WEEG NEWSLETTER September 2019

The newsletter is published monthly by the University of Southampton's Water and Environmental Engineering Group WEEG, and reports things of interest in this field worldwide, as well as ongoing undergraduate student and research work in WEEG itself.

We believe that water and energy are the most important topics worldwide for the next decades. Our work covers river and coastal engineering, water and wastewater and energy related to water.

Editorial: When thinking of irrigation canals, we are most likely to think of slow-flowing, trapezoidal channels in flat farmland. This is not necessarily true, however – in fact there are sections of irrigation canals that show some rather extreme hydraulics. These are mostly overlooked, probably because people think that irrigation canals are... go to beginning of paragraph...

Hydraulic Engineering International: *Extreme hydraulics in irrigation canals*

In many irrigation systems, the water is brought from a source – river, reservoir or lake – to the fields. And although farmland is usually fairly flat, the area between source and fields may not be. This results in some serious hydraulic engineering, and related effects in the so-called conveyor canals. In many canals, drop structures are built to reduce the gradient and dissipate energy. Fig, 1 shows such a drop of around 15 m.

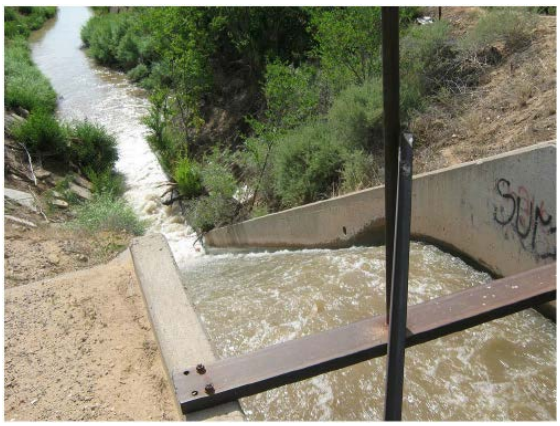

Fig. 1: Steep drop structure, H ≈ 15 m

In order to avoid such expensive structures, canals with supercritical flow are often employed. And here we mean SUPER critical, with Froude- numbers of 16 to a radical 20! Remember, the Froude number ***Fr*** is the ratio of the actual flow velocity v_0 and the shallow water wave velocity:

$$Fr = \frac{v_0}{\sqrt{g\,d}}$$

So, a water depth of 0.20 m with Fr = 20 means that we have a flow velocity of 28.3 m/s or 102 km/h, really quite fast. We will come back to that later. Another effect that occurs in high Froude number flows are so-called roll-waves, as shown in Fig. 2. Such waves develop in steep channels with shallow water depths. They are initiated by small disturbances and indicate an instability of the flow.

Fig. 2: Roll waves in supercritical flow

The effect is a pulsating flow, whereby the pulsation is irregular and difficult to predict.

Usually, when a channel goes into an energy dissipation pond, a hydraulic jump develops where much of the energy of the flow is dissipated. If the inflow is very fast, however, a 'wave' can exist as shown in Fig. 3. This is undesirable since the energy dissipation is far less than in a hydraulic jump, and since the walls of the pool are overtopped. So, what might be the reason for this? The literature is rather obscure on this point, calling it a surging wave but not mentioning anything about its cause.

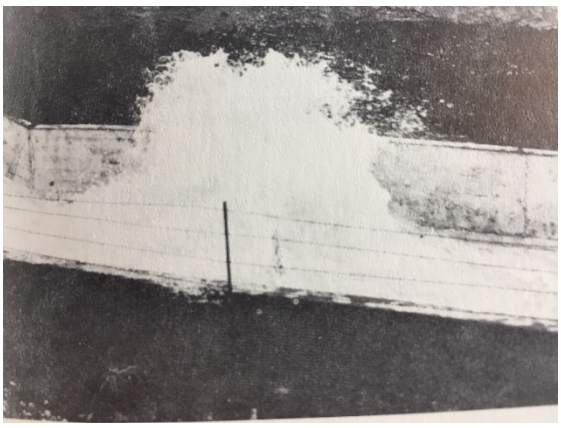

Fig. 3: Surge wave in stilling pool

The very fast flow is highly aerated. This reduces the speed of sound dramatically. For an aeration ratio of 30%, the speed of sound is only 21.8 m/s (i.e. less than the speed of sound in air, which is 300 m/s, or the speed of sound in water, at 1450 m/s). This means that with our high Froude numbers, we can possibly have supersonic flow in such channels. I like to think that what we are seeing in Fig. 3 is not a water wave, but a shock wave – the transition from supersonic to subsonic flow enforced by a change in gradient and increased flow resistance. Well, who would have thought that about irrigation canals?

Recent funding: *Small grant "Small, ultra-low head hydropower in irrigation canals"*

Together with the University of Engineering and Technology in Peshawar, Pakistan we just got a small grant of £5000 awarded from the British Council for the development of a hydropower converter for electricity generation in irrigation canals. Fig. 4 shows a typical drop structure, where we have around 1.5 kW of hydropower which nobody is using. A 4th year Group Design project will develop a solution for this situation – a waterwheel with the roller bearing we have developed here in Southampton - and build and test a 1:1.5 model. Once we are underway, we will also apply for funding to build the full scale thing on a structure like the one shown in Fig. 4.

Fig. 4: Typical drop structure in an irrigation canal in Peshawar

Contact: Dr G Muller, g.muller@soton.ac.uk

Recent 3rd Year Individual Project: *Development of a feasible resource recovery route for artisanal fishery by-products in Tumaco, Colombia*

The search for sustainable waste management is becoming increasingly significant for all countries. In this Year 3 individual project, the student investigated and compared the production of biofuel and bioenergy from a biochemical process using artisanal fishery by-products via technological, environmental and economic assessment. This was supported by a Newton Fund Institutional Links project, with Universidad Nacional de Colombia at Palmira.

Fishery by-products include skin, bones, flesh, shells and entrails. This constitutes 55% of the average weight of a finfish (Fig. 5).

Fig. 5 Illustration of the weight percentage of fish waste, by Julie-Nora Eldin

The production of biogas from anaerobic digestion appeared to be a viable recovery route for fishery by-products. This was chosen over animal feed and production of bulk chemicals as it provides the greatest value to communities in Tumaco, whilst bringing environmental benefits and investment returns. Co-digestion was found to be the best process, using fishery waste and locally available vegetable waste, as this prevented inhibitory effects on digestion. All biogas utilisation routes were viable and provided a reduction in emissions and costs. The most beneficial was using biogas for cooking which could provide 419 houses with fuel and reduce GHG emissions by 72% in comparison to LPG.

Jobs in water engineering:

This section gives you an idea of the type of work you can do when working in industry.

Advert: There are always opportunities to work overseas in this sector. Lots of jobs in New Zealand at present - see e.g.

Senior Wastewater Engineers

https://www.icerecruit.com/job/190113/senior-waste-water-engineer/

Civil and Environmental Engineering at Southampton University:

WEEG: the Civil and Environmental Engineering pathway offers the chance to deepen your knowledge in water-related areas, and gives you a better preparation for environmental engineering projects.

Contact: Dr Sonia Heaven, s.heaven@soton.ac.uk, Bldg. 7, Room 5004

Further information:

We have two Facebook pages, which provide a logbook of our laboratory activities:

www.facebook.com/Hydraulicslaboratory/

www.facebook.com/environmental.lab.university.of.southampton/

Brought to you by:

UNIVERSITY OF Southampton