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Self-regulating tidegate design facilitates habitat creation: Interim report

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Flood and Coastal Erosion Risk Management Research and Development Programme

Self-regulating tidegate design facilitates habitat creation

Coastal and wetland habitats are being lost at an increasing rate. Historic losses to development and reclamation are now compounded by losses to coastal squeeze as sea levels rise against existing hard defences. A new design of tidegate from the Environment Agency will help to facilitate restoration.

Background

As part of its flood risk management activities the Environment Agency's has challenging targets to create 200 ha/year of new BAP habitat, with at least 100 ha being inter-tidal habitats like saltmarsh and mudflat.

Much attention has been focussed on high profile managed realignment projects like Alkborough on the Humber and Wallasea in Essex. Large sites like this are not easy to find and require huge investment in time and funding. It may not be possible to meet the targets through managed realignment alone and regulated tidal exchange (RTE) is an alternative.

RTE allows water to enter areas behind existing defences, while retaining close control over the extent of inundation. It has been extensively used elsewhere, in particular in the USA, but there are still few sites in the UK.

RTE in practice

The RSPB and Environment Agency have worked in partnership at Goosemoor, near Exeter in Devon. This highly successful project demonstrates how RTE can be used to create saltmarsh, saline lagoon and mudflat. It relies on a self-regulating tidegate (SRT) to control the flow of water through a culvert in the existing embankment around the site.

Figure 1: Goosemoor before and after works

A monitoring programme has shown how the site is developing. Accretion rates, salinity, species and habitats are all reported annually.

Self-regulating tidegates

SRT designs available to date have been of overseas origin, with little or no technical or other support available in the UK. There are also associated shipping costs and carbon footprint implications.

Figure 2: American design of floating flap SRT

The Environment Agency recognised the value of the technique and felt it was possible to improve on the design and have it produced locally, with a greater level of technical support. Funding was provided through the Agency's flood risk science research programme.

The objective of the project was to develop a generic design for a structure which will permit and control tidal flows through flood defences and allow controlled inundation of currently defended land. The design should allow the creation of inter-tidal habitats behind existing flood defences whilst maintaining a specified level of protection. A further objective was to construct a prototype device in a suitable location.

Design criteria were that the structure:

- can be safely operated and maintained
- is fail-safe
- can be applied to existing outfalls
- can be produced at reasonable cost by UK manufacturers
- can operate automatically without the need for any power source or telemetry
- requires a minimum of attendance and maintenance

- is applicable to a range of tidal and fluvial locations
- will facilitate fish passage
- does not have an adverse effect on ecology or sediment transfer

Design details

Several potential solutions were discussed and dismissed before a suitable solution was agreed.

The new design essentially consists of a flat plate, which rotates across the face of the culvert. An aperture in the plate is caused to align with the culvert by a float attached to the plate, but at a pre-determined level the culvert opening is covered by the plate, thus preventing unacceptable water levels behind the defences.

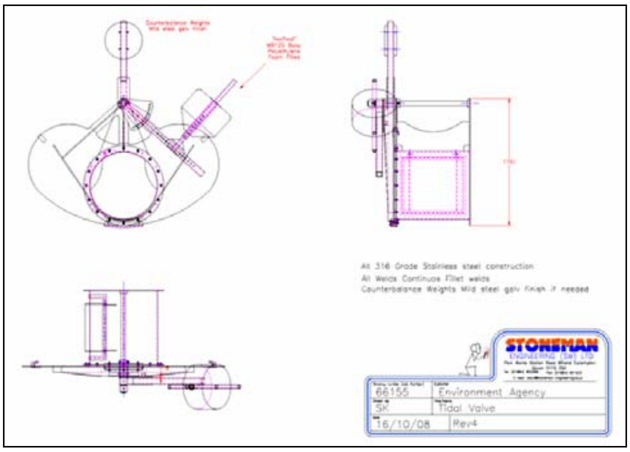

Figure 3: Front and side elevations and plan view of new SRT design.

The design is highly adjustable and adaptable to a wide range of situations. There are two main variants, with the major difference being the shape of the rotating plate.

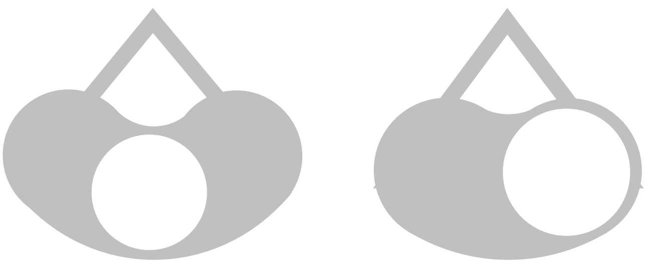

Figure 4: Stop-go-stop (left) and go-stop variants of self-regulating tidegates

The key difference is that in the stop-go-stop variant the gate is closed at low water levels, whereas the go-stop version is open until it closes at high water level. The operating sequence of the stop-go-stop variant is shown in Fig. 5.

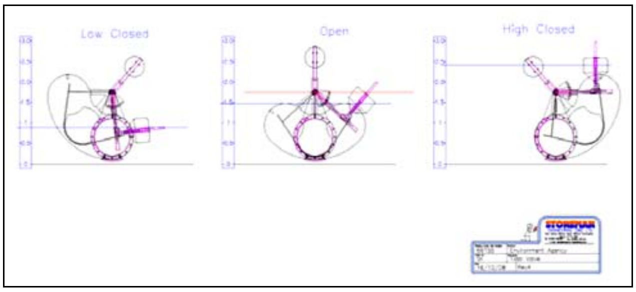

Figure 5: Operating sequence of SRT

There are three main adjustments included: the float arm (on which the floats are mounted) can be moved along the radial arm, altering the point at which the gate begins to rotate; the floats can be moved up and down the float arm, altering the point at which the gate closes at high water; and the radial arm can be rotated on the quadrant, which changes the period of opening in relation to the tidal cycle.

The gate is fabricated from 8mm 316 stainless steel, with the parts laser cut. The prototype is 900mm diameter, but it should be possible to use the design for a range of opening sizes between 300mm and 1200mm diameter. A flap valve is fitted to the side of the tube to allow water to discharge from behind at low tide when the gate is closed.

The whole assembly weighs around 550kg and includes its own gantry to facilitate the installation of the various parts. Opening rotation operates due to three floats, each providing 40kg of buoyancy. Closing takes place with the help of two 60kg counterweights plus an adjustable amount of water in a float.

The rotary SRT was designed, fabricated and installed by Stoneman Engineering from Willand in Devon. The Environment Agency has applied to patent the design to keep some control over its manufacture. However, it should be possible for it to be produced locally by any suitably experienced fabricator. A ‘how to do it’ guide is being produced as part of the R&D project.

Installation and operating trials

The prototype was installed at Black Hole Marsh, near Seaton in East Devon, in January 2009 through a partnership project with the local authority. Here, the SRT is being used to create a saline lagoon as part of the East Devon District Council's Axe Estuary Wetlands Project.

Figure 6a and b: Black Hole Marsh before and after the creation of the lagoon.

The gate uses the stop-go-stop variant which is closed at low tide to prevent ingress of freshwater; opens at mid-tide when the saline wedge underlying the fresh water has reached the gate; and then closes again to prevent levels overtopping the internal embankments. Water in the lagoon with salinity levels around half that of seawater indicates the success of the technique.

The tidal range at the site is approximately 3 metres and the SRT has simply replaced the original rubber flap, bolting on to existing fittings with the use of an adaptor plate.

Figure 7: Installation of prototype nearly complete. Note hoist on gantry to assist with assembly.

The gate has operated well so far, with no maintenance required and little adjustment once the correct settings were achieved. During the summer there has been some growth of algae on parts of the gate, but the rotation of the gate has kept the bearing face clear, where it slides across the polyethylene seal. Debris blockages have not been a problem.

Figure 8: SRT in operation (August 2009). Note algal growth at lower levels.

A device has now been fitted to the counterweight that allows us to monitor the rotation of the gate. This information, when used in combination with tide gauge and lagoon loggers, gives a good understanding of the operation over a range of tidal conditions.

Plans are underway to install a go-stop SRT on the Hampshire coast, where it will be used to create saltmarsh and allow migratory fish passage. The gate is also being considered for replacement of traditional flapped outfalls to open up parts of catchments that are currently inaccessible to fish, without increasing flood risk.

A 1/6th scale model has been produced, to which both gate types can be fitted. This model has proved very useful to demonstrate how the gate works and can be made available for inspection by potential users. Visits to Black Hole Marsh can normally also be arranged.

Further information

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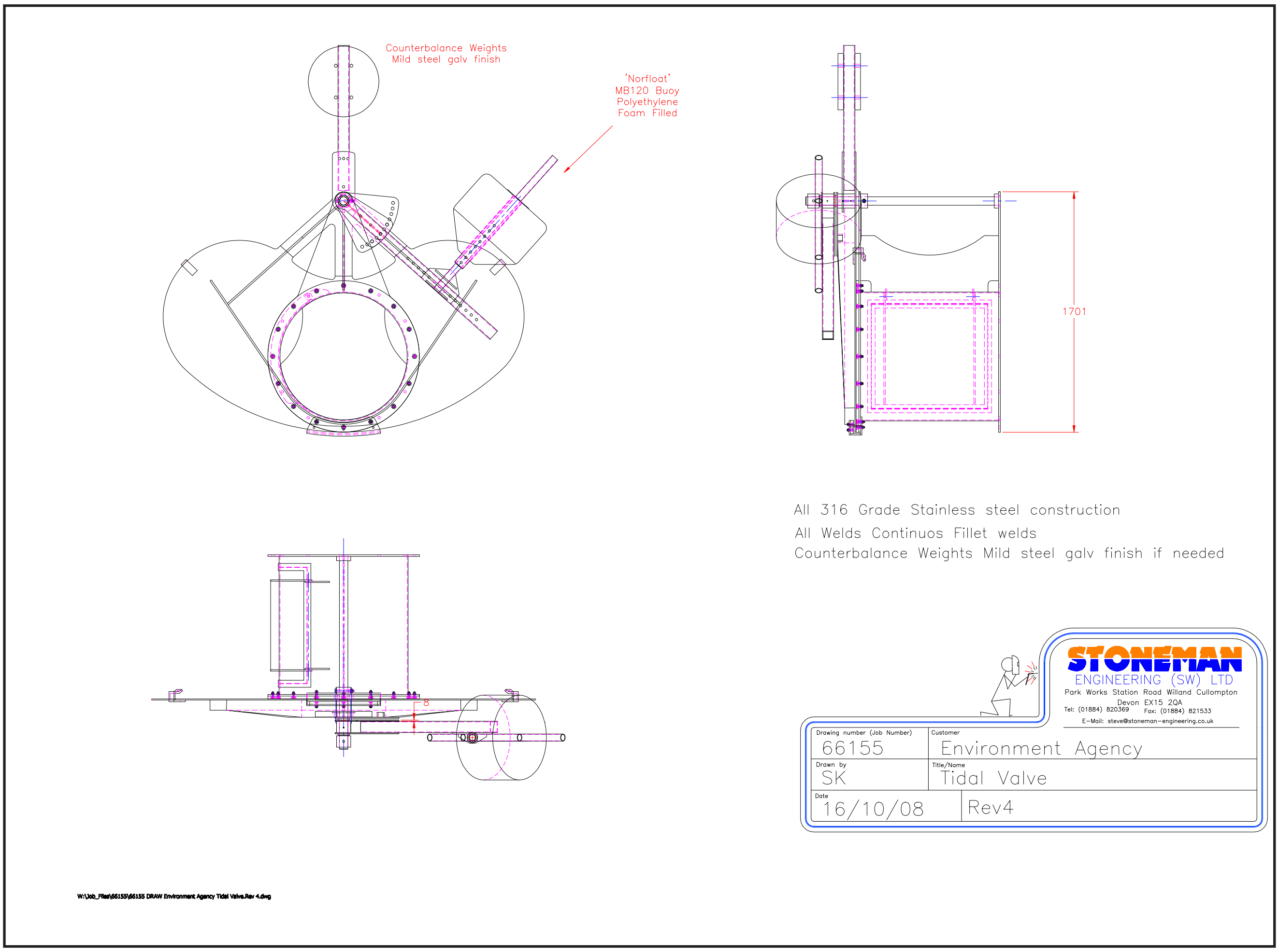
Appendix 1

Front and side elevations and plan view of new SRT design.



Operating sequence of SRT