often long periods between studies while models are built and bathymetry constructed.

Studies also usually use random waves which impose less wear on the components than the peak demands of the regular waves that they have been designed for. For these reasons a wavemaker can be expected to have a life well in excess of 20 years.

Dynamic wave absorption

In many studies, there can be considerable reflection from the model being tested.

However dynamic wave absorption overcomes this problem and provides precise control of wave conditions throughout the model.

Without dynamic wave absorption, these reflected waves will be re-reflected from the paddle and build up in the flume. This results in the wave spectra becoming distorted and, in the extreme case, the waves becoming unstable

Dynamic wave absorption prevents waves being reflected back from the paddle by measuring the wave height at the paddle. It then modifies the demand signal in real time to take account of the additional waves that have been reflected from the model at the other end of the flume.

Hydraulically powered wavemakers

Hydraulically powered wavemakers are usually of the piston type. The largest wavemaker supplied by HR Wallingford to date was hydraulically powered and was for a flume 5m deep and 3m wide.

Hinge flap wavemakers

This type of wavemaker is best suited to deeper water applications and is often used for ship towing tanks.

The wavemaker comprises a paddle that is hinged either on the bottom of the flume or on a raised supporting structure. The movement of the paddle is limited to approximately ±15 degrees to prevent wave distortion.

The control system for the hinged flap wavemaker is the same as that for the piston type.

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HR Wallingford is an independent engineering and environmental hydraulics organisation. We deliver practical solutions to the complex water-related challenges faced by our international clients. A dynamic research programme underpins all that we do and keeps us at the leading edge. Our unique mix of know-how, assets and facilities includes state of the art physical modelling laboratories, a full range of numerical modelling tools and, above all, enthusiastic people with world-renowned skills and expertise.